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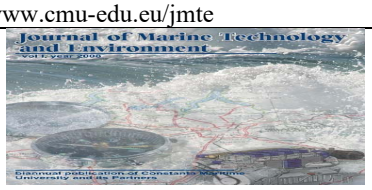

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A REVIEW OF THE USE OF ECDIS FOR THE SAFETY OF NAVIGATION

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Abstract: ***The use of electronic equipment for navigation is widely considered both necessary and useful. The introduction of electronic charts and ECDIS equipment has substantially reduced the officers' workload previously burdened by paper chart navigation. The amount of time previously spent for handling and correcting the paper charts during navigational watch gives the dimension of the effort required by the traditional paper navigation. The valuable time saved by the paperless navigation offers the deck officer the possibility to properly lookout, evaluate and assess the situation before making decisions. The advanced technologies offer multiple benefits, through sophisticated functions, used during navigation to greater or lesser extent. These functions are generally regarded as providing assistance for the safety of navigation and therefore their understanding is paramount. Several casualties related to ECDIS navigation have proved that the deck officers over-rely on the electronic equipment. In many cases, these officers failed to analyse and synthetize the information provided by the electronic equipment. This paper aims at advancing factual information relating to ECDIS navigational incidents and analysing their occurrence with regard to ECDIS implementation timetable. The main result of this review is the understanding of human resistance to change, in spite of common openness to using new technologies.***

Key words: ECDIS equipment, navigation incidents, ships, safety of navigation.

1. INTRODUCTION

Electronic Chart Display and Information System (ECDIS) is a complex navigation tool developed "to assist the mariner in route planning and route monitoring, and if required display additional navigation-related information if required", as specified in the Performance Standards for ECDIS [1].

The legal history of ECDIS starts in 1995 with resolution A.817(19) [2] of the International Maritime Organization (IMO), that allowed the use of ECDIS as bridge equipment on board conventional ships. The statement that marked the acceptance of ECDIS was: "can be accepted as complying with the up-to-date chart required by regulation V/20 of the 1974 SOLAS Convention".

Five years later, in November 2000, the Maritime Safety Committee (MSC) have accepted ECDIS "as meeting the chart carriage requirements of the regulation" [3], by revising Rule 19 of SOLAS Convention, Chapter V, with amendments which entered into force in 2002.

In July 2009, the IMO's MSC, adopted the carriage requirement, specifying that "all new and existing vessels must install ECDIS on board" and established the Implementation timeline, illustrated in the Figure 1.

The transition to ECDIS covers a six-year implementation period, July 2012 – July 2018. During this phase, according to the type of vessel and size, gross tonnage (GT), the ship-owners have to fit the ships with approved ECDIS equipment.

The mandatory implementation starts with fitting the newbuild passenger ships with more than 500GT and newbuild tankers with more than 3000GT in 2012 and is expected to end in 2018 with the existing cargo ships with GT between 10,000 and 20,000.

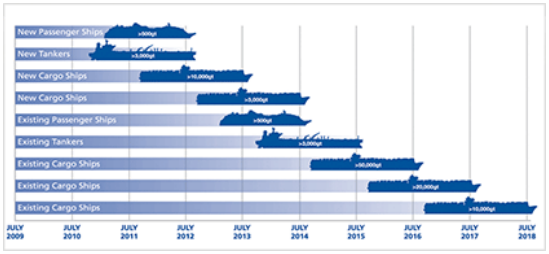

Figure1 ECDIS implementation timeline [4]

As the use of ECDIS software became mandatory on board ships, in excess of thirty different ECDIS manufacturers began the development of such a product.

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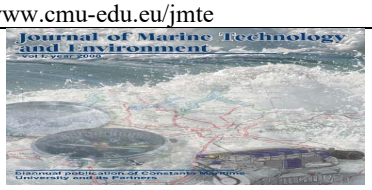

Because of the complexity of ECDIS and the considerable number of equipment manufacturers, IMO has set minimum Performance Standards, ensuring that the equipment developed provided the minimum functions required for the safety of navigation.

Being a modern electronic equipment, integrating almost all bridge tools with multiple functions available with one mouse click, it is likely for the navigators to over-rely on it. Therefore, the Manila Amendments to STCW, 2010 introduced the ECDIS mandatory training for deck officers and Masters. The IMO has established the type and the content of training necessary to be completed by users, the IMO Model course [5].

The use of advanced technologies in shipping is mainly directed towards optimization [6] and increasing efficiency. The following is a review of a series of navigational incidents and near misses related to the use of the ECDIS equipment.

2. ECDIS CASUALTIES

Marine accidents are investigated for several reasons such as providing factual information, establishing liability for insurance purposes, or consolidating the regulatory framework. The investigations of the incidents presented in this section were conducted by different expert offices, the Marine Accident Investigation Branch MAIB (UK), the National Transportation Safety Board (US) and the Federal Bureau of Maritime Casualty Investigation (US).

Factual information are presented below in the scope of analysing the span of the incidents' causes and evaluating the extent to which the actual ECDIS training meets its purpose.

2.1. COSCO BUSAN

On the 7th of November 2007, the containership COSCO BUSAN allided with the fenders situated at the base of the Delta tower of the San Francisco–Oakland Bay Bridge. Figure 2 presents the approximate intended course of the COSCO BUSAN highlighted by the black dotted line.

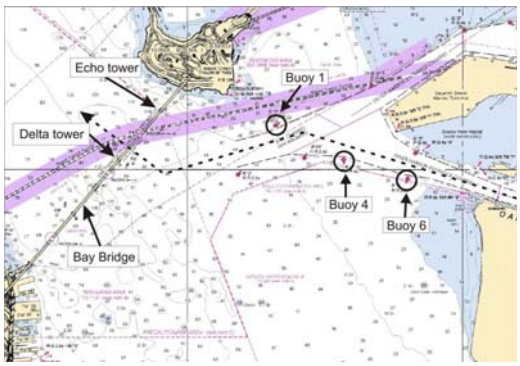

Figure 2 Navigation chart of the accident area [7]

The NTSB stated in their investigation report [7], that the probable cause of the allision was "*the failure to safely navigate the vessel in restricted visibility as a result of (1) the pilot's degraded cognitive performance from his use of impairing prescription medication, (2) the absence of a comprehensive pre-departure master/pilot exchange and a lack of effective communication between the pilot and the master during the accident voyage, and (3) the master's ineffective oversight of the pilot's performance and the vessel's progress*".

Regarding the use of electronic equipment, it is important to mention that the vessel was using vector charts CM-93. Neither the pilot nor the master was familiar with the chart symbols, as resulted from the post-accident interviews and the discussions recorded by the VDR. Even if the electronic chart system was not an approved ECDIS, the symbols used for the conical buoys were similar to those accepted by the International Hydrographic Organization [8]. These symbols and their characteristics are presented in Figure 3.

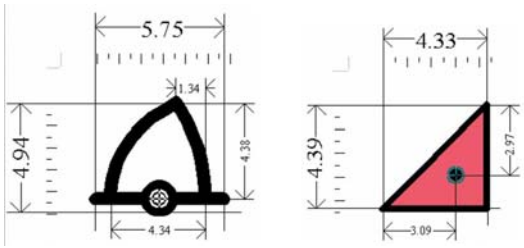

Figure 3 IHO symbol used to represent conical buoys on paper charts (left) and electronic charts (right) [8].

2.2. LT CORTESIA

On the 2nd of January 2008, the container ship LT CORTESIA ran aground on the Varne Bank sandbank in the English Channel, during navigation from the Thames Port to the Suez Canal [9], as presented in Figure 4.

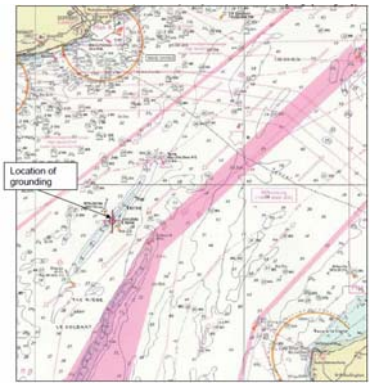

Figure 4 Navigation chart of the accident area [9]

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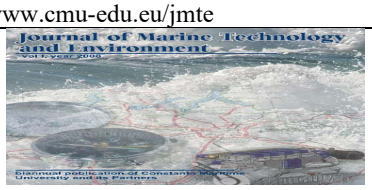

The investigation report concluded that the deck officer failed to assess the navigational situation and also identified that the ECDIS safety parameters were incorrectly set. Figure 5 presents the ECDIS "night" display and the extent to which the brightness can affect the visibility: the buoy symbols were hardly visible and the contrast between areas adjacent to the Shallow contour was low.

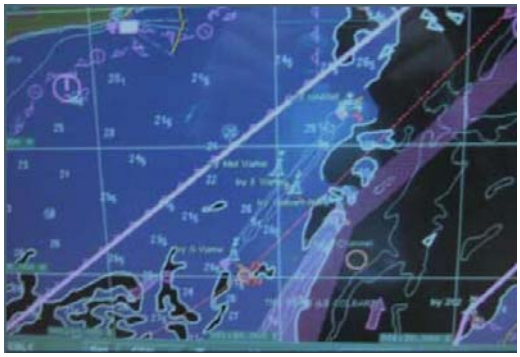

Figure 5 Night display type

According to the investigation report [9] "*If the chief officer had selected a better night display or had chosen a 2 color-display in conjunction with a better setting of the Safety Contour, he would have – even in the night – noticed the absolutely non-navigable critical depth representation of the Varne Bank*", then this type of accidents could have been avoided.

2.3. CFL PERFORMER

On the 12th of May 2008, CFL PERFORMER grounded on Haisborough Sand off the east coast of UK, North Sea area [10] as presented in Figure 6.

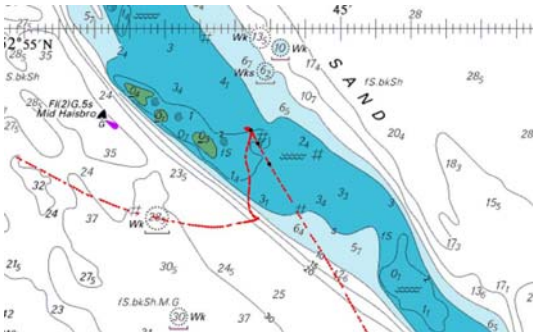

Figure 6 Vessel's track over Haisborough Sand [10]

Besides the fact that not all the deck officers had been trained in the use of ECDIS, from the MAIB investigation report [10] resulted that "*the route plan took the vessel across Haisborough Sand, and the in-built safeguards in the vessel's ECDIS which are intended to prevent accidents of this nature were not utilised and the system warnings were not acted upon*".

The vessel's original passage plan, black line and the revised planned routes recorded by AIS, red line, are presented in Figure 7.

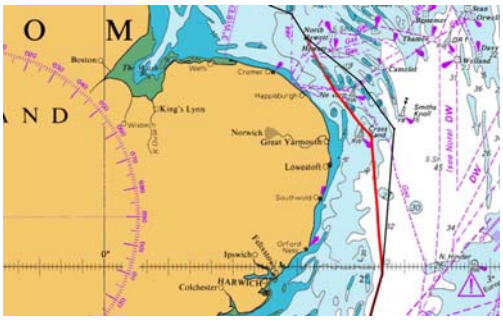

Figure 7 The original and revised planned routes [10]

2.3. CSL THAMES

On the 9th of August 2011, the bulk carrier CSL THAMES, grounded in the Sound of Mull while on passage from Glensanda to Wilhelmshaven, as presented in Figure 8.

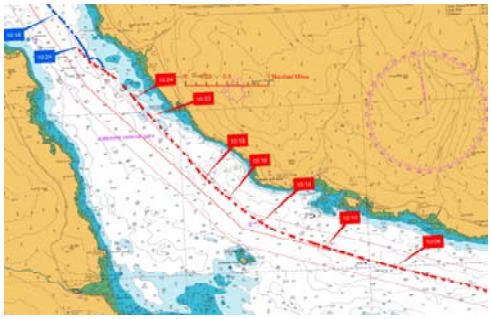

Figure 8 AIS tracks of CSL THAMES (red line) and the sailing vessel (blue line) [11]

From the MAIB investigation report resulted that the intention of the THAMES's officer was to alter the course to the starboard of the planned route in order to avoid collision with another vessel.

If properly used, the ECDIS should have alerted him that the vessel will navigate into shallow water. The investigation report reveals that "*A safety contour setting of 10 metres was inappropriate for CSL THAMES's draught of 10.63 metres. Taking into account the height of tide of 1.4 metres and an estimated squat of 0.9 metre, the vessel would have grounded at a charted depth of 10.13 metres, before crossing the safety contour*" [11].

2.4. OVIT

On the 18th of September 2013, the chemical tanker OVIT ran aground on the Varne Bank, Dover Strait

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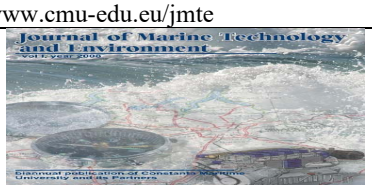

during its voyage from Rotterdam Netherlands, to Brindisi, Italy, as illustrated in Figure 9.

Figure 9 Detail of Dover Strait passage plan [12]

The MAIB investigation report [12], established that "*The passage was planned by an inexperienced and unsupervised junior officer. The plan was not checked by the master before departure or by the officer of the watch at the start of his watch*". Figure 10 presents the ECDIS display with the planned route passing directly over the Varne Bank.

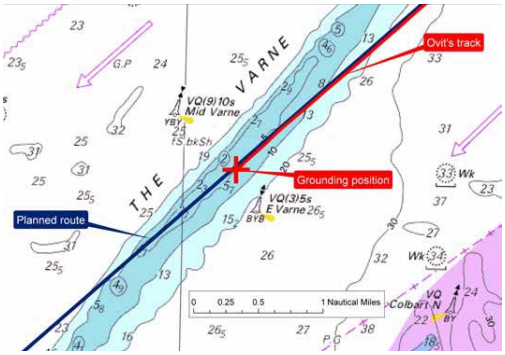

Figure 10 Area of grounding [12]

3. CAUSES OF THE ACCIDENTS

The analysis of the causes of ECDIS related incidents reveals a major influence of the human element. The failures of the team bridge in setting the ECDIS according to the intended voyage and the improper use of additional capabilities of ECDIS has conducted to several accidents. Such failures are: improper use of safety parameters, inadequate selection of the display mode, improper voyage planning or not using the route check facility.

The degree of novelty of the above mentioned functions may be low. Generally, deck officers appear to know common functions such as setting the safety parameters, the purpose of the safety contour or the use of Radar/AIS overlay. But do they know how to establish values of such parameters properly, how to interpret the messages through which ECDIS communicates or the limitations of ECDIS? The analysis of the causes of accidents indicates the improper use of ECDIS. This is likely to be the result of an overreliance on the electronic system, without proper setting of voyage parameters.

4. CONCLUSIONS

The inadequate use of the ECDIS equipment can cause serious accidents. The software failure does not seem to be the main cause of incidents while the human error does. Therefore, the solution for avoiding the occurrence of accidents is in the navigators' hands. Analysing the evolution of causes suggests that the mandatory training period is too short for understanding the system and their functionalities. The use of ECDIS functions which was cause of most accidents may have been included in the training curricula and taught during ECDIS courses. However, there is doubt regarding trainees' understanding of the operation and the importance of the ECDIS functions.

The results of this review highlight the need of a thorough training, even extending the training period, consolidated and confirmed by a more comprehensive assessment of navigators' skills and competencies.

5. REFERENCES

[1] MSC.232(82), Adoption of the Revised Performance Standards for ECDIS, 2006.
[2] IMO Resolution A.817(19), ECDIS Performance Standards, 1995.
[3] IMO's MSC, 73rd session, Proposed amendments to SOLAS, 2000.
[4] IMO, Circ. letter 2916, SOLAS Amendments 2008.
[5] IMO, ECDIS, Model course 1.27, 2012.
[6] Neumann T., *Method of choosing a better route in shipping*, Journal of Marine technology and Environment, Vol 2, 2015.
[7] National Transportation Safety Board. Allision of M/V COSCO BUSAN with the Delta Tower of the San Francisco–Oakland Bay Bridge, 2009.
[8] IHO, Presentation Library for ECDIS, Publication S-52, 2008.
[9] Federal Bureau of Maritime Casualty Investigation, Investigation report of Grounding of the LT CORTESIA on the Varne Bank in the English Channel, 2009.
[10] MAIB, Report on the investigation of the grounding of CFL PERFORMER, 2008.
[11] MAIB, Report on the investigation of the grounding of CSL THAMES, 2012.
[12] MAIB, Report on the investigation of the grounding of OVIT, 2013.

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IMPLEMENTATION OF A NEW INTEGRATED MUNICIPAL WASTE SYSTEM IN CONSTANTA COUNTY

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***Abstract:** EU waste policy has evolved over the last 30 years through a series of environmental action plans and a framework of legislation that aims to reduce negative environmental and health impacts and create an energy and resource-efficient economy. The EU's Sixth Environment Action Programme (2002- 2012) identified waste prevention and management as one of four top priorities. In this paper we will present the implementation of a new integrated municipal waste system in Constanta county. An important feature of the Constanta county, with implications for integrated waste management is represented by the high degree of urbanization: 70% of the county population lives in urban areas, of which over 70% in towns located in the Black Sea area. The overall objective of the system of waste Constanta is developing an integrated, sustainable waste management, by improving waste management based on adequate infrastructure, reducing the number of contaminated sites in the county, mainly aimed at respecting the acquis communautaire of environment and having the effect to grow living environmental and standards in Constanta County.*

***Key words:** waste, management, county, Constanta.*

1. INTRODUCTION

EU waste policy has evolved over the last 30 years through a series of environmental action plans and a framework of legislation that aims to reduce negative environmental and health impacts and create an energy and resource-efficient economy. The EU's Sixth Environment Action Programme (2002- 2012) identified waste prevention and management as one of four top priorities. Its primary objective is to ensure that economic growth does not lead to more and more waste. This led to the development of a long-term strategy on waste. The 2005 Thematic Strategy on Waste Prevention and Recycling resulted in the revision of the Waste Framework Directive, the cornerstone of EU waste policy [1]. The revision brings a modernised approach to waste management, marking a shift away from thinking about waste as an unwanted burden to seeing it as a valued resource. The Directive focuses on waste prevention and puts in place new targets which will help the EU move towards its goal of becoming a recycling society. It includes targets for EU Member States to recycle 50% of their municipal waste and 70% of construction waste by 2020. The Directive introduces a five-step waste hierarchy where prevention is the best option, followed by re-use, recycling and other forms of recovery, with disposal such as landfill as the last resort. EU waste legislation aims to move waste management up the waste hierarchy. (Figure 1)

Figure 1 The Waste Herarhy [1]

It is notable that in several countries, municipalities are grouping together in intermunicipalities or waste

associations to approach waste management on a joint basis. It is important to recognise that the size of local authorities varies considerably across Europe. France has 35,000 communes whilst the UK, withroughly the same population, has around 400 local authorities. On average, thecommune would be one-hundredth the size of the average local authority. As such, the need to collaborate in larger units varies across countries.

It is also quite clear that private sector involvement differs across countries. At the European level, it can probably be said to be increasing, but there is no firm oneway trend in all countries.

It is quite clear that the way in which Member States implement Producer Responsibility legislation affects local authorities in different ways. In some countries, responsibility for the different fractions is given over completely to specific organisations (Austria, Belgium, Finland, France, Germany, Luxembourg and Sweden) so that the municipalities are not paying for this collection. In others (France, Ireland, Italy and Spain), the local authority receives a payment but this does not cover the total collection cost.

In other countries (Denmark, Greece, Netherlands and the UK), there is no direct funding of the collection of packaging fractions. In Denmark, however, all municipalities are required to instigate either kerbside or bring collections for paper and glass. The agreement between VNG (the association representing municipalities) and the AOO (the Waste Management Council of the Netherlands) requires local authorities in the Netherlands to seek to meet high rates of recycling for packaging. In the UK and Greece, however, there are no such compulsions, although in England, statutory recycling targets for each local authority have been established [1], [2].

The arguments concerning the relative merits of different approaches is somewhat complex, but the question of who actually collects the material and how is an important one. Where collection systems become fragmented (through introducing responsibilities upon specific actors for specific material), this can increase the costs of collection systems.

It is well known that our society is a society of growth and development. No doubt the primary objective of any country is a continous economic growth . But this requires adequate protection of the environment in order to ensure sustainable development of society. Among the many environmental problems that exist without doubt that waste is a major problem. The quantities of waste generated in an alert grow from year to year and the impact they have on the environment and therefore the community is increasingly higher.

Municipal waste management is a responsibility primarily for government authorities but also for the population.

2. STUDY AREA

Constanta county has a total area of 7071 km^2 and has a population of 723 831 inhabitants total. In terms of administrative, county includes 3 municipalities (Constanta - city district capital, Mangalia Medgidia), 9 cities (Baneasa, Cernavoda, Eforie, Harsova, Napa, Navodari, Black-Voda, Ovidiu Techirghiol) and 58 communes.

In the county of Constanta was established "Dobrogea Intercommunity Development Association", called ADI, registered on 02.02.2010, according to extract from the register of foundations and associations.

Constanta County Council - is a member of ADI and will participate with other members of the association, according to its state, implementation and operation of integrated waste management system in the county of Constanta.

According to the latest changes in the Law 101/2006 on the sanitation service of the localities, the County Council is the beneficiary of the project in that all goods purchased or produced by the project will enter the public domain of the County Council. County Council will be the main actor in the management and implementation of the investments necessary for integrated waste management system.

Of the total county population, 105 125 inhabitants of 9 villages (towns: Mangalia, Navodari municipalities 23 August, Albesti, Castelu, Cogealac, Costinesti Poarta Alba, Seimeni) are not served by the project, since they are not joined to the Association of Development Intercommunity (ADI) Dobrogea.

Waste management in cities that are not part of the ADI is done either by private operators (Uranus SA, Polaris, Iridex) or by local public services. They provide waste collection, transport and disposal of waste in existing landfills.

These authorities will be responsible for ensuring observance of the regulations on reducing the amount of stored waste, recycling and disposal in landfills.

Existing facilities that can serve non-ADI localities are: Ovidiu waste landfill, sorting plant and landfill Costinesti, landfill Albesti.

The total population of the project area is 619 980 inhabitants, of which 451 675 and 168 304 live in urban areas live in rural areas.

An important feature of the county, with implications for integrated waste management is represented by the high degree of urbanization: 70% of the county population lives in urban areas, of which over 70% in towns located in the Black Sea area.

The overall objective of the system of waste Constanta is developing an integrated, sustainable waste management (called SMID), by improving waste management based on adequate infrastructure, reducing the number of contaminated sites in the county, mainly

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aimed at respecting the acquis communautaire of environment and having the effect to grow living environmental and standards in Constanta County.

Regarding the specific objectives of the system, they have taken into account the following requirements:
• Compliance with legal commitments assumed by Romania's EU Accession Treaty [3]. Proposed investments will contribute to compliance with the requirements of this Treaty, in compliance with relevant Directives on waste management;
• Compliance with Environment legislation and other national targets, with regional and county waste management plans;
• Contribution proposed measures and investment plans to achieve the objectives of national, regional and county waste management;
• Defining an investment program, which aim to identify priority investments in order to comply with the most important deadlines required;
• Strategic development of integrated waste management system, including sorting, transport, storage and other treatment processes, closure and rehabilitation of existing non-compliant landfills;
• The efficiency of the proposed system, taking into account affordability and population services;
• Contributing to the improvement of environment and living conditions;
• Develop appropriate institutional framework for a services sanitation, as required by EU and national legislation.

3. WASTE COLLECTION

Current waste management system includes collection, transportation and final disposal services for waste collected both from the public and from traders.
In some rural areas, local authorities acting through their public waste systems that do not have permits and licences. The equipment used is old and worn, and the operations performed are simple.

Management of waste services could be achieved by:
• direct management of a service organization -By own operating integrated waste management system
• Delegated Administration - by organizing an award procedure under the law, by a licensed operator for each area of waste management and integrated waste management system.

Municipal waste is all waste generated in urban and rural areas,of households, institutions, commercial establishments and service providers (waste), street waste collected from public spaces, streets, parks, green spaces, construction and demolition waste.

Include both municipal waste generated and collected waste (mixed or separate) and uncollected waste generated.

Collection and transportation of municipal waste

At feasability study phase, in consultation with local beneficiaries of the waste management project resulted in the sharing of the county in 6 areas, namely: Area 1 and Area 2 are located in coastal area of the county and includes major cities, as shown below:

1) Area 1 - Constanta, represents the northern part of the coastal area, named after the capital of the county - Constanta.
Cities: The city of Constanta, Ovidiu cities and Murfatlar.Comune: Trajan's Ovidiu, M.Kogalniceanu, Garden, Fantanele, Targusor, Sacele, Istria, M. Viteazu, Corbu.

Area 1 is the total population of 384 284 inhabitants, accounting for nearly 60% of the total county population and 80% of urban population served by integrated waste management system.

Existing facilities for treating waste in the landfill include ecological Ovidiu, sorting plant with small capacity and small capacity decompost station in the village of Corbu and MM Recycling sorting plant in Constanta.

