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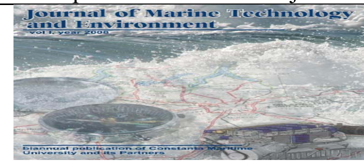

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THE ELECTROMAGNETIC POTENTIAL OF THE EARTH'S MAGNETIC FIELD

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Abstract: The electromagnetic field has two components of it, relative and interdependent, namely the electric field and the magnetic field. The electromagnetic field is a form of existence of matter, determined by the weighting actions of electromagnetic nature on the bodies in its area of action. The electromagnetic field consisting of static magnetic field and electric field varies in time with frequencies up to 300 GHz. The effects of the electromagnetic field are measurable and are thermal effects and mechanical effects. The mode of manifestation of magnetic fields is not perceivable by man, they are not accessible to human senses.
Key words: low magnetic fields, geomagnetic field, zero magnetic field, geomagnetic activity.

1. INTRODUCTION

The electromagnetic field of the Earth is detected at specially constituted observation points and has a complex structure. At those observation points, the electromagnetic field constitutes information about the conditions under the source, about the environment between the source and the place of detection, about the phenomena that took place along the way (reflections, refractions, absorptions), their causes and the associated physical mechanisms.

Depending on the degree of conductivity of the subsoil in the respective area and depending on the variations of the geomagnetic field in real time they can be sized corresponding the energy networks, transport cables and transformers, by switching on or off certain specific protection systems during geomagnetic storms of varying degrees.

2. PRESENTATION OF THE MORPHOLOGY OF THE EARTH'S ELECTROMAGNETIC FIELD

For the transport of petroleum products, to determine the required voltages to be applied on different pipe segments for anticorrosive purposes determine the additional currents induced in the large pipes. The magnetic field of the earth is believed to be generated by electric currents from the conductive material of the earth's core, created by convection currents due to the heat flowing from the core of the earth. According to the Ampère circuit law, current loops generate magnetic fields.

According to Faraday's law a magnetic field changing generates an electric field.
According to the action of Lorentz force the electric and magnetic fields exert a force on the charges flowing in the currents.

The partial differential equation for the magnetic field is called the magnetic induction equation,

$$\partial B / \partial t = \eta \nabla^2 B + \nabla \cdot (u \cdot B). \qquad [1]$$

Where:
u is the velocity of the fluid
B is the magnetic field
and $\eta = 1/\sigma\mu$ is the magnetic diffusion;
which is inversely proportional to the product of the electrical conductivity σ and the permeability μ.

The term $\partial B / \partial t$ is derived according to the time of the field.

In a stationary fluid, the magnetic field decreases, and any concentration of field propagates even when the dynamo of the earth has stopped, the dipole part would disappear in a few tens of thousands of years.

If he were a perfect conductor ($\sigma = \infty$), there would be no diffusion.

According to Lenz's law, any change in the magnetic field they would have immediately opposed currents, and

then the flow through a given volume of fluid could not change.

If the liquid moves the magnetic field moves with it and then in a fluid with finite conductivity, a new field is generated by field lines that extend as the fluid moves in ways that deform it. This process could continue to generate a new field. The movement of the fluid is supported by convection and it is a movement driven by buoyancy.

The temperature rises towards the center of the Earth. This buoyancy is enhanced by chemical separation As the core cools, some of the melted iron solidifies and is covered with the inner core.

In this process the small elements are left behind in the fluid, making it easier.

This is called compositional convection. A Coriolis effect caused by the general planetary rotation, tends to organize flow in aligned rolls along the north-south polar axis. Calculation of additional currents induced in large pipes used for the transport of petroleum products to determine the necessary stresses to be applied on different pipe segments for anticorrosive purposes.

3. THE MAGNETIC FIELD GENERATED BY THE ELECTRIC CURRENTS IN THE CONDUCTIVE MATERIAL OF ITS CORE

The center of the Earth is a region of iron alloys that extend to about 3400 km, the radius of the Earth being 6370 km.

The center of the Earth is divided into a solid inner core, with a radius of 1220 km and a liquid outer core.

The movement of the liquid from the outer core is driven by the heat flow from the inner core, which is about 6000 K (5730° C), to the basic limit of the coat, which is about 3800 K (3,530° C).

Heavier materials submerged to the core and degradation of radioactive elements inside releases potential energy that generates heat.

4. THE IMPACT OF THE ELECTROMAGNETIC FIELD ON THE NATURAL ENVIRONMENT

Electromagnetic fields overlay on the electrochemical environment in the biosphere produce changes, in transport phenomena of load from electrolytes in the mechanism and kinetics of electrochemical reactions which is unfold in biological el ectrochemical systems (such as the cytoplasm / cell membrane system) and those of natural electrolytes (soil, groundwater, etc) and industrialists from complex built environments such as wet reinforced concrete.

Electromagnetic fields from various disturbing sources modifies the natural unfolding of natural electrochemical processes from the biosphere are polluting signals.

The source of all disturbing signals, of the dispersion currents, both in c.c. as well as in c.a. linear and deforming regime is the transport system the system of distribution and use of electricity.

In the operation of the devices in the electrical networks of power are met electrical discharges.

The exposing limits to electromagnetic fields are based directly on known health effects and biological considerations. The compliance with these limits ensures protection in electromagnetic fields against any known harmful effect on health;

In the area of line and bar separators in the power plant and respectively the switches the maximum value of the electric field intensity is obtained.

The personnel trained to work in the transformation stations feel a fear of temporary character at the unexpected triggers of the switches or they feel a continuous fear inspired by the supposed effects of the magnetic field on the health status. The maximum limit of professional exposure is 10kV/m and the maximum value of the electric field intensity 10mA.

In order not to be dangerous to humans, the electric current must not exceed 10 mA. In DC, this limit is 50 mA.[2]

In the alternating current at values greater than 10 mA, depending on the duration of the electric current, the living organism is damaged, the most severely affected being the heart and nervous system.