By implementing integrated waste management system, the existing infrastructure is completed with waste collection containers and the construction of new facilities and sorting and treatment of waste facilities :
• sorting station
• mechanical-biological treatment station in the town of Ovidiu.
Thus, the waste stream in Area 1 will be:
• Waste biodegradable waste - will be transported by mechanical-biological treatment plant Ovidiu;
• recyclable waste collected from households and economic agents will be sorted in existing stations in Corbu (waste generated in the county of Corbu), MM Recycling (waste generated in Constanta) and sorting plant which will be built in Ovidiu (waste generated in area 1);

2) Area 2 - Eforie represents the southern part of the coastal area, named after Eforie, a well-known Black Sea resort and also the main town in the area.
Cities: Eforie, Techirghiol, Negru Voda
Common: Agigea, Baraganu, Mereni, Pecineaga, Topraisar, Tuzla, Cumpana, Amzacea, Comana, Chirnogeni, Limanu

The total population of Area 2 is 72 555 inhabitants, representing almost 12% of the total county population and 4% of the urban population served by SMID.

Existing waste treatment facilities in the area are: ecological deposit from Costinesti new sorting plant built on the site of the landfill facility Costinesti and sorting station small capacity of Cumpăna.

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After the implementation of integrated waste management system, existing infrastructure is complemented by purchasing containers for selective collection of waste.

Thus, the waste stream in Area 2 will be:

• Waste sorting recyclables will be transported to the sorting plant on the site of the existing landfill ecological Costinesti, except Cumpana waste that will be sorted into the existing station in the village;

• Waste from street garbage cans street will enter the sorting stations also mentioned above and those from residual waste and street sweeping will be stored in the existing organic deposit in Costinesti.

Areas 3,4,5,6 are located in the central and western county of Constanta, as presented below:

3) Area 3 - Deleni represents southwestern corner of the county, named after Comuna Deleni.

Cities: Baneasa (5500 inhabitants)

Common: Deleni, Ostrov, Aliman, Lipnita, Oltina, Dobromir, Ion Corvin, Adamclisi, Independence, Dumbraveni

The total population of Area 3 is 32 402 inhabitants, representing nearly 5% of the total county population and 1.2% of the urban population served by the project.

Existing waste management facilities in the area were provided by PHARE project [3], which implemented a system of selective collection and transportation of waste.

By implementing the integrated waste management system, the existing infrastructure is complemented by the construction of a waste transfer stations in Deleni village.

Thus, the waste stream in the area 3 will be [4]:

• recyclable waste will be transported from station trasfer Deleni long-haul trucks through the sorting plant on landfill site Tortoman;

• Waste Waste & biodegradable and street waste will be transported from station trasfer Deleni by truck long-haul by the treatment plant mechanical-biological (MBT) from the site Tortoman for treatment and residues from the station TMB and waste biostabilised be stored on new warehouse built in Tortoman.

4) Area 4 - Cernavoda represents the Phare project "Implementation of integrated management of municipal waste", located in the western part of the county, named after the town of Cernavoda.

Cities: Cernavoda

Common: Saligny, Rasova, Silistea

Area 4 is the total population of 26.420 inhabitants, representing nearly 4% of the total county population and 5% of the urban population served by SMID.

Existing waste management facilities in the area were provided by Phare System selective collection and transportation of waste sorting station / transfer at Cernavoda [5].

After the implementation of SMID, Current infrastructure remains the same.

As a result, the waste stream in area 4 will be:

• recyclable waste - will be treated in the sorting station Cernavoda;

• Waste & biodegradable waste and street waste - will be transported to the station TMB Tortoman / treatment and residues from waste station and TMB biostabilised be stored on storage Tortoman.

5) Area 5 - Harsova represents the north-west of the county, named after the city Harsova.

Cities: Harsova (10 768 inhabitants)

Common: Ciobanu, Cross, Ghindaresti, Pantelimon, Topalu Garliciu, Horia, Saraiu, Vulturu

The total population in Area 5 is 28 524 inhabitants, representing nearly 5% of the total county population and 2.5% of the urban population served by SMID.

There are no existing waste management facilities in the area.

By implementing SMID, existing infrastructure will be filled with waste collection containers and the construction of a waste transfer stations in the city Harsova.

Thus, in the waste stream 5 will be:

• recyclable waste will be transported from the transfer station Harsova long-haul trucks through the sorting plant on landfill site Tortoman;

• Waste Waste & biodegradable and street waste will be transported from the transfer station Harsova by truck for long-haul to the station MBT on site deposit Tortoman and residues from the station TMB and waste biostabilised be stored on storage Tortoman.

6) Area 6 - Medgidia, is a central part of the county, named after Medgidia city.

Cities: Medgidia (45 567 inhabitants)

Common: Tortoman, Mircea Voda, N.Balcescu, Cobadin, Cuza Voda, Ciocarlia Cave

The total population is 74 521 inhabitants in Area 6, accounting for nearly 12% of the total county population and 10% of the urban population served by SMID.

Existing waste management facilities in the area were provided by Phare, which implemented a system of selective collection and transportation of waste.

After the implementation of SMID, existing infrastructure will be completed by the construction of a new landfill, a sorting plant and a mechanical-biological treatment plants[6] in the town Tortoman.

Thus, the waste stream in area 6 will be:

• recyclable waste will be transported to the sorting plant on landfill site Tortoman;

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• Waste & biodegradable waste and street waste will be transported to the mechanical-biological treatment plant and TMB station and residues from waste be stored on storage biostabilised Tortoman.

To reduce the amount of biodegradable waste deposited on deposits was provided consistent measure of purchasing individual composters for 50% of households in rural areas, all 6 areas.

The figure below shows Constanta county map (Figure 2) divided into 6 areas collection, and the next is SMID waste stream in Constanta county., the existing infrastructure is complemented by the construction of a waste transfer stations in Deleni village.

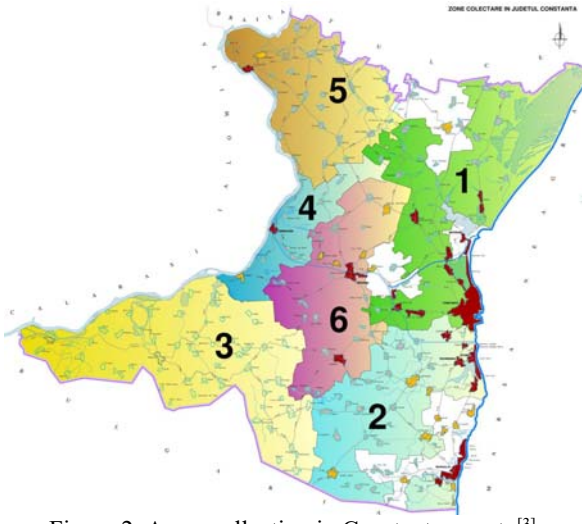

Figure 2 Areas collection in Constanta county[3]

4. CONCLUSIONS

The idea that waste management can be integrated as an element that promotes the welfare of life and improves the ecological conditions of urban settlements lies firstly in recognizing the endemic nature of the waste to be handled.

Secondly, ensuring effective waste collection coverage leads to the reduction of air, noise and soil pollution.

Thirdly, social approaches such as knowledge transfer have shown to be effective in encouraging sustainable household habits, which help improve recycling and the reduction of gas emission in landfills and waste dump sites. Lastly, creating enduring partnerships of collaboration between parties contributes to continuity in waste management practices and avoids palliative improvements. This leads to sustainability in the system humankind has established for living and the preservation of the environment in which it exists.

5. REFERENCES

[1] European Commission, Being wise with waste: the EU's approach to waste management, Luxembourg
[2] European Commission, Costs for Municipal Waste Management in the EU
[3] Consiliul Judetean Constanta, *Sistem de management integrat al deseurilor in judetul Constanta*, Master Plan revizuit, 2016 .
[4] Consiliul Judetean Constanta, *Sistem de management integrat al deseurilor in judetul Constanta, Studiu de Oportunitate pentru fundamentarea si stabilirea solutiilor optime de delegare a gestiunii serviciilor*, 2015
[5] www..recycledevon.org
[6] Panaitescu, I.I., Panaitescu, F.V., *Operational management with applicability on antifouling maritime ecological system,* Journal of marine Technology and Environment, ISSN 1844-6116, vol.1, pp.137-139, 2013, Editura Nautica, Constanta, 2013

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STUDIES CONCERNING THE STRUCTURAL RESPONSE OF THE SHIP DURING REFLOATING OPERATIONS BY HER OWN MEANS

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Abstract : The paper presents the results of a very thorough and prolonged activity. Even if results are succinctly presented, by graphics and diagrams, the volume of data behind them is a huge one, detailed in the paper's informations. In the first stage, starting from a very detailed body plan, the 3D model of the hull was conceived in CAD/CAE - Solidworks. The level of complexity of the model is a very high one, but this one was limited as well by the processing capacity of the calculus system used. In the second stage, the propeller's maximum force was determined when going astern, by a hydrodynamic analysis and then this force was applied as a percentage on the ship in seven different studies, using loads of 100%, 95%, 90%, 85%, 80%, 60% and 40%. In order to perform these studies the CAE ANSYS12.1 was used. In the end of these studies an interesting conclusion is reached from the scientific point of view finalized by a very useful recommendation for masters.

Key words: response, ship, refloating, model, propeller, force.

1. INTRODUCTION

During maritime transport it happens many times for ships to go aground. There are various causes for this combining usually human error with unfavourable meteorological conditions. In most cases, crews try and usually succeed to refloat the ship by her own means. The procedure is a relatively simple one consisting of moving weights from bow to stern if possible and putting the main engine astern in different rudder angles.

In this paper the results of analysis performed by the finite element method are presented when applied through the specialized software.

In order to determine the structural response of the hull's construction elements, first a study may be developed in order to create the refloating process conditions, using the hull's model on which pressures and structural loads generated by the respective situation are applied [1], [2].

2. METHODS AND RESEARCHES

The model adopted for performing this study is that of an oil tanker [3] with the following characteristics:

- Maximum length-333 m;
- Length between perpendiculars-320 m;
- Maximum width-60 m;
- Displacemnt-364018.9 metric tones;
- Draught when fully loaded-22,522 m'
- Height of the free board when fully loaded-4.65 m (Figure1).

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Figure 1 VLCC Ship, chosen for developing the geometrical model [4]

The execution of the hull had as a basis the ship's body plan [3], modelling first the plating and bridge parts after which rigidity element were added (Figure 2).

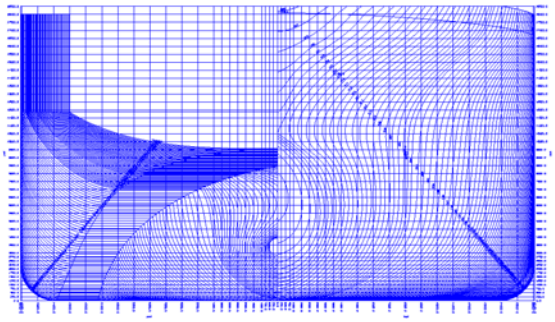

Figure 2 The basic Body plan for the mathematical model [2]

In order to simplify the modelling process, limited first of all by the available calculus power, from the 231 couplers, 40 theoretical couplers were used, and rigidity elements of the structure were also simplified. The model was executed with the CAD SolidWorks 2010 software (Figure 3, a, b, c, d, e).

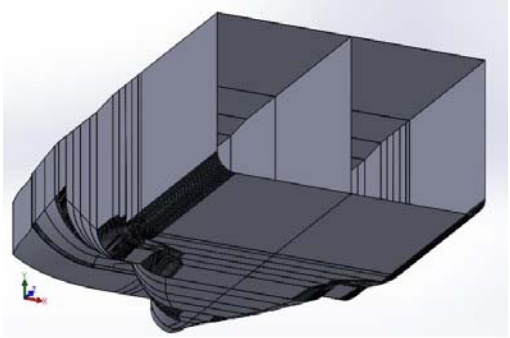

Figure 3 Execution stages for the three dimensional model. 3a. Stern section [2]

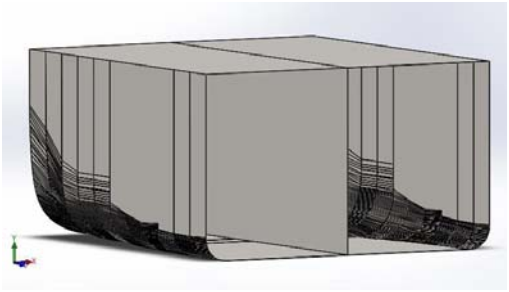

Figure 3 Execution stages for the three dimensional model. 3b. Cylindrical section [2]

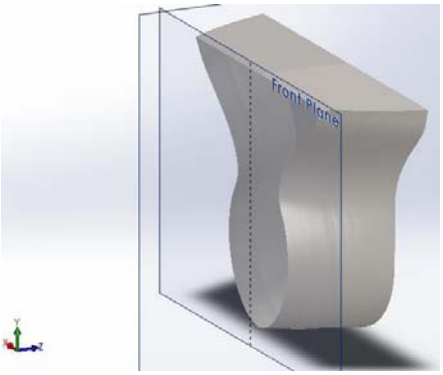

Figure 3 Execution stages for the three dimensional model.
3c. Forecastle section [2]

Figure 3 Execution stages for the three dimensional model.
3d. Bow section [2]

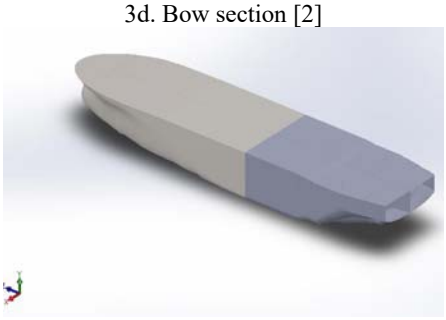

Figure 3 Execution stages for the three dimensional model.
3e. The ship's hull [2]

It was considered that the plating parts have a width between 10 and 13 mm, made of steel type AISI 1080, normalized at 900°C and cooled under air.

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2.1 Determination of loads applied to the model:

In order to establish the loads to be applied on the model, this is subjected first to a study CFD performed through CAD / CAE Ansys 12.1 – CFX.

In order to get as high an accuracy as possible, it was used the model on a 1:1 scale, applying a refinement of the digitized structure from the limit layer area (Van 1998). The model used for this study is the one developed for the structural analysis [2].

The simulation parameters were established, considering that during the refloating procedures the ship has not the maximum draught, setting therefore a 7m draught both at the bow and stern. Also, for the functioning conditions of the propelling installation when going astern, a maximum speed of 5 knots was considered, corresponding to the speed of 2.6 m/s. The calculus field is limited to 50m from the stern area and four time the maximum length, on the Oz axis, respectively four time the maximum width and height of the model on Ox and Oy axes (Figure 4).

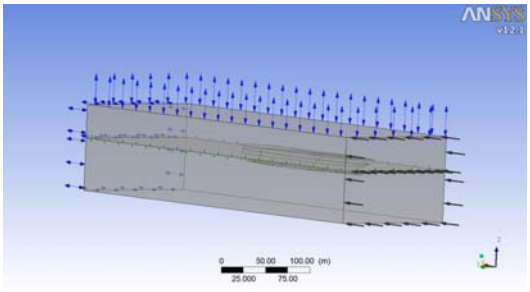

Figure 4 Determination of the calculus domain [2]

Following the digitization process 393208 knots and 1478147 elements resulted for the whole digitization structure of the model (Figure 5).

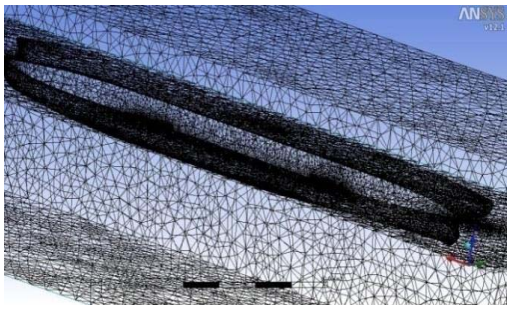

Figure 5 Digitized structure of the model and work domain [2]

In the next figures variations of the values of forces are graphically represented as well as pressures and speed at the flow around the immerse hull (Figure 6a,b,c,d).

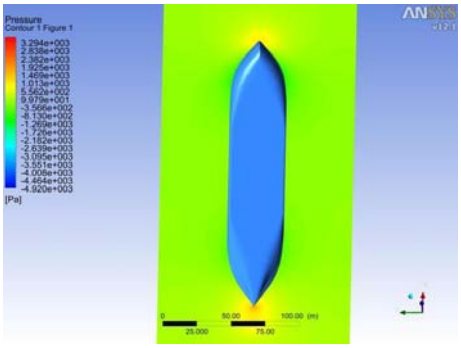

Figure 6a. Pressures' variation in the floating plan

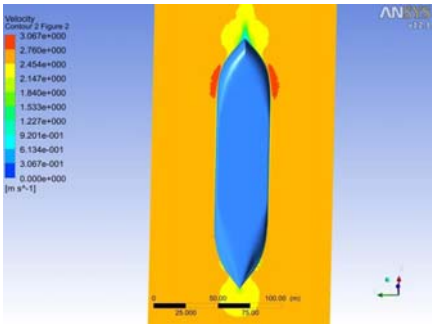

Figure 6b. Speeds' variation in the floating plan

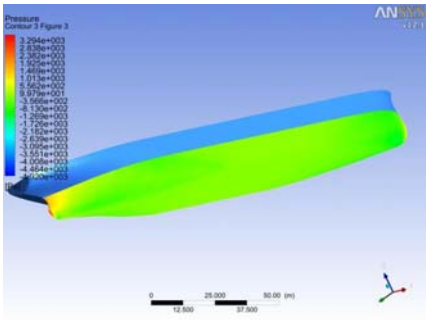

Figure 6c. Pressure's variation around the ship's hull

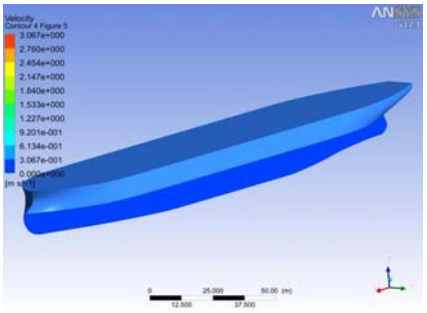

Figure 6d. Speed magnitude variation around the hull

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2.2 Results of the water flow study:

Following the study of the results, the conclusion is that in order to analyse the structure it should be kept in view a towing force of 219.86 kN, corresponding to an approximate load of 12% of the nominal power of the main engine when making headway (Figure 6a, b).

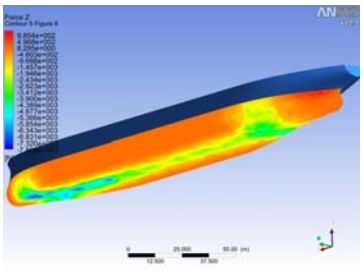

Figure 6 Results of the water flow study
6a. Force variation on Oz direction (floatability)

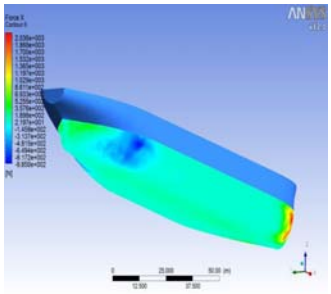

Figure 6 Results of the water flow study.
6b. Force variation on Oy direction (resistance when making headway)

This resultant force when going astern in the case of the free body ship, calm water case, is the force which needs to be added to the friction force resulted from the contact between the bottom bow – ground (light grounding), in order to determine the total towing force at the maximum speed of 5 knots, corresponding to an intermediary transitory stage of the displacement operations when refloating the ship (in the initial phase t=0 of the refloating operations the ship's speed is zero).

2.3 Structural analysis of the hull's response in the situation of refloating the ship by her own means:

It is well known the fact that in order to re-establish the manoeuvring capacity of the ship if she goes aground, there are two possible alternatives:

1. Refloating the ship by using the propulsion system onboard;
2. Refloating the ship by using tug boats – push boats.

In the first situation, when trying to refloat the ship by her own means, the purpose of such a structural analysis is to determine the ship's hull response to arising pressures and to establish the convenient maximum regarding the hull's pressures and the pushing/towing force of the main engine. The purpose is for this determination to be expressed also as a percentage of the available power of the main engine.

In order to reach such a desire, a structural static analysis is considered to be appropriate, considering the fact that registered peaks do not vary according to the simulation time. 3D-FEM (Ansys) model is developed for the supplementary pressures' analysis in the VLCC tanker's structure, in the initial grounding phase (displacement from the grounding location, zero speed of the ship) with the ship's own propulsion, in the case without water hole (light grounding), for the case of loading when damaged (7m draught).

The model presented in figure 3 was simplified, on one hand establishing a symmetry plan, defined by the ship's longitudinal plan, and on the other hand, the model includes the main platting for the ship's hull, with a very simplified idealization of the frame elements, without pressures from her own weight and hydrostatic push, considering as a reference the case of equilibrium ship – fluid – ground in the light grounding stage. Practically the extreme case is considered when in the initial phase of displacement, the friction force is very high (modelled through constraint), including 7 values in the study for the longitudinal towing force (generated by the ship's own propulsion system) starting with 100% of the pushing force and continuing with 95%, 90%, 85%, 80%, 60% and 40% of the pushing force.

In figure 7 the geometrical model used for the simulation is presented and in figure 8 is the geometrical model after applying the symmetry plan.

Figure 7 The complete geometrical model used for simulation

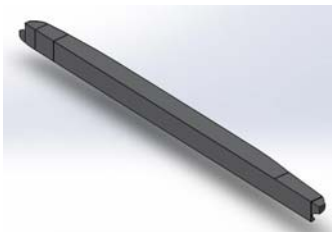

Figure 8 The geometrical model after applying the symmetry plan

The geometrical model was introduced in the sequence software CAD / CAE Ansys Workbench 12.1.

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In the next stage, the defining manner of constraints and loading models was established (Figure 9).

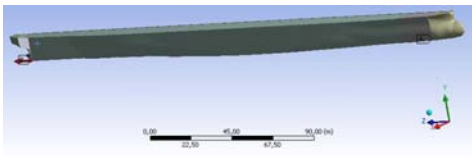

Figure 9 Edge conditions and FEM structural model loadings
a – constraint in the contact area with the bottom

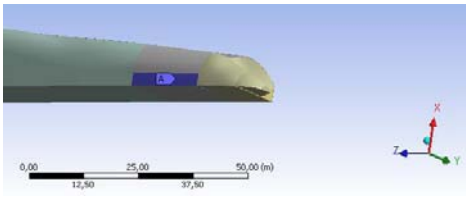

Figure 9 Edge conditions and FEM structural model loadings
b – towing force

As previously mentioned, the model will be considered as constrained in the contact area with the ground, on the surface of 32 m^2 (figure 9), and afterwards it will be applied at the pushing bearing level with a force uniformly distributed on its surface on Oz direction.

For all considered situations, the maximum values for the Equivalent Tensions Von Misses are established in the limited interval by the couplers 4-5 (figure 10).

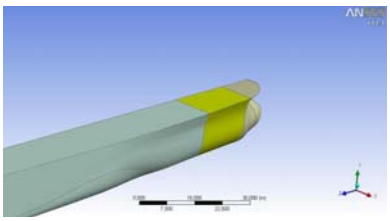

Figure 10 Bow section, limited by the theoretical couples 4 and 5

In Figure 10 local variations of the Von Misses tensions are presented for the analyzed model.

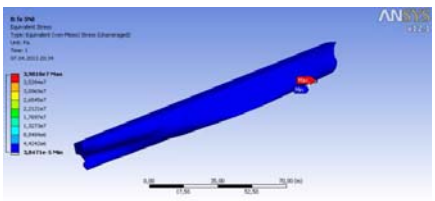

Figure 11 Von Misses tensions for the maximum loading case

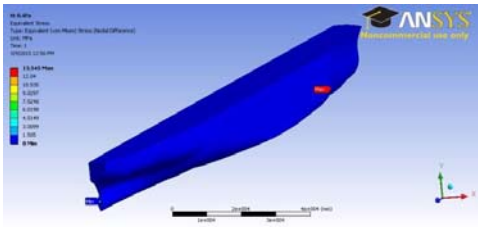

Figure 12 Von Misses tensions for 40% of the maximum towing force

In the Figures 11 and 12 variation of equivalent tensions von Misses for the different loading cases are presented. It is noticed the fact that in the joining area of plates right near the constraint area, tension enhancers are registered generating peaks of the determined values. Analyzing the maximum values of tensions equivalent and comparing them with the established value for the limit flow of the material used (55x107 N/m^2), it is noticed the fact that for neither of the analyzed cases does not exist the danger of reaching some characteristic values for the plastic deformation field.

Further on, the study of specific deformations proceeds on the development direction of the towing force in order to determine the areas in which they reach maximum values (Figure13, a,b).

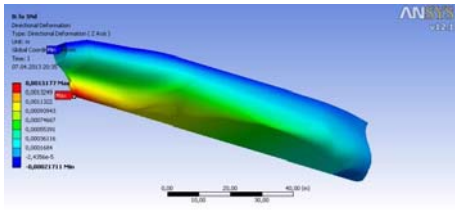

Figure 13 Movements on Oz axis for the simulated situations
a. Movement on Oz axis for maximum towing force

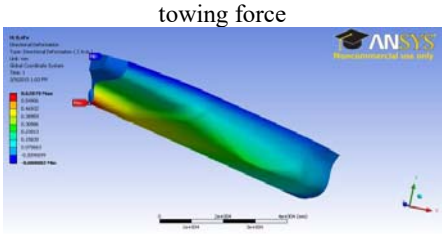

Figure 13 Movements on Oz axis for the simulated situations
b. Movement on Oz axis for 40% of the maximum towing force

As expected, the maximum deformation area along the Oz axis is the joining area between rigidity elements at the stern and the pushing bearing. This leads to an

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interest for facts related to elastic deformations developed on the pushing bearing level (Figure 14,a,b).