Burns generated by the thermal effect of the electric arc on the living organism are more serious than burns caused by other causes.

5. DETERMINING THE ELECTROMAGNETIC POTENTIAL OF THE EARTH'S MAGNETIC FIELD

5.1. Magnetic field outside the Earth's core

The Earth's magnetic field is called the geomagnetic field. The geomagnetic field is variable in time and space. The geomagnetic field is produced by sources present inside the terrestrial globe and from external sources. The contribution of internal sources is constant and very important in relation to the contribution of external sources. [1]

The potential of the magnetic field, scalar size, it can be written with the relationship:

$$V(r,\theta,\varphi) = a\sum_{n=1}^{\infty}\sum_{m=0}^{n}(g_n^m cos m\varphi + h_n^m sin m\varphi)\left(\frac{a}{r}\right)^{n+1} P_n^m\,(cos\theta). \qquad [2]$$

Where “a” is the radius of the earth and “g” and “h” are the Gaussian coefficients.

The magnetic moment of the geocentric dipole it has a potential equivalent to the corresponding potential for n=1 situation in which the terms are dominant.

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$$m = \frac{4\pi a^3}{\mu_0}(g_1^1 \hat{x} + h_1^1 \hat{y} + g_1^0 \hat{z}). \qquad [3]$$

The Earth's magnetic field on the Earth's surface is dominated by the dipolar component, non-polar terms, representing less than 10% of the measured field.

Solving Laplace's equation for magnetic potential allows separation of the effect of external sources from that of internal sources. The spherical harmonic analysis showed that the internal sources are dominant over the external ones.

The spherical harmonic analysis showed that the internal sources are dominant over the external ones.

Due to high voltages and high current currents that appear in the electric transmission and distribution lines the capacitive and inductive coupling phenomena plays an important role in the modes of manifestation of electromagnetic interference.

Electromagnetic interference is of the type of surges produced directly/indirectly by lightning of maneuvers performed in the electrical networks temporary overvoltages or with very fast front

Atmospheric discharges can produce overvoltages in the power lines or transformer. Knowledge of the radiant electromagnetic field produced by lightning can be used to achieve correct and efficient protection. The atmospheric electric field on the ground can touch voltage of kV/m and it is compulsory to produce electric discharge to the ground.

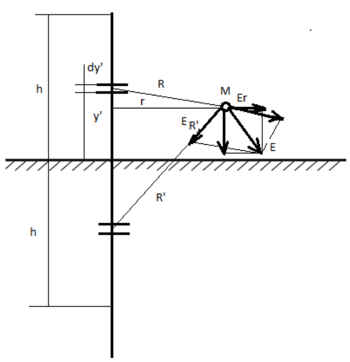

Figure 1 Image method for the created electromagnetic field

Point M is a point taken as a landmark for the electromagnetic field created. Applying the image method we have the same distance above and below the conductive plane. Horizontal component of the electric field intensity obtained by applying Maxwell's equations.

$$(r,x,t) = \frac{1}{4\pi\varepsilon_0}[\int_{-h}^{+h} \frac{3r\,(y-y')}{R^5} \int i\left(y',\tau-\frac{R}{C}\right) d\tau dy' + \int_{-h}^{h} \frac{3r(y-y')}{cR^4} i\left(y',t-\frac{R}{C}\right) dy' - \int_{-h}^{+h} \frac{r^2}{C^2R^3} \frac{\partial i\left(y',t-\frac{R}{C}\right)}{\partial t} dy' . \qquad [4]$$

Magnetic field component:

$$B_\varphi(r,x,t) = \frac{\mu_0}{4\pi}\left[\int_{-h}^{h} \frac{r}{R^3} i\left(y',t-\frac{R}{C}\right) dz' + \int_{-h}^{h} \frac{r}{cR^2} \frac{\partial i\left(y',t-\frac{R}{C}\right)}{\partial t} dy'\right). \qquad [5]$$

6. CONCLUSIONS

The static component of the geomagnetic field is reduced by a factor of ~ 100. A FLUXMASTER magnetometer with an accuracy of ± 1 nT can be used to monitor the variations of the magnetic field on the selected surface.

In different positions the field varies in the range 0-500nT. [3]

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IMPACT OF HVAC SYSTEM UPON FUNCTIONAL PARAMETERS OF MAIN ENGINE FOR A VLCC SHIP

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Abstract: The performance of any system on board ship is specifically identified with its reliability. So as to get the best out of marine motors, it is critical to screen their performances and take measures to accomplish productive combustion. As a result of heat gains on board ships from engine rooms and crew, the increase in humidity as well as due to the various releases of gases from on board systems, room air deteriorates, requiring replacement and its processing through the HVAC (heat, ventilation and air conditioning) system. The combustion process in diesel engines is the most complex and difficult to address. HVAC system has a definitory role for diesel engine combustion.
Key words: HVAC, VLCC, engine room, ventilation, heat.

1. INTRODUCTION

VLCC is among the greatest working cargo vessels on the planet. With a limit, in excess of 250,000 dwt, these huge vessels are prepared for passing on a massive measure of raw petroleum in a solitary voyage. Known as supertankers, these vessels are essentially utilized for whole deal rough transportation from the Persian Gulf to Europe, Asia and North America. This paper comprises in ideas studying of a *VLCC* of 305,000 dwt. Principle attributes of VLCC ship are described in table 1.

Table 1. VLCC tanker ship dimensions

Characteristics	Value
Length overall	333.00 m
Length between perpendiculars	324.00 m
Draft	20.83 m
Deadweight	305301 MT

2. ENGINE ROOM FOR VLCC SHIP

To obtain good working conditions in the engine room, it is necessary to investigate its layout from a very beginning of any design. Attention shall be paid to the ventilation, transport ways, escapes, maintenance hatch and space for maintenance etc. The accommodation block is usually arranged above the engine room and both of them must be very well coordinated to create one logical solution.