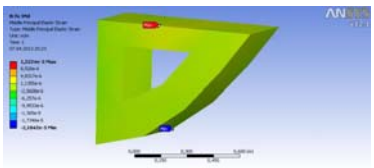


Figure 14 Elastic deformations resulted for the analyzed situations
a. elastic deformations for the maximum value of the towing force

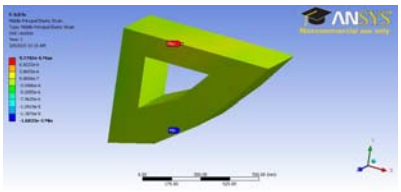
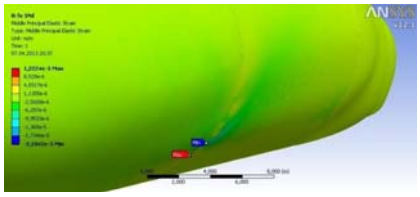
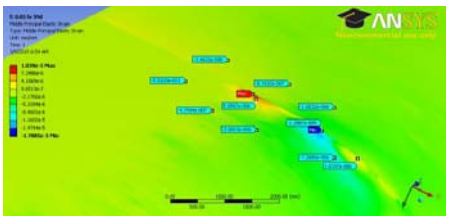


Figure 14 Elastic deformations resulted for the analyzed situations
b. elastic deformations for 80% of the maximum value of the towing force

Given that the maximum and minimum values are registered in the same areas and distribution of elastic deformations is similar for all cases, in figure 6 only the cases in which amplitudes have the highest values were presented.



a. Elastic deformations resulted for the maximum value of the towing force



b. Elastic deformations resulted for 85% of the maximum value of the towing force

Figure 15 Elastic deformations resulting in the constraint area

This distribution of elastic deformations become of interest also in the joining area of the plates right near the constraint area (Figure 15a,b).

3. CONCLUSIONS

Considering the registered values for the observed dimensions, it can be noticed that the structure's answer during a possible refloating manoeuvre is favourable, without the existence in normal conditions of the suspicion of touching the rupture limits for the plates'material and rigidity elements.

At the same level, relatively high values of movements being observed, which in the maximum towing forces area reach peaks of over 10mm, in order to overcharge the joints of the structural elements, the avoidance of applying forces with amplitudes higher than 175.88 kN may be considered.

For this value of the towing force, considering the existent main engine onboard the ship taken as a model (MAN B&W 7S80ME-C) and considering the next estimated values of capacity of the component elements of the propulsion system:
- propulsion capacity: 50%;
- axes line capacity: 98%;
- mechanic capacity of the main engine: 80%.

It results in the next values for established powers on the level of every element in the propulsion system:
- towing power: 1356.03 kW;
- propeller power: 2643.34 kW;
- indicated power of the main engine: 2996.68 kW.

Knowing the effective power of the main engine, respectively 31570 kW [3], [5] and reporting to the determined power for the studied situation, it results in a charging of the main engine of 9.5% of its nominal power.

4. REFERENCES

[1] Dinu, D., Stoian, M., 2008, *Distorsional simulation in the study of flow through circular conduits*, Journal of marine Technology and Environment, vol. 1, Nautica Publish House, 2008.
[2] Varsami, A.E., 2013, C*ontributions regarding the improvement of refloating methods for sea going ships,* Doctoral thesys, Constanta Doctoral School, 2013.
[3] http://[www.man.com.
[4] http:// www.aukevisser.nl.
[5] http:// www.simman2008.dk.

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CURRENT STATE OF SLUDGE PRODUCTION, MANAGEMENT, TREATMENT AND DISPOSAL IN ROMANIA

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Abstract: For many years, the large amount of sludge generated at the WWTPs in Romania has been of great trouble, raising significant concerns for plants operators. This paper reviews the current situation of sludge production, management, treatment and disposal routes. The continuous development of the wastewater sector and the need to align to the European regulations that state that all settlements with over 2000 inhabitants should have sewerage systems connected to a wastewater treatment plant which includes a sludge processing line, will lead to a great increase in the total amount of sludge generated. The total sludge production in Romania has been growing in the past decade and current studies estimate that by the end of 2018 the total amount will exceed 400000 tonnes. Choosing the most appropriate sludge treatment technology is a key factor in the application of integrated sewage sludge management system. Together with economic and social considerations, sludge managers need to implement more sustainable management systems. Decision makers should combine in an optimum way the alternatives for sewage sludge handling, considering all available information on technical, economic and environmental issues.

Key words: disposal routes, impact, sludge management, treatment, WWTP

1. INTRODUCTION

Recent investments in wastewater treatment technologies have led to an increase in the annual quantities of sludge generated from this processes. Sludge has many toxic substances such as pathogens, heavy metals and some organic contaminants, which can cause serious environment pollution. Therefore, sludge treatment has always been a great challenge, so it is essential to manage, treat and dispose it properly.

The main objective of this study was to comprehensively review the current status of sludge production, management, treatment and disposal routes in Romania, based on recent available data. According to the overall situation, future option for integrated routes of sludge treatment and disposal were presented.

For this purpose, data were obtained from statistical reviews, literature, government reports or official websites, professional organizations and field reports.

The wastewater treatment consist in a complex of mechanical, physical, chemical and biochemical processes. This processes have as a result a primary effluent– the treated water and a number of by-products consisting in the materials resulted in the separation process. From a quantitative perspective, the most important by-product that results from the wastewater treatment process is the sludge.

According to EU negotiations, by December 31, 2018, Romania has the obligation to enter into full compliance with EC Directive 91/271/ EEC. All cities with more than 2000 inhabitants should be served by wastewater treatment plants and so the sludge production will increase. The available data on the current situation regarding the sludge management in our country is synthesized in the National Wastewater Sludge Management Plan [2].

2. CURRENT SITUATION

Typically, for European countries four different types of disposal make up a considerable share of the total volume of sewage sludge treated: agricultural use, incineration, landfill and composting. If for the western European countries at least three quarters of the total

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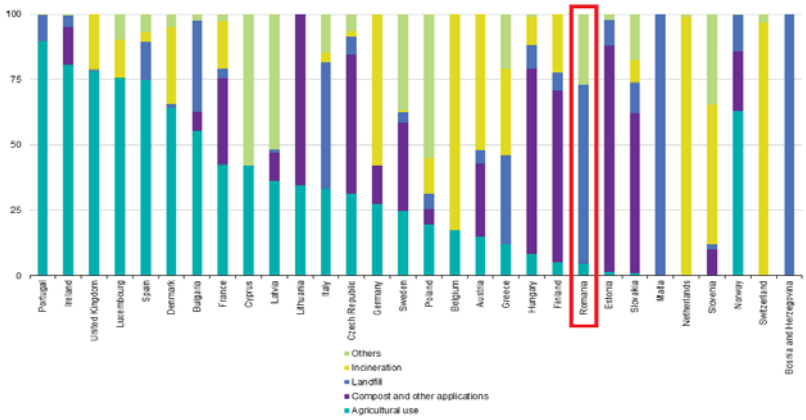
amount of sludge was used as fertiliser in agriculture, by contrast, around two thirds of sewage sludge was composted in Lithuania and Finland, rising to 86.6 % of the total in Estonia. While the Netherlands, Belgium, Germany, Slovenia and Austria (as well as Switzerland) reported incineration as their principal form of treatment for disposal, discharge into controlled landfills was practised as the principal type of treatment in Malta (where it was the sole form of treatment), **Romania** and Italy, as well as Bosnia and Herzegovina.



Source: Eurostat

Figure 1 Sludge disposal in Europe

Table 1 shows the total amount of sludge generated by Romanian wastewater treatment sector over the past few years (2007-2014), with the main routes of disposal that were applied. As we can see, in our country, the main practice when it comes to sludge disposal is land filling (90 to 95%), while the rest is disposed in agricultural fields as soil conditioner/fertiliser (5 to 10%) or other recycling. As Romania was getting more and more connected to the European framework, by developing new WWTP, implementing new wastewater treatment practices and modernising the existing ones, 2013 and 2014 brought a significant increase in the total amount of sludge generated by this sector.

Table 1. Sludge amounts generated in Romania. 2007 – 2014

Types of sludge treatment	*Exp.*	*Measure units*	*Years*							
			Year 2007	**Year 2008**	**Year 2009**	**Year 2010**	**Year 2011**	**Year 2012**	**Year 2013**	**Year 2014**
Total sludge production	**DS**	**Thou tonnes / year**	99,55	79,21	120,47	82,06	114,1	65,8	172,6	192,33
Sludge disposal	**DS**	**Thou tonnes / year**	43,93	39,6	44,74	36,58	36,64	37	172,39	192,33
Agriculture use	**DS**	**Thou tonnes / year**	0,74	0,49	0,11	1,93	1,84	2,24	8,01	13,05
Compost	**DS**	**Thou tonnes / year**	2,73	1,96	15,82	1,33	0,17	1,31	0,28	0,2
Landfill	**DS**	**Thou tonnes / year**	44,43	35,97	58,09	40,5	73,95	42,98	117,65	145,14
Incineration	**DS**	**Thou tonnes / year**	:	:	:	:	0,02	0,43	:	1,24

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Other proceeding	**DS**	**Thou tonnes / year**	7,73	1,2	1,71	1,71	1,48	1,41	46,45	32,7

Romanian National Insitute of Statistics

When it comes to the conditions for sludge disposal (sanitary landfill), these are regulated by the Government Decision no. 349/2005 on waste disposal. Considering the present strict regulations and the limited number of the potentially suitable disposal sites only regional sludge deposits can be considered. It is also desired/required that below the deposit a water tight layer should be established to prevent infiltration into the ground water. Selection of the feasible site has to fulfil other criteria as well. Among these the most important ones are the safety distance from various establishments such as residential areas, public roads, river dikes, etc. Another point is that the land should not be of high value from an agricultural point of view and the future development plan is not to be intercepted by the establishment of the sludge deposit. Finally, economic points have to be considered as well. Among these the distance of transportation should be minimized, but occasionally the presence of natural depressions, or pits of former mines are taken into account. Usually, upon finishing disposal operations shrubs and forest are planted on the top of the area, a practice that is very rarely taken into account in our country.

Agricultural use of raw sludge or other composting practices is encouraged by national authorities as the best way for recycling, while landfilling is considered the worst. Directive 86/278/EEC on Sewage Sludge in Agriculture requires, however, that no-one may permit the use of sewage sludge on agricultural land unless specific requirements are fulfilled. This aims at avoiding the accumulation of toxic substances, especially heavy metals that might reach excessive levels in the soil after a number of applications. In Romania, the 344/2005 Order states the technical norms for environmental protection and especially soil, when using sludge from wastewater treatment plants in agriculture.

A great care should always be taken when applying sewage sludge to land in order to prevent any form of possible environmental impact. The sludge must not contain any non-degradable materials, such as plastics, or others. The sludge transport by tanker from sewage treatment plant to agricultural land can create traffic problems and give rise to noise and odour nuisance. The transport vehicles should be carefully selected for their local suitability and routes chosen so as to minimize inconvenience and any risks. The risk associated with sludge usage in agriculture are related to the accumulation of HM, pathogens, organic pollutants in soil, GHG emissions, (e.g. CH4 and N2O), leakage of sludge from the transporting tanker, sludge dehydration costs overcomes the benefits, the sludge is not carefully spread in the area rising the possible human health risk of contracting parasites, bacteria or viruses due inhalation or contact.

3. FUTURE SCENARIOS

As the agricultural use of sludge, by direct application, as well as landfilling of sludge are subject to more and more regulatory control, there is a constant requirement from WWTP operators for tailored sludge treatment systems. There are many ongoing research projects that aim at the development of new and innovative solutions for the best sludge management techniques. Some of the scenarios are discussed below.

In Romania, a fifth of agricultural land is suitable for sludge application, the criteria being a gradient of less than 10% and alkaline soil. However, crops must be compatible with sludge disposal and land must be close enough to a wastewater treatment facility for cost-effective transport. In parts of the country concentrations of heavy metals in the sludge are too great to allow agricultural use, therefore there is the need to implement other treatment options for the generated sludge.

The National Wastewater Sludge Management Plan mapped out alternatives for agricultural use of sludge, identifying cement kilns capable of using dried sludge as a fuel, plus other sites where waste to energy sludge incinerators could be built. Using anaerobic digestion or thermal treatment technologies to produce combustible biogas are also some of the most attractive options.

More and more research activities are directed to the utilization of waste sludge as a renewable resource for energy recovery. This should be the most appropriate way to manage the continuously increasing waste sludge generation effectively in order to meet the very stringent environmental quality standards. At the same time this will be a good example of how to sustain the supply of reliable and affordable energy for our future generations and ourselves.

The valuable characteristics of sludge, including high energy and nutrient content, is driving the scientific community to change their point of view and consider sludge as a viable resource of energy instead of a waste.

It may be an important move towards the development of a sustainable sludge management solution but also an energy generation solution to fulfil the present and future energy requirements and thus reduce the dependency on non-renewable resource.

For this reason, incineration of sludge for energy recovery purposes is expected to increase, even though it can be a capital intensive investment and it is also subject to strict regulation pertaining to combustion criteria, management of the emission gasses and so on.

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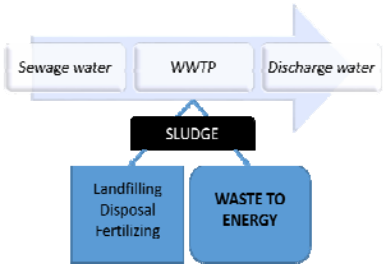

Figure 2 Sludge to energy – an alternative to the usual disposal routes

The road from being a waste product to one that can produce both useful material and energy requires the sludge to be submitted to a thermal process with the following special features: there should be a considerable reduction in the sewage sludge volume (by thickening, dewatering, drying) and also, the alternative fuel that is generated to have a calorific value comparable to that of a traditional fuel.

As we mentioned above, one of the options considered for future implementation is incineration of sewage sludge in cement factories, an option that is gaining more and more interest worldwide. In addition to the fact that municipalities can solve the problem of how to dispose of dewatered or dried sewage sludge, cement factories offer the perfect facility for the required sewage sludge treatment. The dried sludge can be used as fuel and, depending on its content, it can replace a significant part of costly fossil fuels, such as coal. After being dried to >90% dry solids, sewage sludge normally shows calorific values of 10 to 12 MJ/kg.

The benefit of combining a sewage sludge drying installation with the cement production process in a factory is the perfect environment for the sewage sludge drying line. Cement processes normally generate a lot of waste heat that can be used as a heat source for the demanding sewage sludge drying line. For this reason, the sewage sludge drying installation will not require external heating sources, minimizing in this manner, the costs for the thermal energy, which is the largest share of the overall operating costs for the drying lines for wastewater sludge. An essential requirement for treating sewage sludge in a cement factory facility is the flexibility of the sewage sludge drying system that should be valid for different kinds of sewage sludge.

Normally, cement factories take sludge from various stations, where the sludge may also be submitted to different forms of pre-treatment, so the sludge consistency at the intake of a cement factory will vary much more than the sludge from a single wastewater treatment plant. But in any way, the sludge that will be received by a cement factory will normally be dewatered (decanter, centrifuge, belt filter press). After the dewatering process, the sludge typically has a dry solids content of approximately 18-25%, and sometimes up to 35% if stabilization has been applied. [3]

There are many other solutions (in various stages of testing/implementation) for processing the sludge and turn it into fuel, such as carbonization system to recycle sewage sludge for electric power generation fuel, pelletizing and incinerating it in special designed thermal boilers, but there is still a long way with a lot of work to do, for the Romanian operators to be able to implement these type of solutions. For this, it is of great importance the support from the local authorities, regarding the funding of this type of projects, from research activities conducted in this field, to testing demonstrators and pilot installations.

4. CONCLUSIONS

Traditionally landfilling and agricultural use are two of the most popular techniques used in present days for the management of the sludge in Romania. However, the industry is evolving and a number of developments that extract more energy from sludge are either being implemented or are nearing the full scale demonstration. Taking into account this fact a number of alternatives to the landfilling option are either already implemented or ongoing in other countries, there is a great the need to bring this innovative solutions to our system as well, working to tailor them for the current Romanian situation. It will require a great amount of work and cooperation from wastewater companies as well as public authorities, to share information and expertise so that existing success solutions can be reproduced and adapted country-wide. With less than 10% of sludge going to agriculture in the past years, the collective goal is to dispose of 50% in this way by 2019. Entering the next decade, it is hoped that waste to energy plants will be up and running, usefully diverting the other half from landfill.

5. REFERENCES

[1]. Bodzek et al., 1997; Feng et al., 2014; Zhang et al., 2009a
[2]. National Wastewater Sludge Management Plan, Ist part, June 2011
[3]. https://www.andritz.com/

ISSN (Print): 1844-6116
ISSN (Online): 2501-8795 http://www.cmu-edu.eu/jmte

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PERSONALITY FACTORS AFFECTED JOB INVOLVEMENT IN CONTAINER TERMINAL

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Abstract: Employees with higher job involvement would pay attention to their work. At the same time, it would increase organizational efficient and effective. Therefore, this study analyzed the personality factors and job involvement in container terminal, to determine the personality factors that affected the degree of job involvement. Mann-Whitney U and Kruskal-Wallis tests are used to analyze the data. The results are displayed that education background and job specification are affected the job involvement. The initial output can use in managerial decision making, to assist in organization planning.

Key words: job involvement; personality factors; container terminal; managerial decision making.

1. INTRODUCTION

The employee is an asset to a company. Every degree of job involvement increment among the organization's members would increase the organizational effectiveness. This is supported by Elankumaran (2004) statement; job involvement can be defining as an important variable to optimize organizational effectiveness. Therefore, job involvement is selected as a key indicator for the effectiveness measurement of this studied. Besides, the personality factors that affected the degree of job involvement in a container terminal also be studied; likes age, marital status, educational background, and job specifications.

2. OVERVIEW

Job Involvement is a expression and attitude of a person towards their work. The people whom has high job involvement would consider their work as important part in their life; They would satisfied with their work and accomplishing their work with best effort (Elankumaran, 2004; Cohen, 1995). Brown (1996) stated that person with higher job involvement would more loyalty to their work and looking for foreseeable future in the same organization. Furthermore, people with higher job involvement will giving positive employee characteristics; like high satisfaction, high commitment, positive affect and low stress (Mudrack, 2004).Thus, job involvement is important in organization success and work productivity.

Various studies have done toward job involvement with different chareteristics. Jayawardana et.al. (2013) used job involvement to analysed the productivity outcomes of middle managers in a garment sector. The higher performing managers experienced higher perceptions of organization support. They are more resulting in social relationship, job satisfaction and lower turnover rate. His study highlighted that organization need to pay attention to factots affecting job involvement and receiving organization suport. Besides, Tastan and Turker (2014) also highlighted that organizational culture having positive relationship with job involvement. It is further supported by Fletcher (1998), Ho (2006), Manetje and Martins (2009), and Quyang et.al. (2010), they indicated that employees would increase their job involvement and job commitment if an organization culture giving supporting to their employees and achievement oriented. However, Rabinowitz et.al. (1977) claimed that job involvement is a personal characteristic, its affected by personality characte then organizational factors. The person who has higher job involvement would look at job as their identities, interests and life goals, therefore they would more involved in their job.

Numerous studies have determine the reaction of job involvement with organizational factors, but rare in personality characte. Thus, this study further looking for the degree of job involvement affected by personal factors, to analyse status between personality factors and job involvement.

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An extensive observation and pilot tests data search were done. Personality variables were chosen based on the pilot test results. After that, survey activities and primary data were collected from container terminal. Statistical Package for Social Science was used for statistical analysis. Then Mann-Whitney and Kruskal-Wallis tests were used to analyse the hypotheses, to test status among personality variables with job involvement.

Hypotheses:

H_{O1} : There is no significant difference between job involvement and age.

H_{O2} : There is no significant difference between job involvement and marital status.

H_{O3} : There is no significant difference between job involvement and educational ackground.

H_{O4} : There is no significant difference between job involvement and job specifications.

H_{O5} : There is no significant difference in mean degree of job involvement between management and non-management level.

3. RESULT AND DISCUSSION

3.1 Analysis on reliability test

Table 1 shows reliability analysis for personality factors and job involvement. Reliability analysis was tested on the level of reliability of the questionnnaires data that are collected. Abu et. al. (2001) showed that an alpha value above or equal to 0.6 can be assumed as good and it is acceptable. The alpha value of the study is 0.6813. Thus, it can be assumed as reliable.

Table 1. Reliability analysis

Reliability Coefficients	
Item	Value
No. of Cases	201
No. of Items	14
Alpha	0.6813

3.2 Kruskal-wallis and mann-whitney U tests

The Kruskal-Wallis test is a non-parametric alternative to one-way Analysis of Variance (ANOVA). Significant levels below 0.05 indicate that the group locations differ. Table 2 analyzed position between job involvement and age. The initial result shows the significant value is more than 0.05 (0.116), hence it can be assumed that the degree of job involvement does not differ between age. Therefore, H_{O1} is accepted and H_{A1} is rejected.

Table 2. Kruskal-Wallis test for job involvement and ag

Test Statistics[a,b]	
	Job Involvement
Chi-Square	10.209
df	6
Asymp. Sig.	0.116
[a.] Kruskal Wallis Test	
[b.] Grouping Variable: Age	

Table 3 analyzed position between job involvement and marital status. The initial result shows the significance value is more than 0.05 (0.939) and it can be assumed that the degree of job involvement is not affected by marital status. Therefore, H_{O2} is accepted and H_{A2} is rejected.

Table 3. Kruskal-Wallis test for job involvement and marital status

Test Statistics[a,b]	
	Job Involvement
Chi-Square	0.126
df	2
Asymp. Sig.	0.939
[a.] Kruskal Wallis Test	
[b.] Grouping Variable: Marital Status	

Table 4 analyzed the position between job involvement and educational background. The initial result shows the significant value is below 0.05 (0.005) and it can be assumed that the degree of job involvement is different between educational background. As a result, H_{O3} is rejected and H_{A3} is accepted.

Table 4. Kruskal-Wallis test for job involvement and educational background

Test Statistics[a,b]	
	Job Involvement
Chi-Square	20.208
df	7
Asymp. Sig.	0.005
[a.] Kruskal Wallis Test	
[b.] Grouping Variable: Education Background	

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Table 5 analyzed the position between job involvement and job specifications. The initial result shows the significant value is below 0.05 (0.000), hence it can be assumed that the degree of job involvement may be influenced by job specifications. Thus, H_{O4} is rejected and H_{A4} is accepted.

Table 5. Kruskal-Wallis test for job involvement and job specifications

Test Statistics[a,b]	
	Job Involvement
Chi-Square	28.902
df	4
Asymp. Sig.	0.000
[a.] Kruskal Wallis Test	
[b.] Grouping Variable: Job Specifications	

Table 6 further analyzed job involvement and job specifications with Mann-Whitney U Test. In this case, the job specifications were divided into two groups; there are management level and non-management level. The Mann-Whitney test is a non-parametric test alternative to two independent samples. Small significant value (<0.05) indicates that the two groups are from different locations. The significant value is smaller than 0.05 (0.001). It shows that the degree of job involvement may differ between the management level and non-management levels. Therefore, H_{A5} is accepted and H_{O5} is rejected.

Table 6. Mann-Whitney test for job involvement and job specifications

Test Statistics[a]	
	Job Involvement
Mann-Whitney U	2054.500
Wilcoxon W	15420.500
Z	-3.239
Asymp. Sig. (2-tailed)	0.001
[a.] Grouping Variable: Job Specifications	

3.3 Summary of result findings

Table 7 shows the summary findings for Kruskal-Wallis and Mann-Whitney U Tests. Kruskal-Wallis test was done to test the difference between age, marital status, educational background and job specifications. Results show the educational background and job specifications may affect the degree of job involvement. However, results also show the age and marital status do not have any significant difference between groups. Further, the Mann-Whitney U test was used to test the difference between two categories; likes management and non-management levels. Between the two categories of job specifications, result show the job specifications level may affect the degree of job involvement.

Table 7. Findings for Kruskal-Wallis and Mann-Whitney U Tests

		Kruskal - Wallis Test			Mann - Whitney Test
		Marital	Education	Job	Job
	Age	Status	Background	Specifications	Specifications
Asymp. Sig.	0.116	0.939	0.005	0.000	0.001
Hypotheses	H_{O1}	H_{O2}	H_{A3}	H_{A4}	H_{A5}
Accepted					

4. CONCLUSIONS AND RECOMMENDATIONS

People play an important role in work. People do the work; hence the ways they do the work affect the work efficiency and effectiveness. Therefore, personality factors of human are important to determine the degree of job involvement. This study tested the status between variables of personality and job involvement. To maximize organizational efficiency and effectiveness, it depends on the highest degree of job involvement. Thus, it examined the variables of personality that influence job involvement. Four personality variables were studied; there are age, marital status, educational background and job specifications.

The results showed that age and marital status do not affect the degree of job involvement. Therefore, age and marital status do not play an important role in work efficiency and effectiveness.

On the other hand, educational background and job specifications have a significant impact on job involvement. Thus, educational background and job specifications play an important role in work efficiency

and effectiveness. According to Carmeli (2005), the top executives have higher job involvement. Its further support the findings, there are a significant different between management and non-management levels. Besides, the higher the people are educated, the more degree of job involvement is achieved. This may occur because people who are highly educated work in the management level.

Top executives are more involved in their jobs. Therefore, further research is suggested to examine what motivates top executives to be involved in their jobs, to disseminate the motivational factors of the management level to the non-management level.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] Abu, M.S. and Tasir, Z., *Pengenalan kepada Analisis Data Berkomputer SPSS 10.0,* Venton Publishing, Kuala Lumpur, pp. 299, 2001

[2] Brown, S.P., *A Meta-Analysis and Review of Organizational Research on Job Involvement,* Psychological Bulletin, Vol120, pp. 234-255, 1996

[3] Carmeli, A., *Exploring Determinants of Job Involvement: An Empirical Test Among Senior Executives,* International Journal of Manpower, Vol26, no5, pp.457-472, 2005

[4] Cohen, A., *An Examination of the Relationship between Work Commitment and Non-Work Domains,* Human Ralations, Vo l48, pp. 239-263, 1995

[5] Elankumaran, E., *Personality, Organizational Climate and Job Involvement: An Empirical Study,* Journal of Human Values, Vol10, No2, pp. 117-130, 2004

[6] Fletcher, D.E., *Effects of Organizational Commitment, Job Involvement, and Organizational Culture on the Employee Voluntary Turnover Process,* Unpublished Doctoral Dissertation, Texas Tech University, USA, 1998

[7] Ho, C.C., *A Study of the Relationships between Work Values, Job Involvement and Organizational Commitment among Taiwanese Nurses,* Unpublished Doctoral Dissertation, Queenslan University of Technology, Australia, 2006

[8] Manetje, O. and Martins, N., *Relationship between Organizational Culture and Organizational Commitment,* S. African Bus. Rev. 13, No1, pp. 87-111, 2009

[9] Mudrack, P.E.,*Job Involvement, Obsessive-Compulsive Personality Traits, and Workaholic Behavioural Tendencies,* Journal of Organizational Change Management, Vol17, No5, pp. 490-508, 2004

[10] Quyang, Y., Cheng, C.H. and Hsieh, C.J., *Does LMX Enhance the Job Involvement of Financial Service Personnel by the Mediating Roles?* Problems and Perspectives in Management, Vol8, No1, pp. 174-181, 2010

[11] Rabinowitz, S. and Hall, D.T., *Organizational Research on Job Involvement,* Psychological Bulletin, Vol 84, No2, pp. 265-288, 1977

[12] Tastan, S.B. and Turker, M.V., *A Study of the Relationship between Organizational Culture and Job Involvement: The Moderating Role of Psychological Conditions of Meaningfulness and Safety,* Procedia – Social and Behavioral Sciences, Vol149, pp. 943-947, 2014

[13] Jayawardana, A.K.L., O'Donnell, M, Jayakody, J.A.S.K., *Job Involvement and Performance Among Middle Managers In Sri Lanka,* The International Journal of Human Resource Management, Vol.24, Issues 21, pp. 4008-4025, 2013

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COMPARATIVE PERFORMANCE ANALYSIS OF R134a AND R290/R600a REFRIGERANTS IN A VAPOR COMPRESSION REFRIGERATION CYCLE

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Abstract: ***Vapor compression technology is used in the majority of space cooling and food refrigeration applications. Refrigerated ships and marine branches, such as merchant, naval, fishing or cruise-shipping are used to transport perishables. This system is running in several situations on R134a, a HFC refrigerant having excellent thermodynamic and thermo-physical properties, but an adverse environmental impact, considering its global warming potential. This paper deals with a theoretical performance study of a vapor compression refrigeration system working with the pure refrigerant R134a and a mixture, R290/R600a (50% / 50%), considering the effect of the main factors that affect the coefficient of performance: interior tube diameters, working pressures and inlet water temperatures. Are highlighted cases in which the performance when using the mixture is higher than the one when using R134a.***

Key words: coefficient of performance, vapor compression; working parameters.

1. INTRODUCTION

Standards of our present life depend on refrigeration equipment for food preservation or transport and human comfort. Different types of refrigerating systems are met in marine shipboard refrigeration and air conditioning. Vapor compression refrigeration systems with reciprocating compressors are the mainstay of marine refrigeration and air conditioning sector. Clausius statement indicates that energy (heat) will not flow from a cold region to a hot one, without external assistance. The technology used to achieve this result is named "refrigeration unit". Refrigeration is used to reduce and maintain the temperature of a space or material under the temperature of surroundings. In this respect, the heat is removed from the body needed to be cooled and transferred to other one, whose temperature is under that of the refrigerated body.

Figure 1 shows the main component parts of a typical vapor compression refrigeration plant: compressor, condenser, expansion valve and evaporator.

The refrigerant vapors enter in the compressor with low temperature and pressure where suffer an isentropic compression, resulting high temperature and pressure overheated vapors. In the condenser, they are cooled and condensed resulting high pressure liquid which is then throttled to the evaporator pressure and after that led to absorb heat from the refrigerated space.

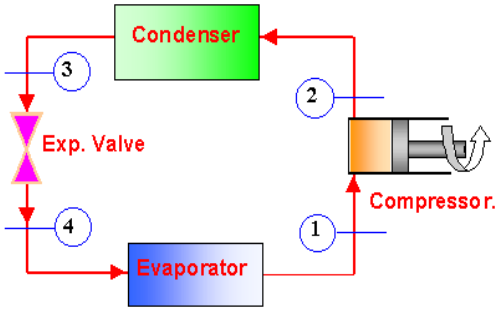

Figure 1 Vapor compression refrigeration system

The theoretical analysis is developed on the following assumptions:

- steady state operation;
- refrigerant is under saturated vapor state when enters in the compressor;
- no pressure loss occurs in the pipes and valves, pressure changes being met only at the compressor and expansion valve;
- gains and losses of heat are neglected;
- compressor presents ideal volumetric efficiency and ideal isentropic efficiency of 75% [1].

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For the cycle analyses are introduces following formula, aiming the evaluation of the performance of refrigeration equipment [2]. Commonly it is expresses by the Coefficient of Performance (COP).

It will be considered a control volume enclosing the refrigerant side of the evaporator in order to apply conservation of mass and energy for the assessment of the rate of heat transfer per unit mass of refrigerant flow in the evaporator:

$$q_e = \frac{Q_e}{m} = h_1 - h_4 \ , \qquad (1)$$

where h is the enthalpy and m is the mass flow rate of the refrigerant and Q_e is amount of heat absorbed in the evaporator.

Applying the conservation of mass and energy rate to a control volume enclosing the compressor, one can get:

$$l_c = \frac{P_c}{m} = h_2 - h_1 \, , \qquad (2)$$

where P_c is the power given to the compressor.

For a control volume enclosing the refrigerant side of the condenser, the rate of heat transfer from the refrigerant per unit mass of refrigerant is:

$$q_c = \frac{Q_c}{m} = h_2 - h_3 \, , \qquad (3)$$

where Q_c is the amount of heat rejected in the condenser.

During the throttling process, the enthalpy remains constant, so:

$$h_4 = h_3 \, . \qquad (4)$$

The Coefficient of Performance is the measure of performance of the refrigeration cycle, on the first law of thermodynamics basis; it is the refrigerating effect produced per unit of work required [3].

$$COP = \frac{Q_e}{P_c} = \frac{h_1 - h_4}{h_2 - h_1} . \qquad (5)$$

The refrigerant must carry away from the evaporator the heat it has absorbed. The refrigerant R134a presents a quite high global warming potential, in the near future its production and use being under the sign of restriction.

This paper deals with a comparative analysis of the performance of a vapor compression refrigeration cycle working with R134a and an ecologic mixture of R290 and R600a (50% / 50%) , on theoretical basis. It will be assessed the influence of working parameters on the COP values. The performance of the system considered depends on capillary tube diameters, working pressures and inlet water temperatures [4].

2. THE NEED OF CHANGE

Refrigerants are used to transport heat between the interior and exterior of a refrigeration system.

In the past, HCFC refrigerants were wide spread, but in the 1980's, specialists indicated them as ozone depleting substances; as a result, under the Montreal Protocol, developed countries agreed to fully phase-out their production by 2020. Thus, efforts were directed towards developing refrigerants having null ozone depletion potential. In this framework, refrigeration industry is phasing-out conventional HCFC refrigerants and switching to HFC.

HFC refrigerants contain Hydrogen, Fluorine and Carbon and they do not contain ozone depleting Chlorine. Even if HFCs do not deplete the ozone layer, they are extremely potent greenhouse gases, some of them even more powerful than CFCs. There is currently no international agreement to phase them out. They are included in the United Nations Framework Convention on Climate Change (UNFCC) basket of controlled gases.

According to the Kyoto Protocol, worldwide governments are voluntarily committed to reduce the greenhouse gas emission to the atmosphere, fact that led investigations to identify long-term energy-efficient and environment-friendly alternative to HFC 134a (R134a) [5], since this refrigerant is one of the most strong representative of HFCs if we rely on data indicating its consumption [6], as seen in Table 1.

Table 1. Estimates for consumption of R134a, in k tones

Year	Consumption
1997	69
1998	79
2000	99
2005	128
2010	154
2015	174

Table 2. Thermo-physical properties of R134a, R290 and R600a

Refrigerant	R134a	R290	R600a
Class	HFC	HC	HC

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Molecular Mass (g/mol)	102,03	44,10	58,12
Critical Temperature (°C)	101,1	96,7	134,7
Critical Pressure (MPa)	4,06	4,25	3,67
ODP	0	0	0
GWP (years)	16	<1	<1

In E.U., Hydrocarbons (HCs) are considered to be the suitable substitutes for HFCFs [7]. These refrigerants are environmentally friendly and show features which make them attractive for the refrigeration sector.

Moreover, HCs have good physical and thermodynamic properties, present material capability, are not expensive and are safe in operation. Some useful properties of the refrigerants involved in the study are given in Table 2.

3. COP ASSESSMENT ACCORDING TO THE INFLUENCE OF WORKING PARAMETERS

The performance expressed by COP is analyzed when factors affecting this value are varying.

Thus, are considered three levels for the refrigerant pressure ($4,82 \cdot 10^5$ Pa ; $5,17 \cdot 10^5$ Pa ; $5,51 \cdot 10^5$ Pa), inlet water temperatures (20°C, 28°C, 38°C) and interior diameters (0,09cm, 0,11cm, 0,13cm).

Table 3. Inlet water temperature and pressure influence on COP for $p = 4,82 \cdot 10^5$ Pa

$p = 4,82 \cdot 10^5$ Pa									
	t = 20°C			t = 28°C			t = 38°C		
d [cm]	0,09	0,11	0,13	0,09	0,11	0,13	0,09	0,11	0,13
COP_{R134a}	1,38	1,38	1,38	1,48	1,49	1,39	1,29	1,30	1,44
$COP_{R290/R600a}$	1,02	1,02	1,21	1,10	1,00	1,38	1,19	1,11	1,52

Table 4. Inlet water temperature and pressure influence on COP for $p = 5,17 \cdot 10^5$ Pa

$p = 5,17 \cdot 10^5$ Pa									
	t = 20°C			t = 28°C			t = 38°C		
d [cm]	0,09	0,11	0,13	0,09	0,11	0,13	0,09	0,11	0,13
COP_{R134a}	1,37	1,71	1,36	1,28	1,15	1,38	1,37	1,04	1,37
$COP_{R290/R600a}$	1,09	1,00	1,36	1,11	1,04	1,27	1,13	1,00	1,30

Table 5. Inlet water temperature and pressure influence on COP for $p = 5,51 \cdot 10^5$ Pa

$p = 5,51 \cdot 10^5$ Pa									
	t = 20°C			t = 28°C			t = 38°C		
d [cm]	0,09	0,11	0,13	0,09	0,11	0,13	0,09	0,11	0,13
COP_{R134a}	1,53	1,21	1,12	1,38	1,28	1,13	1,44	1,29	1,23

$COP_{R290/R600a}$	1,53	1,55	1,37	1,13	1,07	1,27	1,18	1,16	1,38

For the lowest pressure value considered $\left(p = 4{,}82 \cdot 10^5\,Pa\right)$, when using the mixture as a refrigerant in the system COP value is close or even higher to the one of R134a for the bigger interior diameter considered (d=0,13cm) and for the highest level of inlet water temperature (38°C).

When increasing the refrigerant pressure till $p = 5{,}17 \cdot 10^5\,Pa$, when using the mixture COP value is same to the one of R134a for the bigger interior diameter (d=0,13cm) and the lower temperature considered (20°C).

For the higher pressure value considered $\left(p = 5{,}51 \cdot 10^5\,Pa\right)$, COP value resulted for the mixture is higher than the one for R134a when inlet water temperature is 20°C and for all three diameters, while if increasing this temperature, $COP_{R290/R600a}$ is higher only for the bigger interior diameter (d=0,13cm).

3. CONCLUSIONS

The performance of a vapor compression refrigeration system was analyzed in this paper because this is the most common type of technology met in marine refrigeration.

Was discussed the effect of refrigerant type and values of working parameters such as refrigerant pressure, inlet water temperature and interior diameter, on COP.

Because of the high GWP of R134a, a refrigerant mixture of R290/R600a (50/50%) is seen as an alternative. From environmental data point of view, the substitution is justified because this mixture has a zero ODP and a negligible GWP.

Most of the results showed that COP has better values when R134a is the working fluid.

Still, in some situations, the mixture leads to an improved COP, such is the case of $p = 5{,}51 \cdot 10^5\,Pa$, when it is found also the best COP value of the analysis: $COP_{R290/R600a}$=1,55 when t=20°C and d=0,11cm.

4. REFERENCES

[1]. Almeida I.M.G., Barbarosa C.R.F., Fontes, F.A.O., 2010, *Thermodynamic and thermo physical assessment of hydrocarbons application in household refrigerator*, Engenharia Termica (Thermal Engineering), Vol. 9, 19-27

[2]. Thangaval P., Somasundaram P., Sivakwar T., Selva Kumar C., Vetriselvan G., 2013, *Simulation analysis of compression refrigeration cycle with different refrigerants*, International Journal of Engineering and Innovative Technology, Vol.2, Issue 10, 127-131

[3]. Bolaji B.O., Akintunde M.A., Falade T.O., 2011, *Comparative analysis of performance of three ozone-friends HFC refrigerants in a vapor compression refrigerator*, Journal of Sustainable Energy & Environment, 2, 61-64

[4]. Agrawal Mukesh K., Matani Ashok G., 2013, *Evaluation of vapor compression refrigeration system using different refrigerants*, International Journal of Engineering and Innovative Technology, Vol.2, Issue 9, 86-92

[5]. Mohanraj M.,Yayaraj S., Muraleedharan C., 2008, *Comparative assessment of environment friendly alternatives to R134a in domestic refrigerators*, Energy Efficiency, No.1, 183-198

[6]. Boumaza M.M., 2007, *A numerical investigation and comparison of chlorines compounds refrigerants and their potential substitutes operating at high ambient temperatures case for the replacement of R22*, FINAL RESEARCH REPORT, PE-39-26-27, 1-71

[7]. Matsunaga K., *Comparison of environmental impacts and physical properties of refrigerants*, Research by the Earth Engineering Center, Columbia University, 1-50, 2002

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THE SHORTEST PATH PROBLEM WITH UNCERTAIN INFORMATION IN MARITIME TRANSPORT ROUTING

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Abstract : The purpose of this paper is to find a solution for route planning in a maritime transport networks, where the costs of tracks, factor of safety and travel time are ambiguous. In this paper author propose a hybrid routing algorithm with Ant Colony Optimization.

Key words: Dijksta Algorithm, Traveling Salesman Problem, Ant Colony Optimization.

1. INTRODUCTION

Many papers meet a challenge with a route selection problem, navigation in the transport sector, some few examples take uncertainty into account evidence (or lack of knowledge). It is easy to find a few papers in transport study, which take account of the uncertainty by Dempster-Shafer theory. The primary application of citied above theory is the decision making, geographic information systems and statistics. Intelligent Driving recognition with Expert System used Dempster-Shafer theory for recognizing executed by the driver manoeuvres the evidence from the transducer fixed in a carriage. Uncertainty evidence models can been used only for the neighbourhood problem, but coverage of this problem is worldwide. The aim of the study is based information to find a solution of routing problems on uncertainty. Dempster-Shafer theory is a hypothesis of uncertainty that can appraise a specific statement the extent to which support a few sources of different data. In fact, there is an substitute to conventional probability theory, so that the accurate representation of ignorance and combination of evidence. Presented above approach was formerly introduced by Dempster [5] and then continued by Shafer in his publication in 1976, A Mathematical Theory of Evidence [11].

The scientific and industrial development is bringing some new ideas. There is an increasing number of electronic equipment on the vessel's board. For this reason watch officer has the access to miscellaneous systems of the interchange of many data. Certain of them can only collect data, other devices can combine send-receive process. The navigator's estimate of collision risk rely on his recognition about own ship's and other ships' rate. The accessible means for evaluating the other ships' rate are for example: radar, ARPA, AIS, visual sighting and the communication by statements with a crew of other vessels. Each of these units have specified dependable traits. Voice communication, radar and visual sighting provide actually references. Each of these systems is a independent structure on the bridge of the ship. The hardest for the watch officer can be forecasting the position in progress if the reserve of protection are very small, as in congested areas. The identical concerns for Automatic Identification Systems (AIS) if only the short messages are presented. It looks like the AIS will be able to change many of listed above structures of connections [6].

The previous papers have presented the usage of mathematical theory of evidence in evaluating of the possibility of object detection by monitoring radar stations. The level of object detection allows for effortless conversion to optimisation problem of monitored area coverage. Development of such task enables such distribution of observatory stations that maintains the detection rate higher than the assumed value. An appropriate rate level is achieved by covering the analysed set of points with sufficient number of radar stations. Combining evidence allows for calculating corresponding parameters for each set of observing equipment. In this work mathematical theory of evidence is used to the routing problems. [7]

Routing problems in networks are the problem in the context of sequencing and in recent times, they have to receive progressive note. Congruous issues usually take places in the zones of transportation and communications. A schedule problem engages identifying a route from the one point to the other because there are many of optional tracks in miscellaneous halting place of the passage. The cost,

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time, safety or cost of travel are different for each routes. Theoretically, the method comprises determining the cost of all prospective tracks and the find with minimal expense. In fact, however, the amount of such options are too large to be tested one after another. A traveling salesman problem is a routing problem associated with preferably strong restrictions. Different routing problem emerges when it can to go from one point to another point or a few points, and choose the best track with the at the lowest estimate length, period or cost of many options to reach the desired point. Such acyclic route network problem easily can be solved by job sequencing. A network is defined as a series of points or nodes that are interconnected by links. One way to go from one node to another is called a path. The problem of sequencing may have put some restrictions on it, such as time for each job on each machine, the availability of resources (people, equipment, materials and space), etc. in sequencing problem, the efficiency with respect to a minimum be measured costs, maximize profits, and the elapsed time is minimized. The graph image and the example of costs of borders are given in the figure 1. In this hypothetical idea the tract network is illustrated by a graph. Presented graph is given with an ordered pair G: = (V, E) comprising a set V of vertices or nodes together with a set E of edges (paths), which connect two nodes. The task is to reach the N1 node from N3 node in the graph at smallest cost. [8,9]

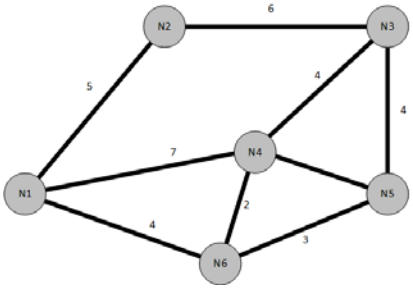

Figure 1 Graph with defined values of costs of paths

Conventional Dijkstra's [2] should provide the shortest route in the graph with non-negative edge path costs, but described example include uncertainty. Therefore Dempster-Shafer theory is required, which concern with uncertainty by belief functions. In Dempster-Shafer theory the set $\Omega = A_1, A_2, ..., A_n$ of all the eventual conditions of the structure. It can be presented by $P(\Omega)$ the powerset 2^{Ω}.

$$P(\Omega) = 2^{\Omega} = \{\{\ \}, \{A_1\}, \{A_2\}, ..., \{A_1, A_2\}, ..., \Omega\}. \quad (1)$$

Dempster-Shafer theory designate functions (m) called Basic Belief Assignment on the $P(\Omega)$.

$$m : 2^{\Omega} \to [0,1]. \quad (2)$$

It permits not commonly work out the portions of evidence presented by power set $P(\Omega)$. A basic belief assignment (m) appeases:

$$m(\phi) = 0; \quad (3)$$

$$\sum_{A \in P(\Omega)} m(A) = 1. \quad (4)$$

Belief function $Bel(A)$ for a set A is defined as the sum of all Basic Belief Assignment of subsets of A defined and said that a part of faith B are assigned, must be assigned to other hypothesis, that it means:

$$Bel(A) = \sum_{B|B \subseteq A} m(B). \quad (5)$$

The Dempster-Shafer theory also defines the plausibility $Pl(A)$ as the sum of all the Basic Belief Assignment of sets B that intersects the set of A:

$$Pl(A) = \sum_{B|B \cap A \neq 0} m(B). \quad (6)$$

2. THE PROBLEM

Since the entire linear programming model of an abridged interpretation of the problem of the routes of the ship is an unacceptable solution times for a typical daily planning process, a heuristic approach to decide on the hand. Author determined on this approach for its implementation comparatively straight computation, as well as its record of good results with congruous issues to the inherent.

There are a few other algorism such as Dijkstra′s algorithm, which is an individual source-single goal shortest path algorithm, the Bellman-Ford algorithm to calculate the shortest path algorithm with a free hand, A* algorithm solves the single pair shortest path problems using a heuristic algorithm and Floyd Warshall algorithm to find all pairs of Johnson-perturbation and the shortest path algorithm to find the shortest path locally. Genetic algorithms are also used to finding shortest path [1]. In this article to calculating author decided to use algorithm presented by Dijkstra.

2.1. Model input

Contribution to the example record vessel properties, motion report data and digital climate

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prognosis data: the example will join consumption curves, velocity diminution curves, vessel class, ship wind and weather sea borders, motion statement velocity, maximal permitted speed, motion statement trace data to contain waypoints, their latitude and longitude. On top of it to data related to the motion of the ship it is indispensable to the specification of the surroundings. In particular significant is the specification of the practicable routes between the first point and the last one.

2.2 Dijkstra's algorithm

For a published source apex (node) in the graph, the algorism discovers the way with smallest cost (i.e. the shortest path) among that vertex and every other ones. It could also be used for discovering the smallest cost way from one vertex to a goal vertex by stoppage the algorism is intended by the smallest way to the goal vertex. For instance, if the apexes of the graph describe the cities and there are given costs of flowing ways distances among pairs of points combined immediately to the road, Dijkstra′s algorism can be used to discover the briefest route among one city and all other cities. Consequently, the briefest path algorism is highly used in routing protocols in a web network, in particular the IS - IS and Open Shortest Path First. [10]

2.3 Ant Colony Optimization

Ant Colony Optimization is the general name of the algorithm which is inspired by a behavior of feeding of ant. Almost all Ant Colony Optimization algorithms are based on Ant System [4] which was proposed by Dorigo. Ant Colony System [3] is an algorithm which improved Ant System and it has better searching performance than Ant System. Therefore, we adopt Ant Colony System as a base algorithm. Hereafter, Ant Colony Optimization indicates Ant Colony System in this paper. The searching on Ant Colony Optimization utilizes two evaluations which consist of the static value and the dynamic one. The static evaluation is peculiar information of the target problem. Usually, a reciprocal number of the distance is adopted as the static evaluation value, when Ant Colony Optimization is applied to the route searching problem such as Traveling Salesman Problem. On the other hand, the dynamic evaluation introduces pheromone amount. Specifically, the optimization procedure of Ant Colony Optimization is explained using an example of which Ant Colony Optimization is applied to Traveling Salesman Problem. First, the random number q between from 0 to 1 is generated. Next, q is compared with benchmark (parameter) q0. When q is smaller than q0, the city that has the largest value of the product of the static evaluation and the dynamic one is selected as the next destination.[12]

2.4 Extended version of routing algorithm

It differs from general Traveling Salesman Problem when Ant Colony Optimization is applied to the route searching problem, and there are the following two problems:

- the moving destination has been limited, and
- the ant argent is trapped in the blind alley.

Regarding the problem (1), the proposed algorithm solves it by separately handling the un-visit node, the visited node and the moving candidate node, respectively. In addition, regarding the blind alley of the problem (2), the proposed algorithm overcomes it by adopting Tabu search. Here, the situation of which the ant agent is trapped in the blind alley represents that the ant agent has not reached the final destination and no moving candidate node exists. In other words, the current node of which the ant agent stays has only the connections to the visited nodes. Specifically, the situation of which the ant agent is trapped in the blind alley is explained using Fig.2. In this example, the ant agent moved in order of a, b, c, d and e, and is trapped in the blind alley.

In the proposed algorithm, first of all, the ant agent returns to the previous node. That is, the ant agent moves to node d, and the node e is set on taboo. Thus, the node e is excluded by ant agent's moving destination candidate as shown in Fig.3.