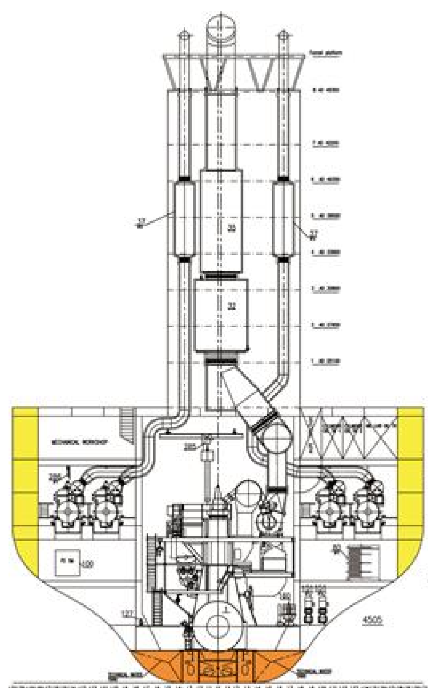


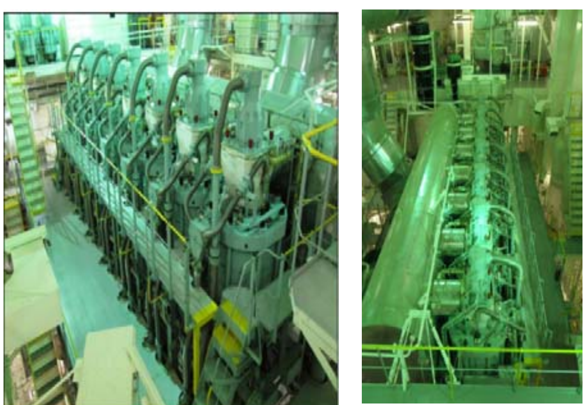
Figure 1 Engine room arrangement

Table 2. Main engine characteristics

Characteristics	Value
Bore	850 mm
Stroke	3150 mm
Number of cylinders	7
MCR power	27020 kW
NCR power	22965 kW
Speed	76 rpm

3. MITSUBISHI-UE MDE 7UEC85LSII main engine

MITSUBISHI-UE MDE 7UEC85LSII is a two-stroke, slow speed and reversible engine, with a constant overcharging pressure that develops a rated output of 27020 kW at a speed of 76 rpm, the ship shifting with a maximum speed of 16 kN (knots). MITSUBISHI type 7UEC85LSII two-stroke engine has big bore size and a total power output up to 20000 kW, being part of the category of high efficiency slow engines.



(a) (b)

Figure 2 MITSUBISHI 7UEC85LSII main engine: (a) side picture; (b) top picture [real photo onboard VLCC ship of 305000 dw

Energy balance for main engine

For main diesel engine we have formulas for heat flux:

$$\dot{Q}_{rad} = (0{,}02...0{,}04)\cdot \dot{Q}_d\ [kW] \quad (1)$$

$$\dot{Q}_d = \frac{1}{\eta_e}\cdot P_e = \frac{22965}{0{,}45} = 51033\,[kW] \quad (2)$$

$$\dot{Q}_{rad} = 0{,}02\cdot 51044 = 1020\ [kW] \quad (3)$$

- $\dot{Q}_{rad}$ – radiant heat flux;
- $\dot{Q}_d$ – dissipated heat flux;
- P_e – engine effective power;
- η_e – effective efficiency.

Air flow calculation for machinery room

Mass air flow calculation for engine room:

$$\dot{Q}_{rad} = \dot{m}_{air}\cdot c_{air}\cdot \Delta t\ [kW] \quad (4)$$

$$\dot{m}_{air} = \frac{\dot{Q}_{rad}}{c_{air}\cdot \Delta t}\left[\frac{kW}{s}\right], \quad (5)$$

- $\dot{m}_{air}\left[\frac{kgair}{s}\right]$ - air masis flow;
- $c_{air} = 1\cdot\left[\frac{KJ}{kgK}\right]$ - specific air heat;
- $\Delta t = [5.....10]\ [K]$ - temperature difference;
- $$m_{air} = \frac{1020}{1\cdot 10}\left[\frac{kg\ air}{s}\right] \quad (6)$$
- $$m_{air} = 102\left[\frac{kg\,air}{s}\right]. \quad (7)$$

Volumic air flow calculation for engine room:

$$\rho = \frac{P}{RT}; \quad (8)$$

$$\rho = \frac{100}{0{,}286\cdot 300} \quad (9)$$

$$\rho = 1{,}16\left[\frac{kg\,air}{m^3}\right], \quad (10)$$

- $P\left[\frac{KN}{m^2}\right]$ - air pressure;
- $R = 0{,}286\left[\frac{KJ}{kg\,K}\right]$ - gas constant;
- $T = 300\,[K]$ – air temperature;
- $\rho = 1{,}16\left[\frac{kg\,air}{m^3}\right]$ – air densisty.

$$\dot{V} = \frac{m_{air}}{\rho}. \tag{11}$$

$$\dot{V} = \frac{102}{1.16} \tag{12}$$

$$\dot{V} = 87,9\left[\frac{m^3}{s}\right]. \tag{13}$$

Volumic air flow calculation for engine room fan:

$$P_{fan} = \frac{\dot{V}\,\Delta P}{\eta_{fan}}\,[kW] \tag{14}$$

$$\Delta P = \frac{80 \cdot 100}{10200} = 0,78\left[\frac{kN}{m^2}\right] \tag{15}$$

$$\dot{V} = \frac{0,75 \cdot 92}{0,78} = 88\left[\frac{m^3}{s}\right], \tag{16}$$

- $P_{fan} = 92[kW]$ – fan effective power;
- $\dot{V}$ – volumic air flow;
- $\eta_{fan} = [0.65…0.75]$ – fan efficiency;
- ΔP – pressure difference.