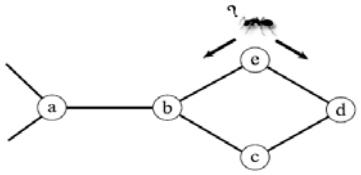

Figure 2 Example of the situation of which the ant agent is trapped in the blind alley

However, the node d has no moving candidate node as well as the previous situation. In this case, the node d has only the visited node and the taboo node. Therefore, the ant agent returns to the previous node as well as the previous processing regarding the taboo operation as shown in Fig.4.

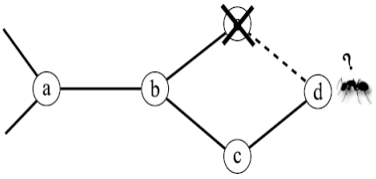

Figure 3 Example of the situation of which the node e is excluded by ant agent's moving destination candidate

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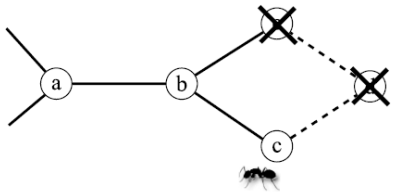

Figure 4 Example of the situation of which the ant agent returns to the previous node

These processing are repeated until the moving destination candidate's node appears. The concrete procedure is as follows.

1 Select the start node and the destination node (target node).
2 Select the node using equations (1), (2), and (3).
3 Move to the selected node and mark the current node as the visited node.
4 Taboo operation is executed when no moving candidate node exists.
5 Repeat from Step2 to Step4 until the ant agent reaches to the final destination.
6 Update the pheromone value.
7 Repeat from Step2 to Step6 until the generations are terminated.

Thus, the proposal algorithm enables Ant Colony Optimization to be applied to the route searching problem including the blind alley, by combining Tabu search with Ant Colony Optimization.

5. CONCLUSIONS

The Dijkstra algorithm is well known. It was first published half a century ago. To this day, finding connections between vertices is used. But not always the shortest path is the best. It is to consider various criteria. This paper is an introduction to further research.

Shortest path problems widely exist in real world applications. The paper presents a model to be considered and an algorithm for routing in road network of uncertainty of status information of roads, cost factors and their uncertainty. In presented model uncertainty have the probability values using defined probability of at least and maximum values using Dempster-Shafer theory. Decision rules can be defined for nodes by the end user. The calculations are based on basic belief assignment values. Results of presented paper can be used for travel decisions, in which the decision is a binary, crisp values, intervals and fuzzy numbers.

The proposed algorithm combined Tabu search with Ant Colony Optimization. This hybrid technique was able to find the shortest route when the blind alley existed in the map. Experiments proved the effective searching performance compared with Dijkstra algorithm

7. REFERENCES

[1] Bagheri H., Ghassemi H., Dehghanian *A.: Optimizing the Seakeeping Performance of Ship Hull Forms Using Genetic Algorithm. TransNav,* the International Journal on Marine Navigation and Safety of Sea Transportation, Vol. 8, No. 1, pp. 4957 (2014)

[2] Dempster, A. P.: *A generalization of Bayesian inference. Journal of the Royal Statistical Society,* Series B, Vol. 30, pp. 205-247 (1968)

[3] Dorigo M., Gambardella L.M, "*Ant colony system: a cooperative learning approach to the traveling salesman problem",* IEEE Transactions on Evolutionary Computation, vol.1, No.1, 1997, pp. 53-66.

[4] Dorigo M., Maniezzo V., Colorni A., *"Ant system: optimization by a colony of cooperating agents"*, IEEE Transactions on Systems, Man, and Cybernetics, Part B, Vol.26, Issue 1, pp.29-41, 1996.

[5] Filipowicz, W.: *Fuzzy Reasoning Algorithms for Position Fixing.* Pomiary Automatyka Kontrola 2010(12), pp. 1491-1494 (2010)

[6] Neumann T.: *Multisensor Data Fusion in the Decision Process on the Bridge of the Vessel. TransNav,* the International Journal on Marine Navigation and Safety of Sea Transportation, Vol. 2, No. 1, pp. 85-89, 2008

[7] Neumann, T.: *A Simulation Environment for Modelling and Analysis of the Distribution of Shore Observatory Stations - Preliminary Results. TransNav,* the International Journal on Marine Navigation and Safety of Sea Transportation, Vol. 5, No. 4, pp. 555-560 (2011)

[8] Neumann, T.: *Method of Path Selection in the Graph - Case Study. TransNav,* the International Journal on Marine Navigation and Safety of Sea Transportation, Vol. 8, No. 4, pp. 557-562 (2014)

[9] Neumann, T.: *Good choice of transit vessel route using Dempster-Shafer Theory*. International Siberian Conference on Control and Communications (SIBCON), IEEE (2015)

[10] Neumann, T.: *Parameters in the softwares model to choose a better route in the marine traffic.* International Journal of Machine Intelligence, 454-457 (2015)

[11] Shafer G.: *A mathematical theory of evidence.* Princeton University Press (1976)

[12] Yoshikawa M., Otani K., *Ant Colony Optimization Routing Algorithm with Tabu Search,* Proceedings of the International MultiConference of Engineers and Computer Scientists 2010 vol III, IMECS 2010, pp. 2104 - 2107

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DATA OF POLLUTION ON SURFACE WATER AND GROUNDWATER

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Abstract: In this paper we investigate the impact of pollution on the surface water and groundwater. For this, we collect samples from Harbour Tomis Constanta, South Mamaia, Siutghiol Lake, Tabacarie Lake , water from a fountain and water which proves from stink.

We analised the physical and chemical parametres of all samples. Finally, the results demonstrated that water samples from areas North Mamaia, Harbour Tomis, Siutghiol Lake, Lake Tabacarie have the values of quality indicators higher that values from Water Pollution Technical Standards. The samples from fountain and from stink are not polluted. So, we can talk about pollution of those waters resulting from the activities undertaken by people of course, because of the attraction of these areas.

Key words : pollution, water, ground water, sample, parameter, harbour, lake, city, collect.

1. INTRODUCTION

Water can not miss in human life and can not be relaced by anything, it is considerate " blood of Earth" or " herth Biosphere", that is always found where there is life.Water in the common name aplied to the liquid state of the Hydrogen- Oxigen. The ancient philosophers regarded water as a basic element, representattive of all liquid substances. Scientists have not given up this conception that in the second half of the eighteenth century.In 1781, the English chemist Henry Cavendish synthetized water by detonating a mixure of hydrogen and air. Water pollution is the contamination of streams, lakes, groundwater,oceans and seas of substances harmful to the environment which results in a change in conditions or physico-chemical and biological characteristics of water that is so prejudicial to its normal use. After business, people give most of the pollutants that damage water quality. Resulting pollutants are considered major water pollutants.

Those there are: *Petroleu products, Sediments, Pesticides and ierbicides, Metals, Wastes, Excessive amounts of organic matter, Infectious organisms, Thermal pollution.*

2. METHOD AND RESEARCH

2.1 Collecting data

Samples analyzed [2] were collected for three consecutive months from January until March 2015, month range of 3-10 from fountain water, water from CET Palas, Tabacarie Lake, Harbour Tomis , North Mamaia, Siutghiol Lake (Figure 1, Figure 2, Figure 3, Figure 4) [1].

Figure 1 The sample from harbour Tomis [1]

Figure 2 The sample from North Mamaia [1]

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Figure 3 The sample from Siutghiol Lake

Figure 4 The sample from Tabacarie Lake

After collecting data the results are centralizing and comparing [3].

2.2 Results

The results of study are presented below (Table 1 to Table 5) [1].

Table 1. Hardeness of Calcium (mg/L)

Data of collect	Experimental values of Calcium Hardness (mg/L)					
January 2015	Collect location					
	1	2	3	4	5	6*
	246,4	70	53,27	39,2	67,33	30
February 2015	210,2	58,8	47,6	42	36,87	33
March 2015	196,2	53,2	44,8	33,6	41,68	35,5
Medium average	217,6	60,6	48,5	38,2	48,6	32.8
STAS 3662 - 62	100 - 180					
Posted difference	37.6	-	-	-	-	-

Where: 1- Tomis harbour; 2-North Mamaia; 3-Tabacarie Lake; 4-Siutghiol Lake; 5-Fountain water; 6- Stink water CET.

Table 2. Hardeness of Magnesium (mg/L)

Data of collect	Experimental values of Calcium Hardness (mg/L)					
January 2015	Collect location					
	1	2	3	4	5	6*
	428	266	266,3	286	223,6	167,8
February 2015	888,8	255,1	263,5	274,7	214,9	167
March 2015	776,6	249,5	260,7	277,6	233,8	172,9
Medium average	697,8	256,8	263,5	279,4	224,1	169,2
STAS 6674 - 77	50 – 80					
Posted difference	617,8	176,8	183,5	199,4	144,1	89,2

Where: 1- Tomis harbour; 2-North Mamaia; 3-Tabacarie Lake; 4-Siutghiol Lake; 5-Fountain water; 6- Stink water CET.

Table 3. Total Hardeness (mg/L)

Data of collect	Experimental values of Calcium Hardness (mg/L)					
January 2015	Collect location					
	1	2	3	4	5	6*
	124,7	33,6	31,96	32,5	26,8	42,8
February 2015	110	31,4	31,1	31,6	34,1	43,1
March 2015	97,2	30,2	30,5	31,1	38,3	44,8
Medium average	110,6	31,73	31,2	31,7	33	43,5
STAS 3026 - 76	20 – 30					
Posted difference	80,6	1,73	1,2	1,7	3	13,5

Where: 1- Tomis harbour; 2-North Mamaia; 3-Tabacarie Lake; 4-Siutghiol Lake; 5-Fountain water; 6- Stink water CET

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Table 4. Values of pH

Data of collect	Experimental values of Calcium Hardness (mg/L) Collect location					
January 2015	1	2	3	4	5	6*
	8,51	8,71	8,19	8,73	7,48	7,49
February 2015	8,62	8,58	8,48	8,78	7,67	7,5
March 2015	8,69	8,92	8,7	8,82	7,5	7,58
Medium average	8,6	8,73	8,45	8,77	7,55	7,52
STAS 6325 - 75	6,5 - 8,5					
Posted difference	0,1	0,23	-	0,27	-	-

Where: 1- Tomis harbour; 2-North Mamaia; 3-Tabacarie Lake; 4-Siutghiol Lake; 5-Fountain water; 6- Stink water CET.

Data of collect	Experimental values of Calcium Hardness (mg/L)					
January 2015	Collect location					
	1	2	3	4	5	6*
	471	602,3	596,2	685	365,65	63,9
February 2015	482	610,3	605,8	692,7	213	64,1
March 2015	479,25	621,25	621,25	710	276,9	63,7
Medium average	477,41	611,28	607,75	695,9	285,18	63,9
STAS 3049 - 88	250 – 400					
Posted difference	77,41	211,28	207,75	295,9	-	-

Where: 1- Tomis harbour; 2-North Mamaia; 3-Tabacarie Lake; 4-Siutghiol Lake; 5-Fountain water; 6- Stink water CET.

2.3. *Graphycal interpretations*

The graphycal iterpretations of results are presented below (Figure 5, Figure 6, Figure 7, Figure 8, Figure 9).

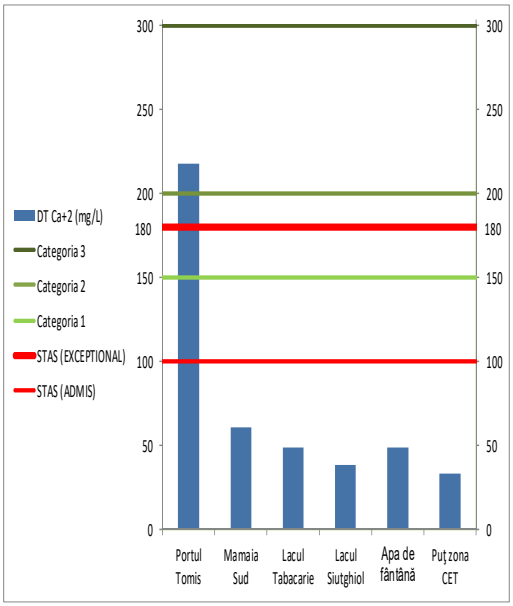

Figure 5 Hardness of Calcium evolution [1]

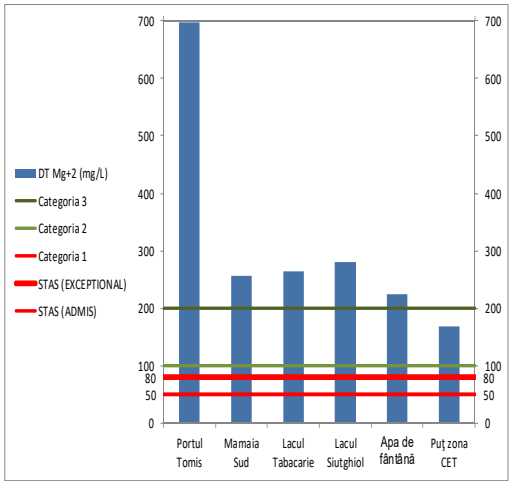

Figure 6 Hardness of Magnesium evolution [1]

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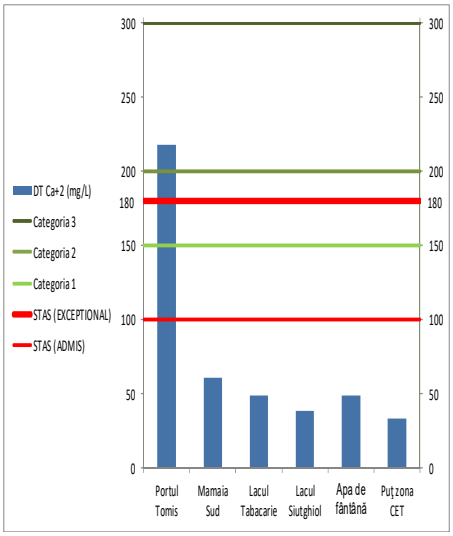

Figure 7 Total Hardness evolution [1]

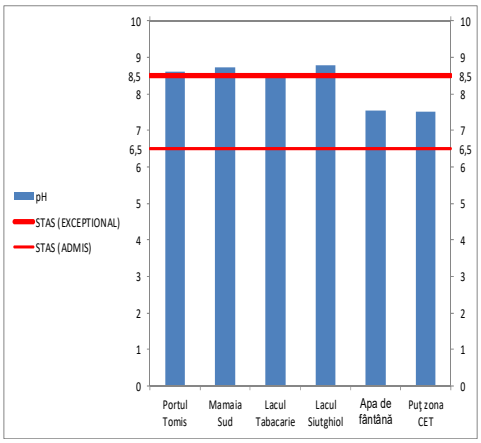

Figure 8 pH evolution [1]

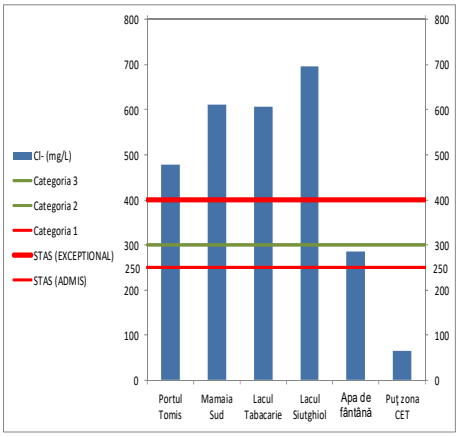

Figure 9 Chloride Hardness evolution [1]

All samples were analized and conclusions were presented for each location.

3. CONCLUSIONS

The results demonstrated that water samples from areas North Mamaia, Harbour Tomis [4], Siutghiol Lake, Lake Tabacarie [3] have the values of quality indicators higher that values from Water Pollution Technical Standards. The samples from fountain and from stink are not polluted. So, we can talk about pollution of those waters resulting from the activities undertaken by people of course, because of the attraction of these areas.

4. REFERENCES

[1] Nichita M., Panaitescu M., Draganoiu A., 2015, *Impact of pollution on surface water*, Scientifical sesion of students, Constanta Maritime University, section Environmental engineering, May, 2015.
[2] Bors, L., *Tehnici de laborator. Indrumar de curs si lucrari practice,* Editura paralele 45, 2002.
[3] Panaitescu, M., Panaitescu, F.V., Draganoiu, A., 2010, *Tehnici experimentale de analiza a apei,* Editura EXPONTO, 2010.
[4] XAVIER MARTÍNEZ DE OSÉS F., MARCEL·LA CASTELLS, *The impact on emissions in sw european short sea shipping based on mopsea emission model,* Journal of Marine Technology and Environment, vol. 1, 2010.

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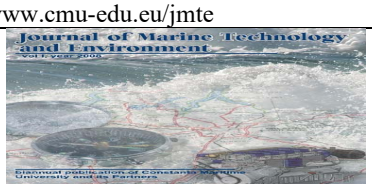

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A METHOD FOR FLOW MODELLING OF VULNERABLE AREAS

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Abstract : This paper presents the floods of the waters on Timis River in compliance with the provisions of the legislation from Romania correlated with that of the European Union modelling in MIKE11 software. Flooding that occurs in the Banat basin is a natural and frequent phenomenon on the water courses in this catchment area, where 1,085 km of the water courses are dammed and there are also numerous hydrotechnical and water management works. Although these works are well made and are intended to protect against floods, a review of these natural phenomena occurring in Banat highlights the fact that over a period of approximately 250 years, major flooding has occurred with a frequency of about once every 30 years, and in some cases these phenomena occur every few years, for example the floods of 2005 which occurred just five years after the floods of 2000. In almost every month in 2005 (February-September), throughout Romania, river water volumes exceeded the capacity that water defences were built to handle. The most important floods in Banat occurred in April. In April 2005 heavy rains were recorded in the Banat region: Oraviţa (226.4 mm), Resia (205.3 mm), Lugoj (201.2 mm), Caransebeş (200.6 mm). These rain falls exceeded reviously recorded maximum monthly levels. This rainfall combined with snow melt – the thickness of snow layers in the mountains at that time exceeded one meter (Ţarcu - 126 cm, Semenic - 26 cm) – led to historically significant flooding from April to September 2005, affecting extensive areas and resulting in casualties and significant property damage. In this paper we present a method of flow modelling (for year 20050) which can use with the same tools for another vulnerable areas.

Key words: flood, flooding, cross section, causes, effects, river.

1. INTRODUCTION

In this paper we choose a white space erodible river in Timis basin, for a flow simulation in Mike11 from DHI.

The Timis River Basin is a large and ramified trans-boundary river system, with a population of over one million people. The drainage area is 13,085 km^2 in Romania and 8,085 km^2 in Ukraine. The river Timis is 241 km long and drains into the Black Sea. The worst floods in 2005 caused loss of human life and substantial damage when the river reached a height of 844 cm. In 2007, elevation works of the embankments took place on both sides of the river along a length of almost 25 km raising the height to an overall 8.5 m. The impact of the floods had been heightened by the lack of real-time water level monitoring and forecasting, as well as a failure to take flood risks and the interests of different water users into account in urban zoning policy. In the absence of accurate and sound flood forecasting, the elaboration and implementation of any flood damage mitigation programme is also less effective. There was therefore a need for realistic and integrated strategies to deal with flooding. The river flows through Romania for 241 km (150 miles), and 118 km (73 miles) through Serbia.[1]. (Figure 1).

Figure 1 Map of Timis-Cebza river[6]

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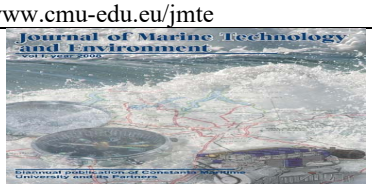

For this model of the river bed we need the following elements need to be studied:

a. Data location and description of the catchment area, applicable to Timis-Cebza ;
b. Data on power sources aquifer basin, applicable to Timis-Cebza;
c. Balance river flows in the Timis basin;
d. Reporting to the climatological normal space Timis basin .
e. Hydrometeorological regime for Timis Cebza catchment area.

Taking into account the implementation of different proposed structural measures some variants were modelled by others, to take into account different polders, flooded area, reservoirs and dams.

Figure 2 Map of vulnerable areas[4]

Using modelling results, both for floods and for water resources development, different scenarios were provided for water management master plan for Timis Basin, looking for solutions for sustainable management. These scenarios help in up-grading the exploitation rules during floods and to make pertinent proposals for rehabilitation of water works. (Figure 3)

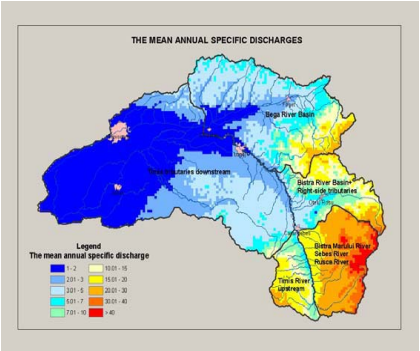

Figure 3 The mean annual specific discharges[4]

General awareness about the Danube Basin as a priceless regional asset has been growing. Since the environment is increasingly recognized as the vital link between the quality of human life and sustainable development, there is also a growing awareness among national governments, industrial and large agricultural plants managers of the need to consider the interests of all stakeholders when making decision about the environment. The management of water resources and protection of the environment must be planned for the long term to ensure a sustainable, wise use of the resources, as well as in real time to protect population during floods and accidental pollution. For both aspects, a continuous registration of data (historical database- Figure 4) as well a good hydrological informational system is the base for the decision – the water body knowledge. This is the reason of our demonstrative project: to organize a monitoring system, as well as a numerical database in a GIS environment. [4]

With this information, a land use planner is then able to make appropriate decisions, taking into account possibilities of flooding, erosion, nutrient export, and non-point source pollution.

River	Station	Qmed	F(km²)	H_m (m)	q_m(l/s/km²)
Bega	Lunca	3.38	73.5	775	18.8
Bega	Fugt	4.89	474	470	10.3
Bega	Balint	7.00	1064	335	6.6
Bega	Chizatau	9.00	1685	270	5.3
Sura	Poieni	1.11	80	763	13.9
Gladna	Firdea	0.681	57	458	12.0
Gladna	Surduc	1.09	130	376	8.4
Hauzeasca	Firdea	0.265	29	364	9.1
Moniel	Minic	0.134	23	261	5.8
Cladova	Cladova	0.083	15	184	5.5
Chizdia	Chizdia	0.564	226	194	2.5
Timir	Teregova	2.77	167	901	16.6

Figure 4 Mean multiannual discharges at the hydrogical stations in the Timis-Bega Basin[4]

In April 2005, precipitation values recorded at 12 meteorological stations in theBanat physiographic zone exceeded normal values, in some cases by 200 mm (Figure 5). Most of these excessive rainfall amounts were recorded in three short intervals during the second half of April. Rainfall in May was concentrated in the southern part of the country with heavy and intense precipitation events exceeding normal amounts by 100 mm at many stations from the Romania river basins. [3]

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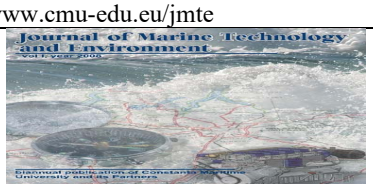

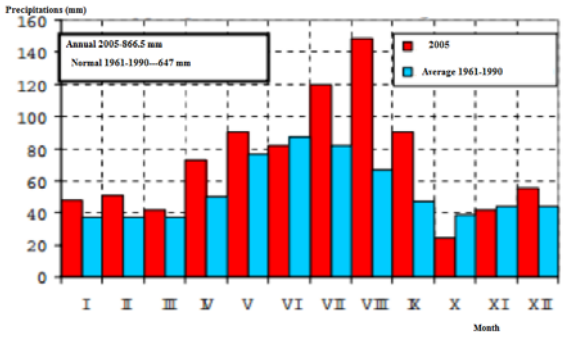

Figure 5 Monthly precipitation in 2005 and normal amounts [3]

The worst flooding of the last 35 years occurred in 2005, primarily due to high quantities of precipitation, which were generated by intense cyclonic air movement across the entire European continent. High air temperatures also helped set the stage for record flood conditions. Last, but not least, extreme water flows were augmented by sudden snow melts. The combination of these causes led to several successive record-level flash floods along the inferior course of the Timiş River. Water spilling over the dam canopy (Figure 6) at Crai Nou led to accelerated erosion and the formed two breaches around the dam on the right bank of Timiş River.

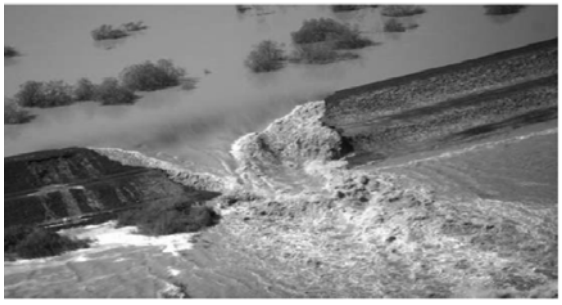

Figure 6 Effects of 2005 floods

2. TIMIS CEBZA FLOW SIMULATION IN THE RIVERBED BY MIKE 11 PROGRAM

a. MIKE 11 software

MIKE 11 is synonymous with top quality river modelling covering more application areas than any other river modelling package available. Mike 11 is useful for project deals with flooding, navigation, water quality, forecasting, sediment transport, a combination of these or other aspects of river engineering.