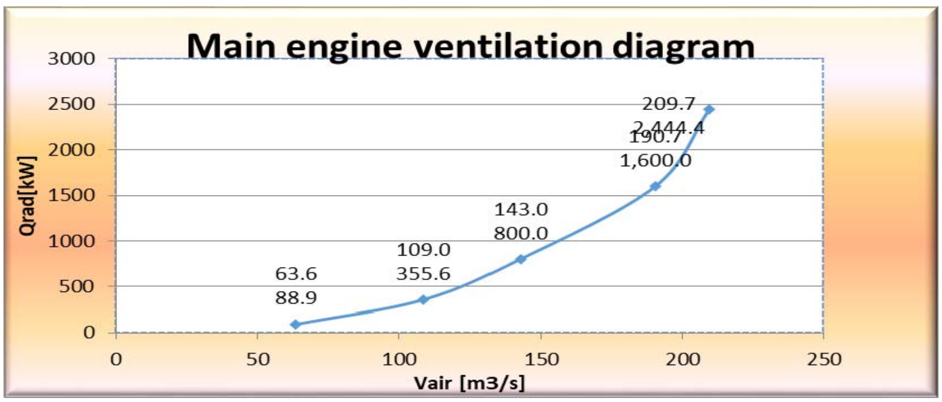


Figure 3 Main engine ventilation diagram

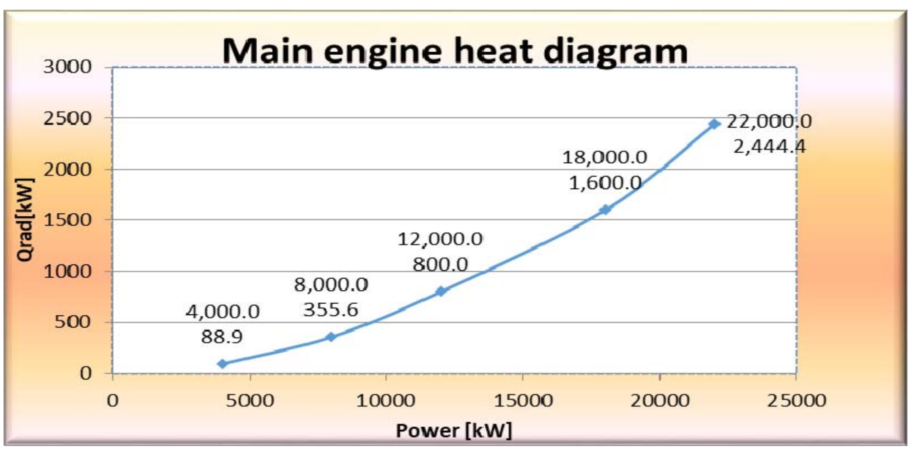


Figure 4 Main engine heat diagram

4. CONCLUSIONS

In order to eliminate thermal flows in the compartments of the ship, it is necessary to calculate the following sizes:

- calculation of the air flow introduced into engine compartments;
- calculation of the air flow extracted from engine compartments;
- the calculation of the airflow required to evacuate the heat flow from the engine rooms.

To improve the energy usage required for air supply fans must consider the heaviness of warm drive machine works, to be specific the number of engines to run at the same time and the amount of steam boilers burners running at the same time.

Ambient conditions require adjusting the air flow which ventilates the engine room and supplies the necessary air for engines, and engine room air temperature control.

5. ACKNOWLEDGMENTS

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GREEN ENERGY DEVELOPMENT TECHNOLOGIES

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Abstract: The concept of green energy means the activity of generating the electrical or thermal energy required for a diverse range of consumers, from renewable and non-polluting energy sources, such as: photovoltaic or solar panels, wind turbines, biomass/biogas/biodiesel, hydrogen, batteries of combustion, wave / tidal energy, geothermal or hydroelectric etc.
By choosing such sources, consumers will be able to support the development of more environmentally friendly hot water for hygienic/household use, electricity or heating the house. Given that the cost of depreciation of the investment is not too long, then for us all, the implementation of green technologies can be a profitable investment not only for the industrial consumers but also for the domestic energies, thereby increasing energy independence but at the same time, reducing the cost of bills for certain utilities such as ones.
Key words: green energy, technologies, cogeneration, photovoltaic or solar panels, sails, wind, biogas, fuel cells, non-polluting / environmentally friendly energies.

1. GENERIC PROBLEMS REGARDING THE LEGISLATION IN THE FIELD

An Order of the Ministry of the Environment, from 2018, directly threatens the largest investment in Romania in the field of high efficiency heating and cogeneration, for the simple reason that the firewood (or forest residues) used in cogeneration plants is removed from the category of biomass. It is strange that this order has exclusive effects on the only power station of this kind in operation in Romania, which ensures centralized heating for over 50,000 thousand people in Suceava city (see figure 1). An investment from scratch, worth about 87 million euros (the only one in Romania) risks becoming inefficient long before it is repaid, exclusively due to an administrative intervention.

Figure 1 View on a thermal power plant in cogeneration, on biomass

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Investments in the production of thermal energy and electricity based on biomass are a priority for both the European Union and for Romania (including in the energy strategy), being given a special importance for this type of renewable energy. Obviously, as in the case of wind, wave or solar energy, the support scheme based on green certificates was the main motivation of the investors, who drew up their business plan on this structure. Interestingly, if wind and solar investments have exploded since the advent of Law 220, the only notable investment in bioenergy was Suceava, where the Romanian company "Adrem Invest" invested 87 million euros for a plant that uses biofuels, namely firewood and wood mass resulting from forestry processing or from what remains after the legal clearing activities of the forest. It is as clear as possible that if the said order removes the firewood from the biomass category that is certified, consequently, for this type of fuel no green bonuses are received. The countries with the highest rate of cogeneration of waste are Sweden, the United Kingdom and Italy. As far as we are concerned, Romania must produce, by 2021, 15% of the energy through recycling. If we do not reach this percentage, we will be penalized by the EU, and the Environmental Guard will fine each city separately.

2. RECOVERY OF GASES FROM LANDFILLS FOR THE PRODUCTION OF ELECTRICITY AND HEAT

Another way to develop clean energy is to use air releases from the storage ramps. In this sense, it is certain that at the pits (platforms), garbage, at least for the large urban agglomerations of Romania, a large amount of natural gas (biogas) is lost, resulting from the fermentation of the quantities of waste deposited in these ecological perimeters (figures 2,3). If Romania were interested in using these quantities of gases (CO, CO2, NOx, SOx, etc.), which are indeed toxic to human beings and not only, they would acquire the technology through which these captured and processed gases generate electricity and / or thermal for consumers. This results in liquefied natural gas (LNG), a more environmentally friendly fuel compared to others, which today provides about 18-20% of the energy needs in industry and transport worldwide.

Figure 2 View on a LNG generation, storage and transport plant

Due to the lack of concern of the authorities regarding the development of a port / naval infrastructure for transport and storage, today in Romania the non-polluting fuels such as LNG or LPG do not occupy 10% of the energy resources needed for the development of the company. The two figures can be examples for entrepreneurship in Romania in the sense of location, obtaining permits, construction, generation and storage / transport (delivery to consumers), green energy (renewable).

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Figure 3 Site for another LNG generation, storage and transport plant

A very important problem for the Romanian state, is not only the production of LNG but also the transport and storage under conditions of maximum safety of this type of fuel, up to the domestic or industrial consumption, for the generation of electricity, ensuring the supply of transport, naval and river naval or, land-based etc. Until recently, it worked under conditions of non-compliance with the law, the garbage dump of Murfatlar in Constanta county. People were bypassing the area because of the unbearable smell of household garbage stored over the past 35 years. Now, at the disposal of the City Hall, the pit was covered with earth, and underneath, because of the heat, the garbage entered the fermentation and began to release methane gas. The biological process that takes place here consists of a fermentation of waste resulting in methane gas that can be captured. Through the care of an entrepreneur, fuel capture probes were installed in the area and in a few years, when the garbage heap will enter maximum fermentation, appreciable quantities of gas will be obtained at lower prices (fig. 4). A well was actually drilled, equipped with a submersible pump, a pipe and an entire faucet installation to capture this fuel. The wells are equipped with a network of collecting pipes, and when the gas in the trash reaches a certain pressure, the capture system starts automatically. The gas is absorbed by a turbine and driven to a tank where it is compressed and transformed into liquid gas. Thus, the former garbage dump of Murfatlar (on the border with Valul lui Traian), covered with vegetable soil, a real outbreak of infection, was transformed by the care of a householder, with money from the European Union, into a green power generator.

.

Figure 4 Green/biogas energy generating plant

The specialists say that in two or three years, only from the waste from here will be obtained methane gas with which it could load weekly between 300 and 500 bottles of gas. The entire investment, made with European funds, as I told you, will be amortized in less than 5 years.

3. PHOTOVOLTAIC ENERGY

One of the most efficient ways to produce pollution-free electricity is by converting solar energy. This is done by means of special remote-controlled mirrors (by means of software), which capture the heat and focus it on some steam generators, whose thermal energy is released on the pallet of a turbine on the shaft with a generator electric machine. Such a technology works successfully in the USA near Lancaster, Australia, South Africa, etc. A difficult problem is the infrastructure for the production and storage of renewable energy, from this point of view, experts say that the public authorities may be in difficulty to finance the technical development and improvement of the network. As a result, investors are advised to use their own funds, without relying on the support of the network operator.

Figure 5 Photovoltaic panels for converting solar energy into electricity

Formulating, in a hypothetical way, a scenario according to which the renewable energy production supported by the support scheme would increase exponentially, reaching the threshold of 8 million MW at the end of 2021, the conclusion would be that there will be no excess of green certificates. This excess can occur if the renewable energy production exceeds the legal level that the support scheme can support, which is unlikely to happen in the next 2 years. "When we are facing an increase in the level of production and a stagnation of consumption, we must advance in the process of developing interconnection lines to ensure the export of surplus electricity.

4. INSTALLATIONS AND EQUIPMENT WITH OPTIMAL ENERGY CONSUMPTION

4.1. Propulsion of ships with fixed or mobile sails covered with photovoltaic panels

Solar energy is harnessed through the use of photovoltaic panels mounted on fixed or mobile sails, fixed on the main deck of a boat (figure 6). In this regard, the shipping company "Solar Sailor" has patented sails type solar sails, which harness both solar and wind energy. These special sails have already been installed and work with good efficiency on a small ship of the company. This is the first hybrid commercial ship powered alternatively with fossil fuel, electricity, wind power and solar power, a ship that has been successfully tested by the new technology. Following the experiments, it was found that when the ship moves at a speed of 12 Nd, at the normal wind intensity (3-4 m/s), the impact angle with the sail surface is 45 grd, the speed of the ship increases by about 1,5 - 1.7 Nd, for the same power of the propulsion engine - 150 kW.

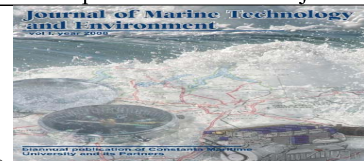

Figure 6 Ship that harnesses solar energy and wind energy

4.2. Use of electric fuel cell with oxygen and hydrogen in marine vessels

Electricity in the case of electric fuel cells is not stored in batteries but is produced on board the ship by means of a combustion cell whose sources are oxygen from the air and hydrogen stored in a special tank placed on board in the energy compartment. In our case, a 330 kW electric battery will be installed aboard an offshore vessel (figure7), built by the Dutch company Feadship, which will be launched on water in 2024. The design would include 28-ton tanks. for storing liquid hydrogen at minus 252 degrees Celsius. The fuel will be used to generate one megawatt electricity for propulsion. Experts say the system will provide a maximum speed of 17 knots, a cruise speed of 10-12 knots and a range of 3,750 nautical miles, more than enough to cover the Atlantic crossing from Southampton to New York, say.