The software has a lot of benefits:

- MIKE 11 can get one of the world's most well proven and widely applied 1D river modelling packages
- MIKE 11 is the preferred choice for professional river engineers when reliability, versatility, productivity and quality are keywords
- It is a powerful river modelling toolbox with more features than any other river modelling package
- MIKE 11 is the software product, which made the MIKE brand name synonymous with top quality modelling software from DHI and it remains one of the most widely used MIKE by DHI products.[8]

On the input/edit side MIKE 11 features:

- graphical data input/editing
- simultaneously input/editing of various data types
- Copy & paste facility for direct import (export) from e.g. spreadsheet programs
- fully integrated tabular and graphical windows
- importing of river network and topography data from ASCII text files
- user defined layout of all graphical views (colours, font settings, lines, marker types etc.)

On the Output side, advanced presentation facilities are available, including:

- coloured horizontal plan graphics for the system data and results
- animated presentation of results in horizontal, longitudinal and time series plot
- synchronised animation of results
- presentation of external time series
- copy & paste facility for exporting result tables or the presentation graphics into other applications (spreadsheet, word processing or others)

b. *Modeling equations*

The equations for the flow cross-section are the Saint-Venant equations and for along the riverbed flow (ec.1, ec.1', ec. 1"), the turbulent flow equations, ie equation for turbulent kinetic energy (eq.2), dissipation equation ε (eq. 3):

$$\rho \cdot Q \cdot dt - \rho \cdot (Q + \frac{\partial Q}{\partial x} dx)dt = \rho \cdot dA \cdot dx = \quad (1)$$

$$= \rho \cdot \frac{\partial A}{\partial t} dx \cdot dt;$$

$$\frac{\partial Q}{\partial x} = \frac{\partial A}{\partial t}; \quad (1')$$

$$\frac{\partial Q}{\partial x} - B \cdot \frac{\partial h}{\partial t} = 0; \quad (1")$$

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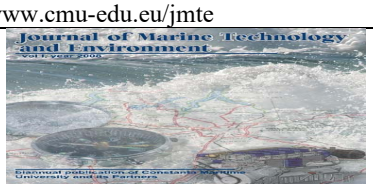

$$\frac{\partial}{\partial t}(\rho_m k)+\nabla\cdot(\rho_m \bar{v}_m k)=\nabla\cdot\left(\frac{\mu_{t,m}}{\sigma_k}\nabla k\right)+ \quad (2)$$
$$+G_{k,m}-\rho_m\varepsilon;$$

$$\frac{\partial}{\partial t}(\rho_m \varepsilon)+\nabla\cdot(\rho_m \bar{v}_m \varepsilon)=\nabla\cdot\left(\frac{\mu_{t,m}}{\sigma_\varepsilon}\nabla\varepsilon\right)+ \quad (3)$$
$$+\frac{\varepsilon}{k}(C_{l\varepsilon}G_{k,m}-C_{2\varepsilon}\rho\varepsilon);$$

where
ρ_m is the mixture density (ec. 4) consists of several phases (α_i .... α_N) with density ρ_i; $\bar{v}_m$ is vector speed (ec. 5), $C_{l\varepsilon}$ is concentration of component z, k is tensor of permeability, $\mu_{t,m}$ is mixture turbulent kinematic viscosity (ec. 6), ε is volume fraction of the α phase:

$$\rho_m=\sum_{i=1}^{N}\alpha_i\rho_i; \quad (4)$$

$$\bar{v}_m=\frac{\sum_{i=1}^{N}\alpha_i\rho_i\bar{v}_i}{\sum_{i=1}^{N}\alpha_i\rho_i}; \quad (5)$$

$$\mu_{t,m}=\rho_m C_\mu\frac{k^2}{\varepsilon}, \quad (6)$$

with C_μ a constant.

c. *Boundary conditions of the flow*:
Boundary conditions of the flow are:
• discharge flow upstream of the control section, downstream;
• tributaries flow;
• condition for convergence solution-end flow, Q = 0;
• water depth, h (1 ÷ 2.0) m;
•weather-wind, currents;
• conditions for Q / h downstream flow (never upstream).

d. *Modelling flood*

First of all, we need a cross section of the river. The cross sections are integrated in the MIKE11 simulation as a function. For example, the function Width (Level). As a result, forelands with a dike between river and foreland have to be simulated separately: otherwise the foreland will already contain water before the water level reaches the top of the dike. Processed data look like follow:

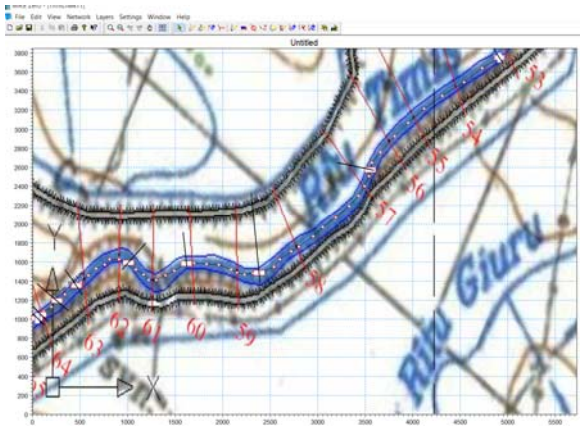

Figure 7 Cross section in Mike11

Here we make a subdivision below the branch name in 'TOPO-IDs'. This can be used for calculating alternative cross sections for one branch. The TOPO-ID being used in the simulation has to be defined for that branch in the network file (tabular view). The last point being mentioned in this chapter is related to the markers of a cross section. For the coupling especially the marker No 2 is obligatory (Bottom of profile). Using the option "Cross Sections/Apply to all sections" the markers 1, 2 and 3 can be updated for all cross sections at once. By using "Settings/Cross-Section/Update Markers" one can select which of the markers have to be updated. Processed data look like follow (Figure 8):

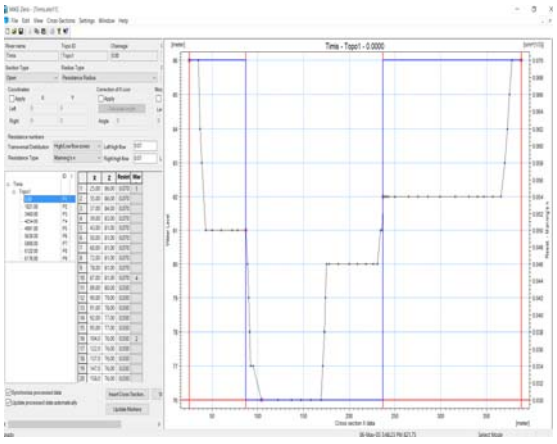

Figure 8 Branch name TOPO1

Based on topographic data, initial hydraulic data and data obtained by graphic-analytical and also the limnimetric key of Timis-Cebza riverbed using MIKE 11 software was simulated a flow specific to a situation of flood in 2005 (Figure 9).

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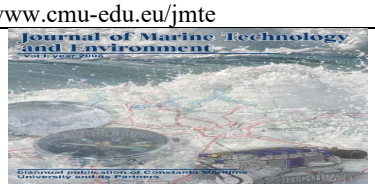
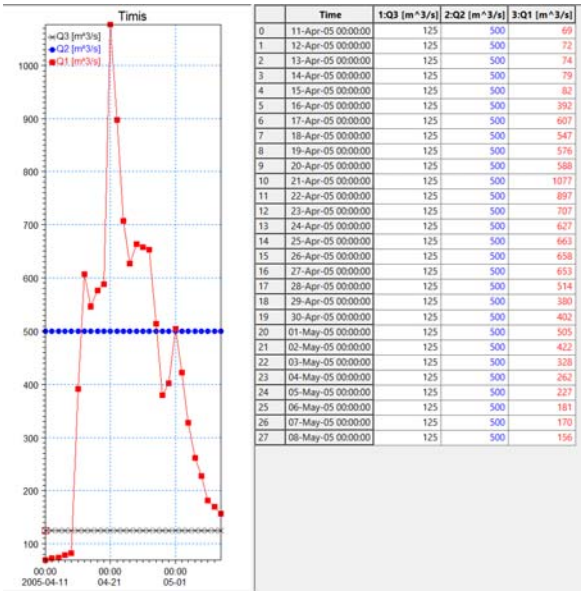




	Time	1:Q3 [m^3/s]	2:Q2 [m^3/s]	3:Q1 [m^3/s]
0	11-Apr-05 00:00:00	125	500	69
1	12-Apr-05 00:00:00	125	500	72
2	13-Apr-05 00:00:00	125	500	74
3	14-Apr-05 00:00:00	125	500	79
4	15-Apr-05 00:00:00	125	500	82
5	16-Apr-05 00:00:00	125	500	392
6	17-Apr-05 00:00:00	125	500	607
7	18-Apr-05 00:00:00	125	500	547
8	19-Apr-05 00:00:00	125	500	576
9	20-Apr-05 00:00:00	125	500	588
10	21-Apr-05 00:00:00	125	500	1077
11	22-Apr-05 00:00:00	125	500	897
12	23-Apr-05 00:00:00	125	500	707
13	24-Apr-05 00:00:00	125	500	627
14	25-Apr-05 00:00:00	125	500	663
15	26-Apr-05 00:00:00	125	500	658
16	27-Apr-05 00:00:00	125	500	653
17	28-Apr-05 00:00:00	125	500	514
18	29-Apr-05 00:00:00	125	500	380
19	30-Apr-05 00:00:00	125	500	402
20	01-May-05 00:00:00	125	500	505
21	02-May-05 00:00:00	125	500	422
22	03-May-05 00:00:00	125	500	328
23	04-May-05 00:00:00	125	500	262
24	05-May-05 00:00:00	125	500	227
25	06-May-05 00:00:00	125	500	181
26	07-May-05 00:00:00	125	500	170
27	08-May-05 00:00:00	125	500	156

Figure 9 Flow simulation for three flow discharge in 2005

The result of the MIKE 11 simulation program consists of a contemporary representation while during flood flow path on the Timis-Cebza course, viewing velocity vector (black, Figure 10) for the entire length of the river.

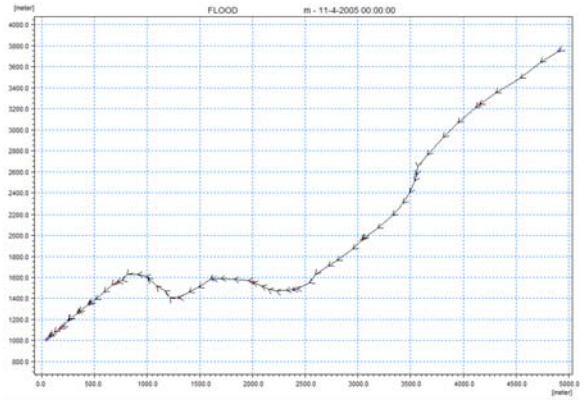


Figure 10 Flow visualization and velocity vector along the riverbed Timis-Cebza

The final results of modeling with MIKE 11 program are plotting and maximum rates for the flood of 2007 (Figure 11) and flow profile along the riverbed Timis-Cebza (Figure 12) .

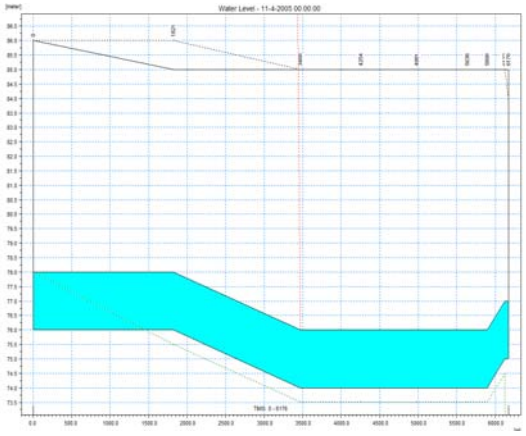


Figure 11 Shares riverbed for flood in 2005

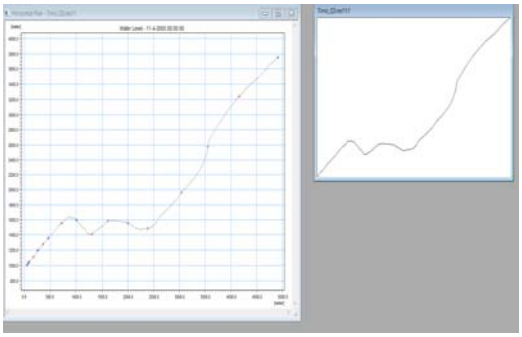
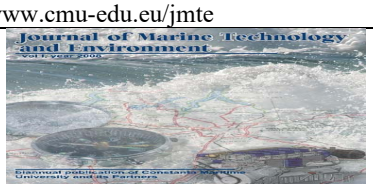


Figure 12 The final flow profile along the riverbed Timis-Cebza

On the length of Timis-Cebza river was represented the allowance variation of the riverbed, the distribution of the velocity vector for related shares initially introduced in the program.

3. CONCLUSIONS

For studying the flow in the Timis-Cebza riverbed eroded with environmental risk were analyzed elements: location and description of the hydrographic area, data sources feeding the aquifer basin data sources feeding the aquifer basin balance flows to the hydrographic area Timis for 2005, reporting to the climatological normal catchment area Timis; morphological and morphometric elements of the bed of the guests; Timis-Cebza riverbed proper flow modeling; risk analysis in the event of floods.



Building the model accordingly to Timis-Cebza basin riverbed assumed the existence of a stage modeling that was done with the program MIKE 11 situation of 2005, the hydrograph basin Timis-Cebza, based hietogramei rainfall; then simulated the flow along the river, indicating the distribution of speeds of flood related natural hydrograph.

Environmental risk analysis appropriate basin bed Timis-Cebza imposed through some stages of analytical calculation [10] and construction of flood wave hydrograph and its separation into its basic components, and use the same program to raise MIKE 11 hydrographer.

Following theoretical and experimental findings about river conditions change in response to the liquid phase flows and sediments are:

Current depth is directly proportional to fluid flow and inversely proportional to the flow of solid material dragged;

• limits the embankments of river bed varies in direct proportion to the flow of liquid and solid material;
• varying flow is directly proportional to the variation solid ratio width / depth;

• slope of the river bed varies in direct proportion to solid and grain alluvial flow and inversely proportional to fluid flow;

• river meanders rate is directly proportional to the variation in relief and inversely proportional to the solid flow.

4. REFERENCES

[1] DHI-WASY Software IfmMIKE11 2.1, User Manual
[2] Panaitescu M., *Hydraulic modelling and evaluation of surface waters with environmental risk (Modelarea hidraulicã şi evaluarea apelor de suprafaţa cu risc de mediu)*, pp.44-47, Editura Nautica, 2016.
[3] Codea D.M., *Timis river flooding in Banat (Romania) in 2005*, Politehnica University of Timisoara, Transylv. Rev. Syst. Ecol. Res. 15- special issue, (2013), The Timis River Basin
[4] LIFE00 ENV/RO/000986 – Riverlife Project
[5] Government Decision no. 893/2006, amending Government Decision nr.1593/2002, approving the National Plan of preparedness, response and cooperation in marine pollution by hydrocarbons;
[6] https://www.google.ro/maps/
[7] http://en.wikipedia.org/
[8] https://www.mikepoweredbydhi.com/products/mike-11
[9] SAJIN TUDOR, NEDELCU DRAGOS-IULIAN, *Mathematical modeling of the new system for capture of wave energy*, Journal pof Technology and Environment, vol;. 2, pp.55-59, Editura Nautica, 2013.
[10] Anton, I.A., Panaitescu, m., Panaitescu, F.V., *Applications in Matlab using Finite element method,* Journal pof Technology and Environment, vol;. 2, pp.7-14, Editura Nautica, 2015.

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VALIDATION OF DIVER'S THERMAL BALANCE EQUATION IN SUBSEA HYPERBARIC ENVIRONMENT AT AIR DIVING

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Abstract: The solution of diver's thermal balance equation in subsea hyperbaric environment was validated by experimental diving with air breathing, in the simulator of Laboratory Hyperbaric Diving Center. They were calculated theoretically end temperatures of divers submerge in heat water (21-22 ^{0}C) and cold water (15-17 ^{0}C), with equation (1.3). They were measured temperatures of end diving, for each subject, in each scenario diving (depth, water temperature, stationary time, thickness suit, etc.). Theoretically temperatures were compared with those obtained experimentally and the differences between theoretical and real values were 0.1 – 0.5 ^{0}C. The mathematical proposed model is valid for diving in hyperbaric environment simulated wet, up to 60 m depth and for air breathing gas unit diving.

Key words: diver, theoretical temperature, experimental temperature, validation, air correction factor.

1. INTRODUCTION

The studies of thermal transfer phenomenal that occur during simulated diving performed in hyperbaric environment wet have lead to the establishment of differential equation of thermal balance of the diver:

$$mc_c\frac{dT}{dt}=\dot{Q}_m-\frac{T-T_a}{R_{(p)}}A-l_{(p)}\rho_{(p)}x_{(p)}\dot{V}_{(p)}- \\ -\rho_{(p)}c\dot{V}_{(p)}(T-T_a). \quad (1.1)$$

[Constantin A., 2013]

$c=4000$ [J/kgK] for a man undressed [Tarlochan F., 2005]

The positive basal metabolic flux, for men $\dot{Q}_m[W]$ is calculated by taking account of metabolic heat $h_m[kcal]$ produced by the body in 24 hours, according to relationship Harris-Benedict [Shepard Roy J., 2015].

$A\ [m^2]$ - body surface from BSA Diagram [Redlarski G., 2013]

$$h_m[kcal]=66.4730+(13.7516)m+ \\ +(5.0033)h-(6.7550)a\,. \quad (2.2)$$

The diver's thermal balance equation in wet hyperbaric environment, theoretical determinate, has provided an easy solution used to estimate the body temperature depending of stationary time in diving.

$$T_{(t)}=\left(T_0-T_a-\frac{\dot{Q}_m-l_{(p)}\rho_{(p)}x_{(p)}\dot{V}_{(p)}}{\frac{A}{R_{(p)}}+\rho_{(p)}c\dot{V}_{(p)}}\right)e^{-\frac{\frac{A}{R_{(p)}}+\rho_{(p)}c\dot{V}_{(p)}}{mc_c}t}+\frac{\dot{Q}_m-l_{(p)}\rho_{(p)}x_{(p)}\dot{V}_{(p)}}{\frac{A}{R_{(p)}}+\rho_{(p)}c\dot{V}_{(p)}}+T_a \quad . \quad (1.3)$$

[Stanciu T., Constantin A., 2013]

This solution can be validated by diving air breathing gas unit and saturation diving with heliox, in hyperbaric environment wet. This paper is reefer to air experimental diving.

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2. THEORETICAL CONSIDERENTIONS

The differential equation governing heat transfer through the body, in wet hyperbaric environment was deducted considering two ways of skin (conduction and convection) and respiratory heat loss (heating and humidification of air).

$$\dot{Q}_p = mc_c \frac{dT}{dt} = Q_m - Q_c - Q_r . \quad (2.1)$$

[Stanciu T., 2010].

*Assumption: Di*ver's body is considered a cylinder radius r_0, with parallel walls. [Constantin A., 2002].

The conductive and convective thermal flux loss at skin level is (2.2) [Constantin A., 2013].

$$\dot{Q}_c = K_{(p)}(T - T_a) = \frac{1}{R_{(p)}}(T - T_a) . \quad (2.2)$$

Global coefficient thermal transfer at skin level $K_{(p)}$ depends on the convection of the layers and the free convection of suit and water.

Thermal flux at respiratory system has two major components [Stanciu T., 2012]:

$$\dot{Q}_r = \dot{Q}_x + \dot{Q}_s , \quad (2.3)$$

$$\dot{Q}_x = l_{(p)}\rho_{(p)}x_{(p)}\dot{V}_{(p)} , \quad (2.4)$$

$$\dot{Q}_s = \rho_{(p)}c\dot{V}_{(p)}(T - T_a) . \quad (2.5)$$

Assumption: As the diver goes in depth, the pressure regulator delivers air at a higher pressure. Although the respiratory air is saturated, increasing pressure, water vapor remain at a constant pressure, density is constant too, temperature remains at 37^0C (body internal temperature), so moist air inspired not reach saturation. While pressure increases, specific vaporization latent heat $l_{(p)}$ decreases.

Absolute humidity $x_{(p)}$ decreases.

3. EXPERIMENTAL PROCEDURES

The studies made in wet environment from the simulator of Laboratory Hyperbaric Diving Center, supply new data which refer to the evolution of the human body temperature during the dive, depending on pressure. The experiments were effectuated in the Laboratory Hyperbaric Diving Center, in two stages of simulated dives (heat water and cold water), with air, at the depths from the testing plan.

To validate the thermal equation, we selected three subjects A, B and C, with different physiognomies. On Remarque that divers A and B are supple. Subject C is corpulent.

3.1. Description of testing procedures for the coetaneous heat loss

In the first stage they were made simulated wet unit dives, at the depths: 15m with stop at 9m and 30m, stopping at 21m. Festival the water temperature was 20-22 ºC (heat water).

In the second stage they were made simulated wet unit dives, at the depths: 0m, 30m and 60m, in cold water (15-17 ºC).

Each depth stop was made during 16 minutes.

Assumption:

- To keep a good control to the basal metabolic flux, the subjects stood quietly and this flow was held constant over time and depth.
- Except extremities (hand's and feet's fingers), the temperature measured from the body surface, was considered constant.

For each depth: 0, 9, 21, 30, 51 and 60[m], recordings were made of the external temperatures (forearm) and internal temperatures (in the ear), of 2 in 2 minutes, until time τ = 16 min. including.

We measured the diver's temperature before t_{mi} [C^0] and after t_{mf} [C^0] diving.

We measured the water's and atmosphere's temperatures, from the simulator.

The measured values were recording in the bulletins test and then were processed.

The diver A wears a wet suit made of neoprene of 7mm thickness. The diver B wears a wet suit made of neoprene of 5mm or 7mm thickness. The diver C wears a wet suit made of neoprene of 5mm thickness.

Temperature gauges used were:

- 1 immerse professional thermometer from the simulator, Cole - Parmer industrial PROBE RTD GEN PURP 10" ANSI, connected to the analyze rack, on digital thermometer;

1 digital thermometer with immerse mobile external sensor.

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Figure 1 Entry divers in pressurized water simulator for tests

3.2. Description of testing procedures for the respiratory heat loss

The divers immersed at the depths: 0m, 9m, 21m, 30m, 51m and 60m. The measurements for the respiratory heat loss were made in the wet simulator of the Diving Center, outer of the water and the inspiration temperature was considered like the water temperature. The expiration temperature was recorded on the mouth, by the digital thermometer's sensor. Simultaneous was recorded the respiratory volume flow rate by a spirometer Shiller.

The subjects stood still during the dives and inspired air from the pressurized precinct, voluntarily controlling their respiratory volume flow rates. For each diver, we measured the volume flow rate.

To determinate the expired flow $\dot{V}$ the diver inspired air from the precinct and exhaled by the oro nasal masque to the pressure regulator. He was assisted by another diver who recorded temperature exhaled by digital thermometer. At surface it picked exhalation through the pressure regulator, to the spirometer from the outside. The spirometer Shiller has accuracy $\pm 2\%$ and it printed diagrams of volume flow rates.

All these data (t_I ,t_E , $\dot{V}_E$ and τ) were collected on the surface, by two divers, who surveyed the correct work of the hyperbaric chamber.

4. RESULTS

The thermal resistance $R_{(p)}[m^2K/W]$ was theoretically determined for each diver, according to his specific physiologic features, for each depth value: 0, 9, 21, 30, 51 and 60 [m]. The resistance was corrected considering an isothermal compression for the air in the neoprene cells.

We calculated for each subject, $R_{(p)}$ the thermal resistance of the outer layers (of human body and of diver's suit), for the depths: 0, 9, 21, 30, 51 and 60[m]. [Stanciu T., 2014]

After completing the values of other parameters from the equation, which depend of pressure (depth), of water temperature and of internal temperature of the subject, we introduced the solution in the program Microsoft Office Excel and we calculated the value of 2 in 2 minutes, until the second 3600 (1 hour).

We designed diagrams with the evolutions of theoretical and experimental temperatures in time.

In the first seconds, for all diagrams, the temperature drop in contact with water cooler, then in time, the decrease of the slope is smoother.

In the same time period, the temperature drops further, for greater depths.

It observes that for the same subject B, the internal temperature has 1 ^{0}C higher, using thicker suit, 7 mm, compared to 5mm suit, in the same conditions, excepting the thickness suit,.

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Subject C (corpulent) lost about 0,5 ^{0}C less than subject B (supple), in the same conditions and the same diving suit. (see Figures 3 and 4).

We compared the theoretical temperatures values (calculated) with the depths measured experimental values

Listed below are a few charts.