Figure 7 Ship that uses electric combustion batteries

The company's product is of greatest interest to amateurs because of alternative fuels. It has already invested in the Heliogen hub, a California start up that uses software to control the field of mirrors that focus the sun's rays to generate extreme heat. The purpose is to create a non-polluting source of hydrogen by separating water molecules without using fossil fuels. The study plans also include an alternative diesel source for the ship, due to the low number of hydrogen charging stations.

Figure 8 shows a series of three ships with different destinations. Thus, the former can successfully carry out port hydro technical activities, the middle ship has on board diving or working equipment at the navigation lights, which are a very valuable personnel when working underwater at low or high depths or for good signaling. the orientation lights on the water. The last type of ship presented in the figure is for interventions or for logistics/service (people travel and maintenance technique). Also in the category of offshore vessels there is also the cabling, intended for storage and extension of electricity or underwater telecommunications conductors between two points on the shore.

Figure 8 Shows a series of three ships with different destinations

5. CONCLUSIONS

1. In 2017 the energy from renewable sources was 17.5% of the total energy consumed in Europe (falls within the parameters, by 2020 the percentage should reach 20). However, at European level the trend is rising in terms of electricity generation from renewable sources, such as: sun, biogas, wave / tidal energy, wind, geothermal energy or waste incineration (not a good solution because emissions dioxin and furan are a real danger to the population). On the first place at European level is Latvia, on the II - Sweden and on the III - Denmark.
2. The calculations show that wind energy is currently the most important renewable source of electricity, the second place being solar.
3. In 2018, the share of energy from renewable sources for transport activity (including water) is 7.6%, a percentage not too favorable but which, in the coming years will increase, exceeding 10 percent.
4. According to the World Health Organization (WHO), air pollution is the biggest health risk in the EU, the EEA estimates that around 400,000 people die each year, the most exposed being urban dwellers (suspended particles). ,COx, CO_2, NOx, SOx, NO_2, SO_2 from the ground level are the most harmful of atmospheric pollutants).
5. The 2016 Directive on ambient air quality is the cornerstone of EU clean air policy, as it sets the limit values for the concentrations of pollutants in the air we breathe.
6. The technologies of development of the clean energy as well as the improvement of the car fleet, will also lead in our country to improve the quality of the atmospheric air, these working states having a special impact on the quality of life of all beings.

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ASSESSMENT OF HEALTH RISK IN THE MARITIME INDUSTRY

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Abstract: This paper presents the methodology for addressing health risk in the maritime domain. The study site is the Black Sea basin. *Methodology*: Risk assessment and analysis – a part of risk management; to show people what can happen before it happened; to create an environment to respond, not to create stress; to prepare the powers to react in case of events. *Materials*: Black Sea Basin, the tools of management and assessment of risk, f̂actors of the environment/health-environment, professional illnesses and human factors. *Results*: identification the risks of systems and subsystems based on the indicators of hazards, choose the risk matrix, analyse the risk, prepare the risk management plan. *Conclusions*: If you control a number of similar workplaces containing similar activities, you can produce a model risk assessment reflecting the common hazards and risks associated with these activities.

Key words: assessment, risk, health, analysis, matrix, indicator.

1. INTRODUCTION

Major industrial accidents involving maritime ones, based on different sources/f.e. dangerous chemicalsin ports or in the ships, fires on the land or on the ship.

For example: "The use of large amounts of dangerous chemicals is unavoidable in some industry sectors which are vital for a modern industrialised society. But even using of hygiene or cleaning materials… at work, in housing…/ connection with the health" [1].

To minimise the associated risks, measures are necessary to be taken in order to prevent major and to ensure appropriate preparedness and response.

On the EU dimension: (Commissioner Laszlo Andor (2014) said: "Each year in the EU over 3 million workers are victims of serious accidents and 4,000 die in workplace accidents. Occupational accidents and diseases affect all sectors and professions, whether the person is sitting behind the desk, driving a truck, working in a mine or construction site. They not only cause personal suffering, they also impose high costs on businesses and society as a whole".

2. HEALTH RISK-STRESSOR

2.1 Health risk:

While there are many definitions of the word "risk", scientists, institutions, agencies consider health risk to be the chance of harmful effects to human healthor to environmental systems resulting from exposure of an ecological, industrial, or any other stressor [2].

2.2 Stressor:

A stressor is any physical, chemical, or biological entity that can induce an adverse response. Stressors may adversely affect specific natural objects or entire ecosystems, including human, plants and animals, as well as the environment with which they interact.

2.3 Risk, work and health:

A great diversity of problems related to safety and health at work Europe is facing could not be solved by single efforts of one institution, one organization, even one country .

This is reason EU to set up the common European policy for health safety at work (Agency for health and safety at work EU –OSH)[3].

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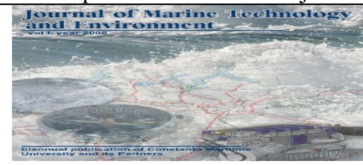

Its goal is to unite and share with Members large base of knowledge and information on issues related to safety and health at work, and in particular the best practices of prevention activities.

3. THE TOOLS OF RISKS

The main tools for risk assessment in various fields are: risk exposure E (Table 1), risk probability P (Table 2), risk identification and assessment (Table 3), risk assessment matrix (Figure 1), checklist with risks, injury I, consequences C and measures M taken.