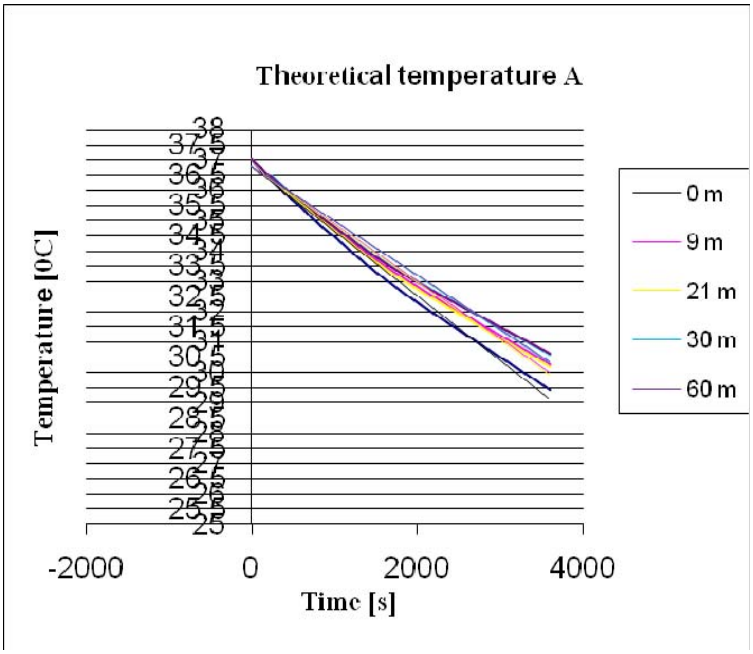

Figure 2 Variation of A (thing) theoretical temperature, suit 7 mm, for 5 depths, heat water

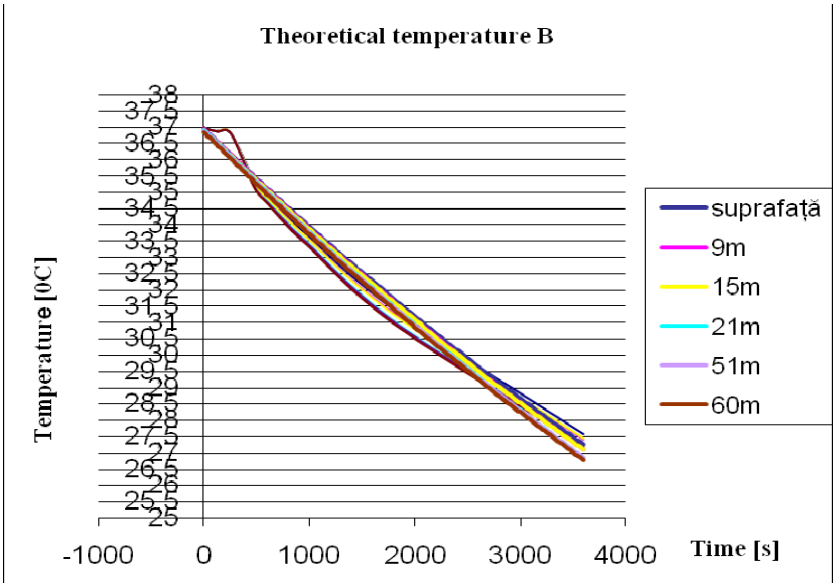

Figure 3 Variation of B theoretical temperature, suit 5 mm, for 6 depths, heat water

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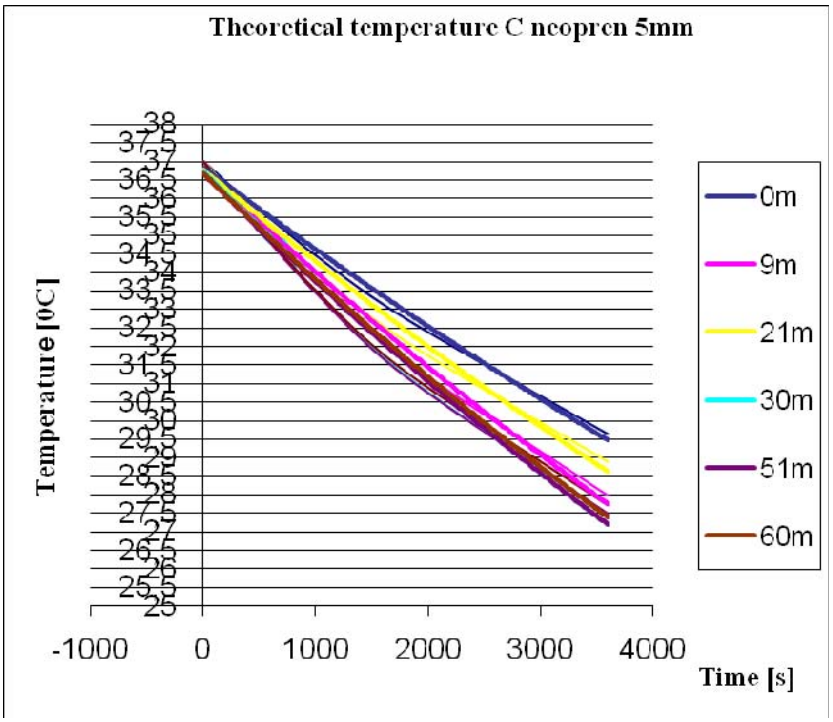

Figure 4 Variation of C theoretical temperature, suit 5 mm, for 6 depths, heat water

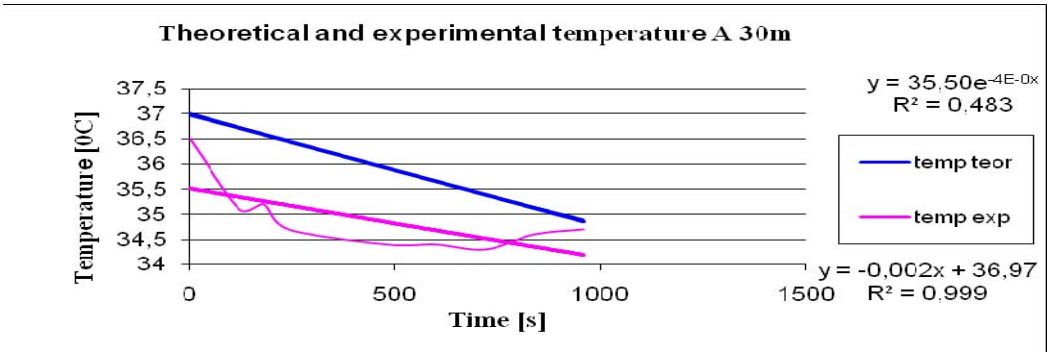

Figure 5 Variation of A theoretical and experimental temperature, suit 7 mm, for 30 m depth

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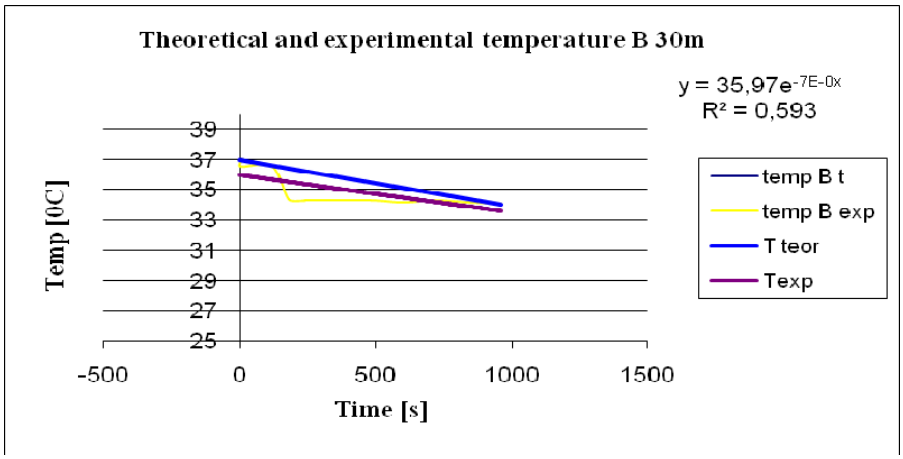

Figure 5 Variation of A theoretical and experimental temperature, suit 7 mm, for 30 m depth

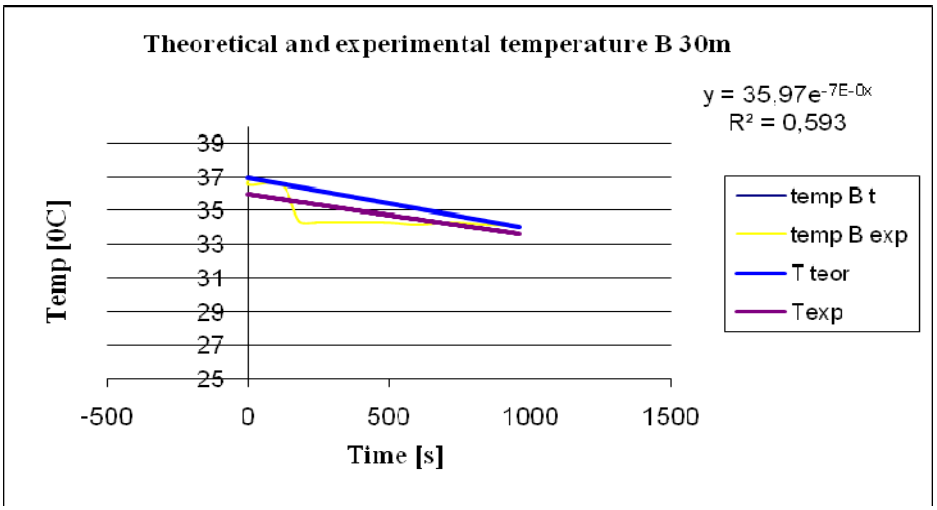

Figure 6 Variation of B theoretical and experimental temperature, suit 7 mm, for 30 m depth

At 30 m depth, the real loss of temperature for diver A (supple) is about 0,5 ^{0}C higher than the theoretical temperature. (see Figure 5).

At 9 m depth, the real loss of temperature for diver B (supple) is about 0,5 ^{0}C higher than the theoretical temperature. At 30 m depth, the experimental and theoretical temperatures are very close. (see Figure 6).

At 30 m depth, the experimental and theoretical temperatures are very close for diver C. (see Figure 7).

It determinate the solution of theoretical temperature variation has the same trend in experimental temperatures for the same subject, in the same conditions. At 30m depth the real temperatures of divers A and B, in the same conditions, have 0.5 ^{0}C difference, after 16 minutes diving. The difference between the theoretical temperatures calculated for subjects A and B, is 1 ^{0}C. (see Figures 8 and 9).

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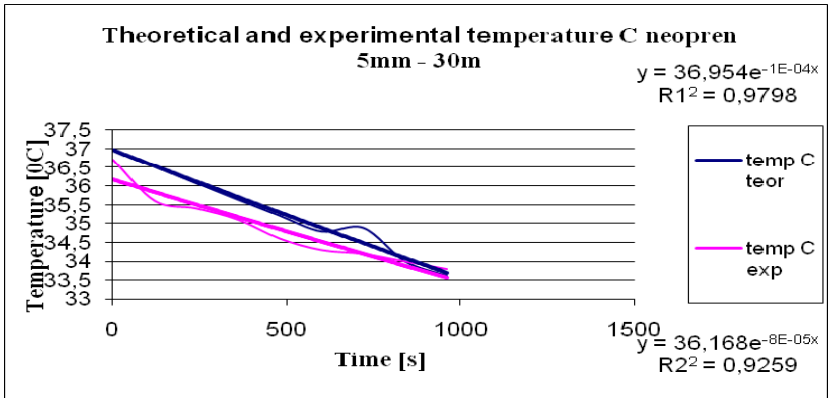

Figure 7 Variation of C theoretical and experimental temperature, suit 5 mm, for 30 m depth

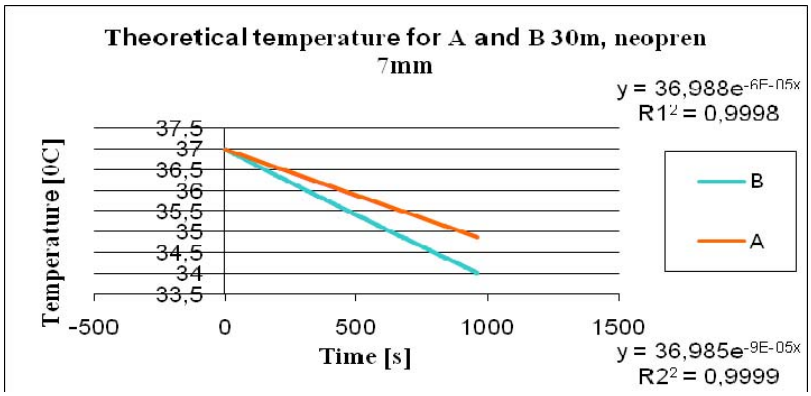

Figure 8 Variation of A and B theoretical temperature, suit 7 mm, for 30 m depth

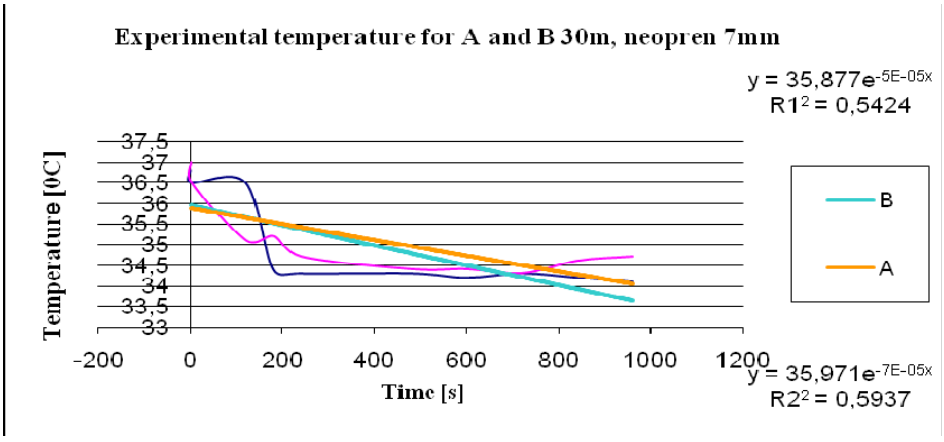

Figure 9 Variation of A and B experimenal temperature, suit 7 mm, for 30 m depth

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5. CONCLUSIONS

Fallowing the theoretical and experimental results during the tests, it observes that is a difference about o.5 [^{0}C] between the calculated and measured values at air scuba diving.

Figure 10 it can be seen that after 3 hours of dive, diver temperature drops to 21 -22^{0}C, depending on depth. This phenomenon should be avoided.

The experimental results were in good accordance with the temperature predicted by the mathematical model. Consequently, the solution of thermal balance of the diver can be utilized to predict the body temperatures of the subjects, after a given time, depending on the parameters specified: diving depth, protection suit, respiratory flow rate.

Analyzing initial assumptions suggest a correction factor due to loss of heat by radiation, considering the fact that the tests were made in terms of simulation, by pressurizing hyperbaric chamber at a speed that influence the body's response. The correction factor is: $c_a = 0{,}5$ [^{0}C].

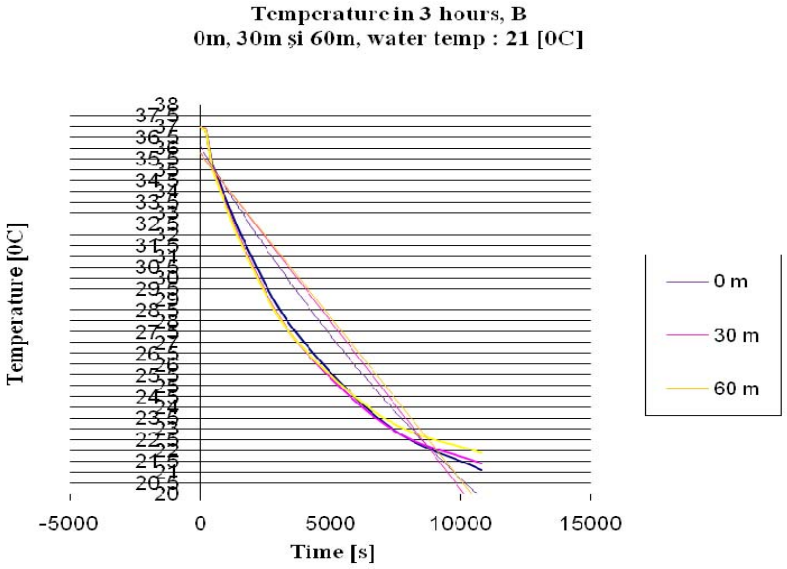

Figure 10 B subject theoretical temperature drop after 3 hours, for 0 m, 30 m and 60 m

The solution equation T(t) becomes:

$$T_{(t)} = \left(T_0 - T_a - \frac{\dot{Q}_m - l_{(p)}\rho_{(p)}x_{(p)}\dot{V}_{(p)}}{\frac{A}{R_{(p)}} + \rho_{(p)}c\dot{V}_{(p)}} \right) e^{-\frac{\frac{A}{R_{(p)}} + \rho_{(p)}c\dot{V}_{(p)}}{mc_c}t} + \frac{\dot{Q}_m - l_{(p)}\rho_{(p)}x_{(p)}\dot{V}_{(p)}}{\frac{A}{R_{(p)}} + \rho_{(p)}c\dot{V}_{(p)}} + T_a - c_a \,. \tag{5.1}$$

The mathematical model proposed is valid for the simulated dives in wet hyperbaric environment, until 60 m depth, with air.

The diagrams showed the most unfavorable situation, the most enhanced temperature decrease of the diver's body. In practice the divers move, the metabolic heat production is higher and the thermal comfort lasts longer.

Accordance with diving plan it can be appreciated the body's temperature after the proposed diving time and can apply appropriate thermal protective strategy to avoid hypothermia (28^{o}C).

6. REFERENCES

[1] Constantin A., *Termotehnica, Ovidius Universiy Press,* Constanţa 2002
[2] Constantin A., Stanciu T., *Transient heat transfer in subsea hyperbaric environment*, 13thInternational Multidisciplinary Scientific GeoConference SGEM, Marine and Ocean Ecosystems, Albena Bulgaria, iunie 2013
[3] Redlarski G. and Tojza P. M., *Computer supported analysis of the human body surface area*, International Journal of Innovative Computing, Information and Control, vol. 9, pg. 1804, May 2013
[4] Shepard Roy J., *Physical Performance and Dietary Restriction*, pg. 16, www.books.google.ro, 2015
[5] Stanciu T., Anca Constantin, *Experimental determination of the thermal flux density variation lost in time by a diver*, Annals of the Oradea University, Fascicle of Management and Technological Engineering, Volume IX (XIX), pp3.59-3.67, 2010.
[6] Stanciu T., *Experimental determinations of the respiratory thermal losses during the diving*, Annals of the Oradea University, Fascicle of Management and technological engineering, 2012
[7] Stanciu T., Constantin A., Adumitresi C., *Transferuri termice în mediul hiperbar umed*, A.O.S.R. "Sesiunea Ştiinţifică de Primăvară, Universitatea Politehnică Bucureşti, 9 mai 2014.
[8] Tarlochan F., Ramesh S., *Heat transfer model for predicting survival time in cold water immersion*, Biomedical engineering-applications, basis & communications, august 2005

ANNEX NOTATIONS

$\dot{Q}_p\ [W]$ - metabolic heat lost by the diver
m [kg] - mass diver
h [cm] – height diver
a [years] – age diver
$c_c[J/kgK]$ - specific heat body
$t\ \ [s]$ - time
$\dot{Q}_m\ [W]$ - metabolic heat flux
T [K] – internal temperature body
$\dot{Q}_e\ [W]$ - heat flux lost at skin level
$R_{(p)}\left[\frac{K}{m^2 W}\right]$ - thermal resistance of the outer layers of human body
$\dot{Q}_r\ [W]$ - heat flux lost at respiratory level $h_m[kcal]$ – metabolic heat produced by the body in 24 hours
$K_{(p)}$ global coefficient thermal transfer at skin level
$\dot{Q}_x$ - latent heat flux that brings the inhaled dry air to 100% humidity exhaled air;
$\dot{Q}_s$ - sensible heat flux that increases the inhaled air temperature to the body temperature
$l_{(p)[J/kg]}$ - specific vaporization latent heat
$\rho_{(p)}[kg/m^3]$ - gas density
$x_{(p)[kg/kg]}$ - absolute humidity of respiratory gas
$\dot{V}_{(p)}[m^3/s]$ - respiratory volume flow rate
$c[J/kgK]$ - air specific heat at constant pressure
c_a – air correction facto

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CONSTRUCTION TESTING OF AN OFFSHORE PIPELINE USING NUMERICAL METHODS

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Abstract: ***The production of oil and gas from offshore oil fields is, nowadays, more and more important. As a result of the increasing demand of oil, and being the shallow water reserves not enough, the industry is pushed forward to develop and exploit more difficult fields in deeper waters. In this paper, there will be deployed the new design code DNV 2012 in terms of checking an offshore pipeline as compliance with the requests of this new construction code, using the Bentley Autopipe V8i. The August 2012 revision of DNV offshore standard, DNV-OS-F101, Submarine Pipeline Systems is supported by AutoPIPE version 9.6. This paper provides a quick walk through for entering input data, analyzing and generating code compliance reports for a model with piping code selected as DNV Offshore 2012. As seen in the present paper, the simulations comprise geometrically complex pipeline subjected to various and variable loading conditions. At the end of the designing process the Engineer has to answer to a simple question: is that pipeline safe or not? The pipeline set as an example, has some sections that are not complying in terms of size and strength with the code DNV 2012 offshore pipelines. Obviously those sections have to be redesigned in a manner to meet the conditions.***

Key words: design check, DNV 2012 code, numerical methods, offshore pipelines, submarine pipeline system.

1. INTRODUCTION

The production of oil and gas from offshore oil fields is, nowadays, more and more important. As a result of the increasing demand of oil, and being the shallow water reserves not enough, the industry is pushed forward to develop and exploit more difficult fields in deeper waters [1].

Deepwater pipelines are used to carry oil and gas from wellheads and manifolds to platforms or to shore. Figure 1 shows a simple representation of a deep-water installation, with the flow lines on the seabed and the risers, a section of pipeline from the seabed to platforms or ships.

As a consequence of the extremely severe work conditions, the constructors of deep-water pipelines need tubular products with enhanced resistance to withstand all the loads that will be applied to the pipeline, both during its construction and in operation; among them: internal and external pressure, bending, fatigue, tension, compression, concentrated loads, impact and thermal loads, impact and thermal load.

If a pipeline is not stable, then it will move under the actions of waves and currents. This is a problem since the movement will cause bending stresses in the pipeline, which may then cause the pipe to fatigue and fail. Alternatively, it may cause damage to pipeline coatings, such as cracking of concrete [2].

Submarine pipeline stability is governed by the fundamental balance of forces between loads and resistances.

This approach to stability design of pipelines was incorporated into DNV's Rules for Submarine Pipeline Systems issued in 1976 and was the basis of design for many pipelines around the world [3].

It was known from experimental research that the hydrodynamic loads on a pipeline could be very much higher than in the DNV '76 model. In 1981, DNV's revised rules incorporated a much more realistic hydrodynamic model.

This created an anomaly - the new approach suggested many of the existing pipelines designed to DNV '76 were unstable. However, annual surveys showed no evidence of a wide-spread problem. The explanation lay in the lateral resistance of a pipeline to movement also being very much higher than predicted by the simple model. It was shown experimentally that during a storm a pipeline undergoes small displacements under the action of wave forces, gradually digging itself into the seabed. The pipeline therefore had small soil berms either side, providing increased resistance to movement and greater hydrodynamic shielding.The results of this research were incorporated into AGA's

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suite of stability design software, providing a state of the art approach. The first pass approach to pipeline stability is a simple force balance model in 2 dimensions. It is the basis of the design methodology used in:

- DNV '76 + '81
- AGA Level 1 stability software

In this paper, it will be deployed the new design code DNV 2012 in terms of checking an offshore pipeline as compliance with the requests of this new construction code, using the Bentley Autopipe V8i. The August 2012 revision of DNV offshore standard, DNV-OS-F101, Submarine Pipeline Systems is supported by AutoPIPE version 9.6. This paper provides a quick walk through for entering input data, analyzing and generating code compliance reports for a model with piping code selected as DNV Offshore 2012.

2. MATERIALS AND METHODS

2.1. Structure geometry selection

In order to input the geometry of the offshore pipeline, the Bentley Autopipe V8i software will be used. Structure geometry shall be selected based on various requirements such as routing, sizing of the pipeline considering various process parameter, thermal design etc. The pipeline is part of an offshore field development, as seen in the figure 1 below [4]:

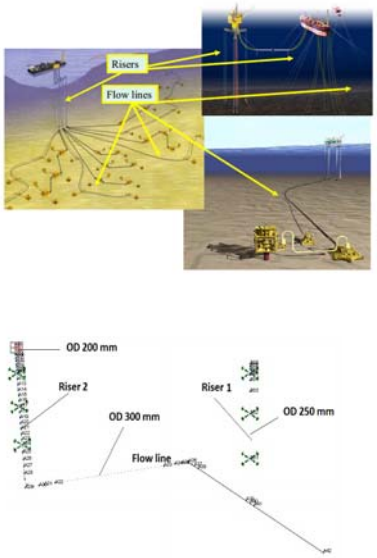

Figure 1 The offshore pipeline field development

The model contains a pipeline with two vertical legs and a buried horizontal pipe representing pipeline resting on sea bed.

The pipe has three segments, one of the end of the second Riser2 (Nominal Diameter 200 mm), second is the Raiser 2 and the rest of the flow line with the ND=300 mm. The Raiser 1 pipe has the ND=250 mm. The material of the pipes is CMN-415 steel (as per DNV 2012).