3.1 Tables

Table 1. Risk exposure

No.crt.	Value	Describing
1.	10	Permanently
2.	6	Frequency/ every working day
3.	3	Rare/oance a week
4.	2	Rare/oance a month
5.	1	Minimal/once a year
6.	0.5	Isolated

Table 2. Risk probability

No.crt.	Value	Describing
1.	P<20	Negligible/ Acceptable
2.	20<P<70	Low, recccommendat uion to take into account
3.	70<P<200	Significant improvement neccessary
4.	200<P<400	High requires immediate improvement
5.	P>400	Very high demand suspension of operation

Table 3. Risk identification and assessment

Hazard identification	Probability	Exposure/Risk/Injury/Measures/Comment
Mechanical: -uneven surfaces -....etc.	P<20	Negligible/ Acceptable
Electrical: -el.equipment -...etc.	20<P<70	Low, recccommendation to take into account
Physical: -high load -....etc.	70<P<200	Significant improvement neccessary
Fire: -ign. Sources -...etc.	200<P<400	High requires immediate improvement
Noise	300<P>400	Very high demand suspension of operation
Ergonomic: -pose -light	200<P<400	High requires immediate improvement

3.2 Figures

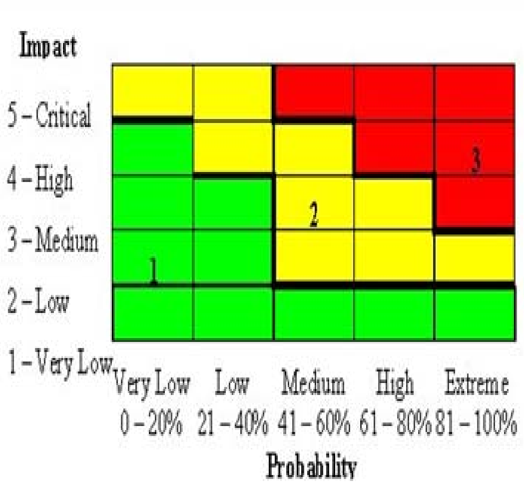

Figure 1 Risk assessment matrix [2]

4. CASES STUDY

4.1 Risk Assessment at work – "small fishing vessel"

1. Describe the vessel in details: physical description, equipments, electrical systems, power systems, technbological systems, materials' characteristics, people, etc.
2. Identify main hazards/probability, severity, frequency: choose the checklist, find an information about the general conditions to which the vessel is faced, ask...for the details, ask...for the history, ask...for the accidents/if some accidents have been realised, how, when, where.., fill the checklist (choose the scale for the probability P/injury I/exposure E
3. Identify the risks of subsystems based on the above indicators of hazard multiply the values: P*I*E
4. Choose the risk matrix
5. Prepare a risk matrix
6. Analyse the risks
7. Prepare the Risk Management Plan RMP
8. Conclusions.

4.2 Risk Assessment at work –ships with dangerous cargo"

1. Describe the ship in details: physical description, equipments, electrical systems, power systems, technbological systems, materials' characteristics, people, etc. Choose the concrete work place.
2. Identify main hazards/probability, severity, frequency: choose the checklist, find an information about the general conditions to which the vessel is faced, ask...for the details, ask...for the history, ask...for the accidents/if some accidents have been realised, how, when, where.., fill the checklist (choose the scale for the probability P/injury I/exposure E.
3. Identify the risks of subsystems based on the above indicators of hazard multiply the values: P*I*E.
4. Choose the risk matrix
5. Prepare a risk matrix
6. Analyse the risks
7. Prepare the Risk Management Plan RMP
8. Conclusions.

4.3 Risk Assessment at work – "port"s pearfor bulk cargo"

1. Describe the pear in details: physical description, equipments, electrical systems, water systems, power system, technbological systems, materials' characteristics, people, etc. Choose the concrete work place.
2. Identify main hazards/probability, severity, frequency: choose the checklist, find an information about the general conditions to which the vessel is faced, ask...for the details, ask...for the history, ask...for the accidents/if some accidents have been

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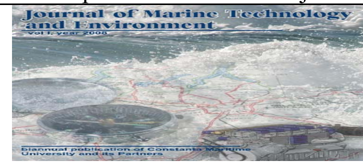

realised, how, when, where.., fill the checklist (choose the scale for the probability P/injury I/exposure E

3. Identify the risks of subsystems based on the above indicators of hazard multiply the values: P*I*E
4. Choose the risk matrix
5. Prepare a risk matrix
6. Analyse the risks
7. Prepare the Risk Management Plan RMP
8. Conclusions.

5. CONCLUSIONS

Risk assessments are very important as they form an integral part of an occupational health and safety management plan. They help to [4]:

- Create awareness of hazards and risk.
- Identify who may be at risk (e.g., employees, cleaners, visitors, contractors, the public, etc.).
- Determine whether a control program is required for a particular hazard.
- Determine if existing control measures are adequate or if more should be done.
- Prevent injuries or illnesses, especially when done at the design or planning stage.
- Prioritize hazards and control measures.
- Meet legal requirements where applicable.