The load cases are as per the construction code as follows:

- Operating Pressure and Temperature data for 3 'T' cases
- Earthquake loading cases: E1 and E2
- Wind loading cases: W1 and W2
- Wave loading cases: Wave2 and Wave 3 (One case for accidental)
- User loads: U1 and U2 (Interference loads, may be from trawling)
- Soil Properties: SND11A

2.2. Pressures and temperatures

The depth of the water is taken as 70 m and the external pressure exerted upon the pipe calculated as a consequence. The fluid circulating inside the pipe will follow three distinct cases:

Case 1-Pressure 0 MPa (r) and temperature 200C corresponding to the pipeline at rest with no fluid circulating inside.

Case 2-Pressure 1.379 MPa (r) and temperature 600C corresponding to the normal operation of the pipeline.

Case 3-Pressure 2.7579 MPa (r) and temperature 900C corresponding to the upset operation condition of the pipeline.

2.3. Soil properties

The model of soil is the SND11A which is a sandy type of soil (figure 2).

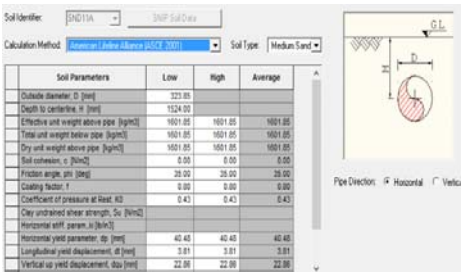

Figure 2 Soil properties

The process of defining a buried piping system is a combination of user defined piping points, and internally generated (by AutoPIPE) soil points. The user only

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needs to define piping points for identifying the following critical parts of a buried piping system:

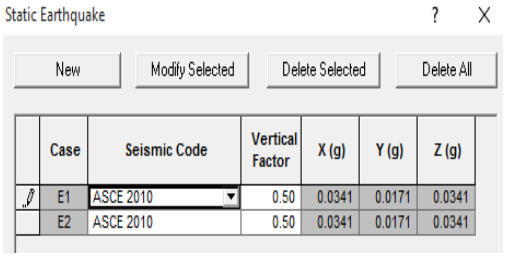
- As required by changes in the system geometry.
- For specification of piping components (e.g. valves, reducers, flanges, anchors, etc.).
- Where soil properties change.
- Where the maximum spacing (between the internally generated soil points) defined for the current soil identifier is to be changed.

2.4. Earthquake load cases

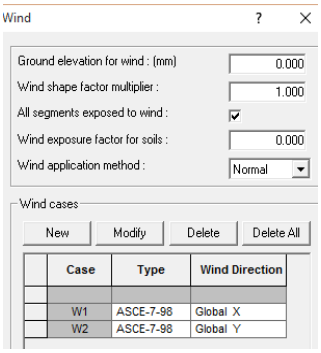
AutoPIPE can define a series of forces action on a structure to represent the effect of earthquake ground motion. This method assumes that the structure responds in its fundamental mode. For this to be true, the structure must be low-rise and must not twist significantly when the ground moves. The acceleration is typically calculated from the natural period of the structure, and applied to the mass of structure to obtain a force.

Static seismic loads are given in factors of gravity, g. As an example, if a static seismic acceleration of 0.5 g's is applied on the x-axis, a force equal to half the systems weight is turned into a uniform load in the x-direction.

AutoPIPE supports the custom creation of these accelerations in the X-, Y- and Z-axes, or can generate accelerations automatically using for instance ASCE 2010 code (figure 3):



2.5. Wind load cases



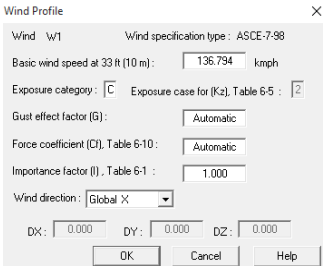


Figure 4 Wind load cases

The wind loads cases are based on ASCE-7-98 code and for instance the Wind load case W1 has the speed of the wind of 136.7 km/h on the OX direction (figure 4).

2.6. Wave loads

The Load/Wave is defined inside the simulation to model the effect of ocean waves impacting a partially submerged piping system.

The following fields/parameters are provided in the Wave Load dialog: Wave data name, Wave type, Load case, Water - Elev., Water Depth, Water density, Phase, Wave - Height and Period, Coeff. - Drag and Inertia, Direction - DX, DY, DZ, Depth Fields.

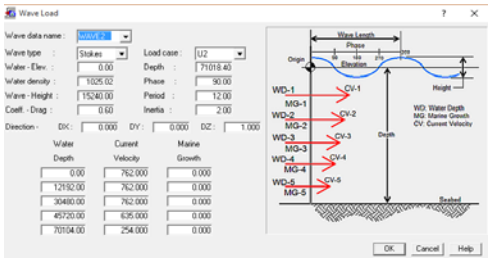


Figure 5 Wave load cases

The load cases will be Wave 2 and Wave 3. For instance, Wave 2 deploys Stokes wave theory, with the wave height of 15 m (under storm conditions), period 12 sec. and the wave current velocity varying from 0.7 m/sec at 12 m depth to 0.25 m/sec at 70 m depth (figure 5).

2.7. Buoyancy loads

The Load Buoyancy command enables us to model the piping system as partially or fully submerged in a fluid (usually sea water) by defining a height of fluid (and related properties) in which the piping system is partially or fully submerged. The buoyant force applies

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an upward pressure on the system, effectively reducing the weight of the submerged piping. AutoPIPE includes the buoyancy load in the gravity load case (GR) for analysis.

3. RESULTS AND DISCUSSION

The goal of all the calculations is to identify whether or not there are sections of the offshore pipeline with a poor behaviour under the load combinations set by the design standard.

3.1. The stress inside pipeline sections

The axial stresses act normal on the member section being by all means a normal stress. For our calculated platform these maximum stresses are shown in the figure below:

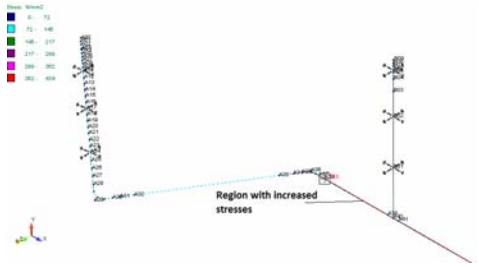

Figure 6 Stresses inside the pipeline

The maximum values are within the range of 400 MPa, far above of the allowable stresses imposed by the code (figure 6).

3.2. The displacements

The calculated displacements are following the load cases considered in the simulation.

For instance, for the Thermal loading case 3 with the upset conditions the displacements are given in the Figure 7 below:

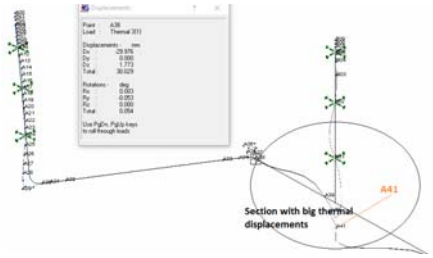

Figure 7 Thermal displacements for Case 3

For the point A41 for instance the displacement in OX direction is 14 mm and in OY direction is 73 mm.

3.3. Mode shapes

The pipeline structure has its own natural frequencies and mode shapes. For instance, the first natural frequency is 1.23 Hz and the mode shape is given in the Figure 8 below:

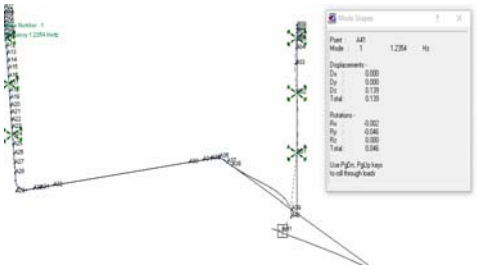

Figure 8 The mode shape for the first natural frequency

3.4. Soil reactions

During various loads acting upon the pipeline the soil will oppose different reactions mainly in the Anchor points. For example, for the anchor point A32 near the critical zone, the maximum reaction is 9587 N/mm in longitudinal direction as seen in the Figure 9 below:

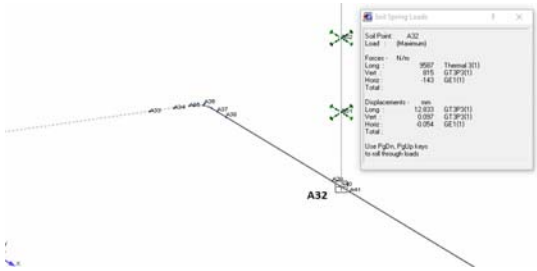

Figure 9 Soil reaction

4. CONCLUSIONS

The offshore pipelines designing is an intricate enterprise following very demanding designing codes since at stake is the integrity of multi-million dollars' investments in offshore oil and gas exploitation facilities. The rupture of a live oil pipeline can have disastrous effects over the environment and sea biota with serious penalties coming from the regulatory.

As seen in the present paper, the simulations comprise geometrically complex pipeline subjected to various and variable loading conditions.

At the end of the designing process, the engineer has to answer to a simple question: is that pipeline safe or not?

The pipeline set as an example, has some sections that are not complying in terms of size and strength with the code DNV 2012 offshore pipelines. Obviously those sections have to be redesigned in a manner to meet those conditions.

5. REFERENCES

[1] Gerwick B. C., 1986, *Construction of Offshore Structure,* John Wiley & Sons, Inc

[2] Dawson T. H., 1983, *Offshore Structural Engineering* (Prentice-Hall)

[3] Ministry of Science & Technology, 1985, *Development of Design Technology of Offshore Platforms for Offshore Oil Production*. Jacket Type Tower Structure Design .KAIST

[4] Calimanescu I., Radu I. and Buzbuchi N., 2015, *Computer aided design of offshore structures*, (Constanta, Editura Nautica)

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CAVITATION AROUND PROPELLERS EQUIPPED WITH ENRGY SAVING DEVICES

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Abstract: The main focus of this article is the development and use of clean renewable energy sources – energy saving devices, on ships. These mechanisms improve the propulsion performance and lower the fuel consumption of the ship using reaction fins for low-speed full ships and stator fins for high-speed slender ships. By using CFD - fluid flow computer program, we analyzed and evaluated the cavity propellers on ships equipped with energy-saving mechanism, including keel and rudder. This helps in understanding the flow characteristics such as pressure distribution on the propeller that would otherwise require many hours of effort and experimental analysis. The result is a high degree of propeller optimization and of the mechanism with the role of energy saving.
The main reason of this article is to try to reduce cavitation around the propeller and show a modality for reducing ship pollution, so the quantity of fuel used, that mince, to reduce the price of transportation and it becomes a method of saving money for the ship owners and charters.

Key words: Hull; Ship; Cavitation; Energy; Propeller.

1. INTRODUCTION

The first legislation in the world for CO_2 control emissions in shipping industry and lowering fuel consumption for new and existing ships was been conducted.

This legislation is applying from 1 January 2013 and is made up of 4 parts. As a result, we note the significant reduction of CO_2 emissions and reduce fuel consumption.

Many energy saving devices have been developed to improve the fuel economy, that mince reducing in the cost of fuel and represents a saving for ship owners and charterers.

Mitsubishi Heavy Industries have developed a ship bulb, which has the right shape depending of the type of the ship. This bulb reduces the ship resistance through the waves.

The properly designed bulbous bow has the role to reduce wave-making resistance by producing its own wave system that is out of phase with the bow wave from the hull, creating a cancelling effect and overall reduction in wave making resistance. The flow is more horizontal, reducing eddy effects at the forward bilge. Physical factors considered in bulb optimization include: volume, vertical extension of the centre of volume, longitudinal extension and shape.

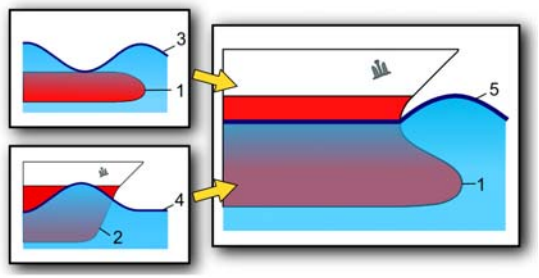

Figure 1 Bulb optimization

NYK shipping company modified on one of their container ships the bulb. As a result they had a reduction of more than 23 % carbon dioxide (CO_2) emissions over half a year, greater than the amount estimated prior to the tests.

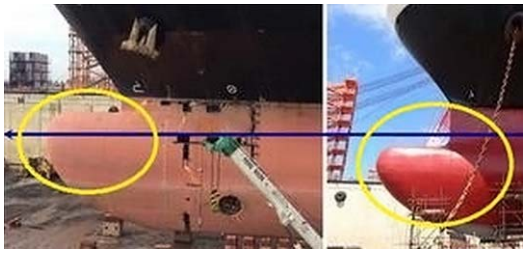

Figure 2 NYK ship bulb optimization

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Mitsubishi Heavy Industries have developed also Mitsubishi Air Lubrication System (MALS), which covers the hull of the ship with some mill bubbles that have the role in reducing friction; no other effective way to lower frictional resistance of the hull in the water have been proposed for many years, even if it represents 50 to 80%.

The first new ship which was equipped with a MALS has reduced energy consumption by about 10%. Over time various technologies were created for the purpose of propulsion efficiency and energy saving.

In response to the requirements of technology with the role in energy saving, different shipyards have developed this kind of mechanism to achieve this goal. Mitsubishi Heavy Industries have developed mechanisms with the role in energy saving and propulsion performance since 1980.

They develop two systems:

a. Fins reaction represents installation of palettes before the main propeller on the main ax intended to improve efficiency propulsion, rotating them due to water current flow when the main propeller rotates. It is used for ships that do not develop a high cruising speed like tanks and LPG (Liquefied Petroleum Gas carriers).

b. Stator fins is installing on the helm of some paddles behind the main propeller, intended to improve the efficiency of propulsion, by turning due to water current flow when the main propeller rotates. It is used for ships that can develop a high speed cruise, which have a supple hull form, such as car carriers and container ships.

Numerous benefits were brought by the development of these types of energy saving devices.

By installing such a device around the propeller shaft, water currents flowing around the main propeller will be more complex, making it difficult to predict cavity phenomenon. If cavity occurs on a propeller it is causing problems such as poor performance, erosion and noise.

Before designing or assessing a propeller equipped with an energy saving device it requires an examination review and a verification of cavitation characteristics of such device.

Theoretical methods and experimental models were used to predict the cavitation on the propeller. Theoretical methods require numerous assumptions and are less secure when there are significant shifts flow conditions, while experimental models are more expensive and they require a fairly long time for building the model, especially when multiple versions are required.

To eliminate these disadvantages, we use CFD (flow dynamic computer program) to estimate cavitation by analyzing and interpreting flows around the propeller, rotating in rear hull, considering the hull, rudder and rescue device power simultaneously. By using the result of this analysis for designing new propellers, we have developed energy saving devices which are equipping the propellers, safe and efficient, with minimal risk of erosion.

2. DIFFERENT TYPES OF PROPELLER CAVITATION

There are different types of propeller cavitation that can occur on a marine propeller as:

a. tip vortex cavitation;
b. sheet cavitation;
c. cloud cavitation;
d. bubble cavitation;
e. root cavitation;
f. face cavitation;
g. boss vortex cavitation.

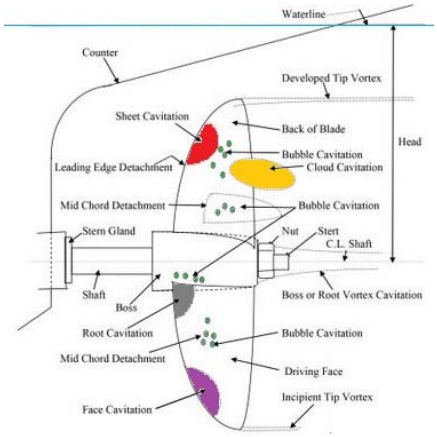

Figure 3 Different types of propeller cavitation

a. Tip vortex propeller cavitation – is due to low pressure within the vortices shed at the blade tips.

b. Blade sheet cavitation - occurs when large suction pressures build up near the leading edge of the blade resulting in the back of the blade being covered with a sheet of bubbles and is largely a function of the angle of attack of the propeller blade sections to the varying wake field encountered as the propeller rotates.

c. Cloud cavitation - is frequently found close to the collapse area of sheet cavitation and is extremely aggressive due to the damaging effects of the collapse of large numbers of bubbles and should always be treated with caution and must be eliminated.

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d. Bubble cavitation - occurs at mid chord and is usually associated with too high a curvature or camber of the blade sections.

e. Root cavitation - appears at different times in the propeller's rotation if the circulation round the root is sufficiently strong and can be sufficiently aggressive to cause erosion damage to the boss.

f. Face propeller cavitation - occurs on the driving face of the propeller and is often due to an incorrect pitch distribution along the length of the blade resulting in the tip pitch being too small and the blade sections developing a negative angle of attack.

g. Boss / hub vortex cavitation - is usually due to a high angle of incidence between the direction of flow of the water and the blade leading edge in way.

A propeller is said to be fully cavitate / super cavitate when the whole of the back is covered in sheet cavitation.

3. THE PRINCIPLE OF ENERGY SAVING DEVICES

Energy saving devices are based on energy saving technology and are installed around the shaft propeller for improving propulsion efficiency.
Energy saving devices are designed to recover the energy lost through rotating the propeller of the ship. Depending on the energy recovered are several types:

I. Devices that recovers the propeller flow;
II. Devices that reduce the propeller load;
III. Devices that scatter the vortex created by the propeller hub.

The reaction and stator fins described above are included in (I). Those from Mitsubishi Heavy Industries conducted Mitsubishi Advanced Propeller (MAP), a propeller with a large diameter which is cataloged in (II) with a low speed and HVFC - Hub Vortex Free Cap, which is included in (III).

Reaction fins consist in more vanes installed in front of the propeller (Figure 4), which due to water current influx, is rotating in opposite direction of the ship propeller. Stator vane must be installed behind the propeller. He cancels the current flow generated by the propeller. Stator fins create resistance, so is suitable for ships with a low speed cruising, where the resistance is smaller comparing with the effect of rotation flow recovered due to slower flow on aft. The reaction blades may not apply to ships with a big cruising speed, with a slim body, where the resistance is high due to high velocity flow of water currents. A stator vane generates energy.

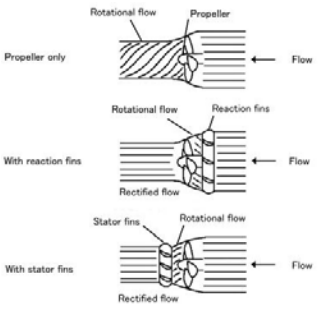

Figure 4 Principle reaction of stator fins

4. CFD ANALYSIS OF HULL, PROPELLERS AND ENERGY SAVING DEVICES

The equation used for CFD analyze consists of incompressibility equation of Navier-Stokes and continuity equation, which were divided in a high finite volume of method using an unstructured grid. Network assessment is including fix areas which define a space (hull, rudder, devices used for energy saving) and the area fixed for the rotating propeller. At joints an adjustable network promises continuity and preservation of natural values which have been used. Two turbulent flow equations models are closing the equation set. The cavity model was based on the Rayleigh-Plesset equation, which describes the movement of a single bubble.

To be under test conditions of a large cavities - tunnel (HYKAT) at the Experimental institute for tanks from Germany HSVA (Hamburgische Schiffbau Versuchsanstalt GmbH), calculated targets, hull, propeller, rudder and flaps reaction have been placed in a field that reproduces the measurement points in a cavitation tunnel - Figure 5.

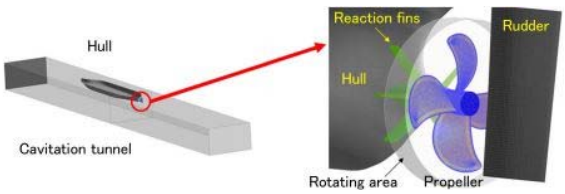

Figure 5 Calculating grid used for analyze the hull, propeller and fins reaction as a unit

5. EXEMPLES OF CFD APPLICATIONS AT ENERGY SAVING DEVICES WHICH ARE EQUIPPING THE PROPELLERS

5.1 Fins Reactions

Figure 6 envisages the inflow of the propeller, for the cases with or without the reaction of the blades. The results show that the fins are generating reaction flow in reverse rotation sense of the propeller.

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The angle of fine installation blades can be optimized based on these results.
Speed distribution of mass in the direction is shown by the outline, blue means high speed and the flow rotating is indicated by the vectors. The flow field without the rotational fins is symmetrical.

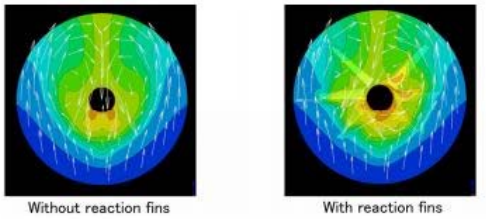

Figure 6 Prediction of flow fields of the propeller influx with or without blades response

Despite this, the flow field generated by the reaction fins, of rotational flow, has the flow in opposite direction of the propeller - clockwise.
Figure 7 shows the cavitation calculations for two different propellers A and B, which are rotating in the flow field shown in Figure 6.

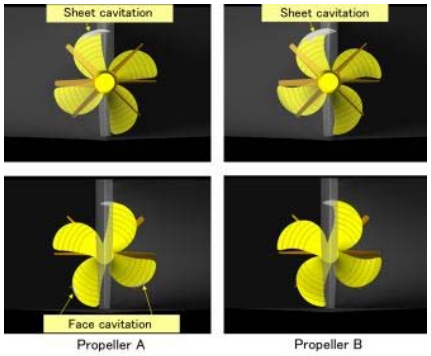

Figure 7 Comparison between the appearance of cavity on the propeller A and B

For propeller A, sheet cavitation occurs on the suction side (the sides curved with blade) and the cavitation sheet occurs on the face where is the pressure (back part).

Usually, a propeller is designed to prevent cavitation. When this occurs, is eliminated on the blade surface, increasing the risk of erosion due to cavitation phenomena. Propeller B prevents appearance of cavitation and therefore has a low risk of erosion by it.

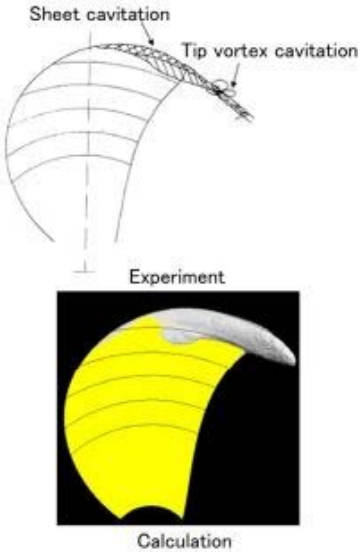

Figure 8 The appearance of the cavity behind the propeller B

Figure 8 compares the cavitation occurrence of the propeller B obtained from CFD with a design based on experimental data. Calculated area for the occurrence of cavitation sheet at the back, was almost identical to the experimental results. Also, the calculations reproduced the cavitation sheet caught in the vortex.

These results demonstrate that the unified CFD analysis lows the prediction of cavitation generated by an engine equipped with reaction fins.

CFD analysis is effective for designing a reliable high performance propeller without cavitation sheet. He is already being used on oil tankers.

5.2 Stator Fins

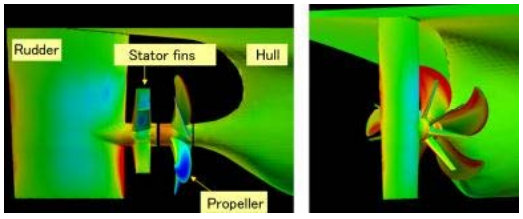

Figure 9 Distribution of pressure around the propeller equipped with stator

Figure 9 shows the results of CFD for a propeller equipped with stator fins. This figure shows the surface pressure distribution obtained from ship hull analysis, propeller, rudder and fin stator as a unit.

Surface pressure distribution of the propeller blades, stator fins and rudder had followed the same trend.

There was a decrease in pressure on the negative pressure side of the stator fins and an increase in pressure at the leading edge of the rudder.

Based on the predicted flow field and pressure distribution around the stator fins, a highly efficient stator fins, can be designed by optimizing the number and mounting angle of the stator fins installed behind the propeller.

6. CONCLUSIONS

The importance of reduction of energy consumption of ships will increase in response to the appearance of the first international regulation of CO_2 emissions controlling for shipping industries and increase of oil prices.

We will continue to develop fuel efficient ships and extremely reliable for proper design using CFD analysis based on performance prediction tools.

This paper introduced CFD technology in the designing of propellers, serving to predict the occurrence of cavitation on energy saving devices, by analyzing the hull, propeller, rudder and energy saving device as a unit.

By using this method, useful information, such as the flow and pressure distribution around a propeller in real operating conditions can be visually displayed for engineers; this data is difficult to measure experimentally. This allows us to improve and optimize the propeller and energy saving devices.

7. REFERENCES

[1] ANTHONY F. MOLLAND, *The marine engineering reference book - a guide to ship design, construction and operation*", Elsevier, 2008.

[2] SATO, K. ET AL., *Numerical Prediction of Cavitation and Pressure Fluctuation around Marine Propeller*, Proceedings of the 7th International Symposium on Cavitation, 2009.

[3] KAWAKITA, C. ET AL., *Prediction of Unsteady Cavitation on Propeller in Consideration of Hull and Rudder Using CFD*, Conference proceedings, the Japan Society of Naval Architects and Ocean Engineers, Vol. 13, 2011.

[4] http://www.resolvedanalytics.com

[5] http://www.cehipar.es

[6] http://www.iims.org.uk

[7] http://www.green4sea.com

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