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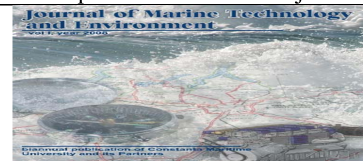

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ENERGY EFFICIENCY ANALISYS OF A MARINE REFRIGERATION PROCESS

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Abstract : Marine transportation is very convenient due to its very low costs. Due to the constant growth of population and its food demand, marine refrigeration is an attractive business. The purpose of this work is to find a way in order to enhance the total energy efficiency of a marine refrigerating plant working with R 134 a. In this study will be make a comparative analysis of the performance of a vapour compression refrigerating plant- met in marine transportation of perishables goods. The temperature values of the sea water at the inlet and outlet of the condenser will be considered to be 23, respectively 26 Celsius degrees. By studying the main parameters of the refrigerating plant cycle, we can establish the value of the convenient refrigerated power, so that the process is streamlined to the fullest. This work is in accordance with the measurements of the water temperature of the seas and oceans, at a depth of 2-3 meters, during the summer period. Depending on the temperature fluctuation, it has different values on the surface, but retains a constant value of 23-26 degrees at the indicated depth.
Between the main parameters calculated in this study are the following: the mass flow of the refrigerant (q_m), the total thermal power of the condenser (Φ_{RHE}), total power input at the compressor (Pc) and Coefficient of Performance of the plant (COP). Considering that on board the ships, refrigerating effect might have different values, depending on the type of the ship, this study focuses on very clear criteria related to the cold production in optimum conditions. In this paper the refrigeration effect will take this three different value: 20 kW, 25 kW and 30 kW. On this bases will result three situations which will be analysed comparatively. Will be analysed the main values: the mass flow of the refrigerant, the total thermal power of the condenser, the power input of the compressor and the Coefficient of Performance.
According to the above mentioned, will be possible to be indicate which is the best operating situation, among the three cases of study.
Key words: efficiency, energy, marine, process, refrigeration

1. INTRODUCTION

The role of perishables is dominated by the fact that their value is fasting decreasing in time, this is why it is recommended to sell these goods very soon after they are placed on market, in this aspect maritime transportation is beneficial because it responds properly to the demands of perishables [1].

The most common refrigeration method met in marine refrigeration is represented vapour compression that includes reciprocrating compressors [2], [3].

In these type of plants, HFC, (respectively R134a) are the most used refrigerants, due to international resolutions requiring such as not to deplete the ozone layer (ODP=0) and not to contribute in a significant manners to global warming (low GWP) [4], [5].

This paper will deal with the calculus related to the energy efficiency of a marine refrigerating plant working with R 134a. The analyses will be done by knowing the refrigerating power of the plant, the inlet/outlet temperature of the brine and the inlet/outlet temperature of the sea water. Following the stages of the specific thermal calculus will be found important parameters of the plant such as: the mass flow, the thermal flux of the compressor, the power input at the condenser, the power input at the compressor and coefficient of the performance (COP).

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2. MATHEMATHICAL APPROCH

In figure 1 it is provided the cycle of the analysed plant, in (p-h) diagram, below being given the mathematical formulation used in the assessment of a plant, at the smallest pressure the liquid refrigerant absorbs heat in a heat exchanger (evaporator), and a highest pressure, the vapour of refrigerant release in the other heat exchanger (condenser); the relationships used in the following analysis are given below [6], [7], [8], [9], [10].

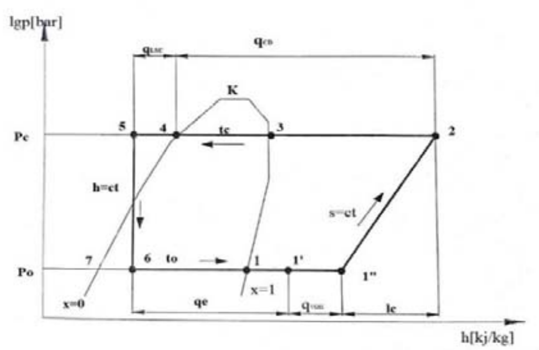


Figure 1 Theoretical thermodynamic cycle

In this approach, the calculation data are the following:
- refrigerant - R134a
- refrigerating power 20, 25 and 35 kW
- cool agent - brine
- brine temperatures $t_{b1} / t_{b2} = (-3/-8)$ [°C]
- cooling agent - seawater
- the temperatures of the cooling agent

$$t_{sw1} / t_{sw2} = (26 / 31) \text{ [°C]}.$$

The next step is the thermal calculation; and in the first phase to determine the characteristic temperatures:
- temperature of evaporation:

$$t_e = t_{b2} - \Delta t_e = -8 - 3 = -11 \text{ [°C]} \quad (1)$$

- condensation temperature;

$$t_C = t_{sw2} + \Delta t_c = 31 + 3 = 34 \text{ [°C]} \quad (2)$$

- overheating temperatures;

$$t_{1'} = t_0 + 7 = -11 + 7 = -4 \text{ [°C]} \quad (3)$$

$$t_{1''} = t_{1'} + 11 = -4 + 11 = 7 \text{ [°C]}. \quad (4)$$

The determination of the thermodynamic parameters corresponding to the saturation states of the thermodynamic cycle is done by using the tables and the log-p- h diagram for R134a. The same method is applied in determining the parameters at the other points of the cycle.

In order to be able to make an adequate comparison of the most important parameters of the cycle, for the three cases described in the present work, it is necessary to determine and analyse all the calculation elements starting with the mass refrigeration power and ending with the COP.

The calculation formulas used for the three cases are described below, and the results are presented in table 1.

Massic cooling power:

$$q_e = h_{1'} - h_6 \text{ [kJ/kg]}. \quad (5)$$

Volumetric cooling power : $q_{ev} = \frac{q_e}{v_{1''}}$ [kJ/m3]. (6)

Refrigerant massic flow: $q_m = \frac{\Phi_e}{q_e}$ [kg/s] . (7)

Massic condensation thermal power:

$$q_{cd} = h_2 - h_4 \text{ [kJ/kg]}. \quad (8)$$

The total thermal power of the condenser:

$$\Phi_{cd} = q_m q_{cd} \text{ [kW]} \quad (9)$$

Mass mechanical compression work:

$$l_C = h_2 - h_{1''} \text{ [kJ/kg]} \quad (10)$$

Total power of the compressor:

$$P_C = q_m l_k \text{ [kW]} \quad (11)$$

The massic thermal power of the exchanger:

$$q_{VOH} = q_{LSC} = h_{1''} - h_{1'} = h_4 - h_5 \text{ [kJ/kg]} \quad (12)$$

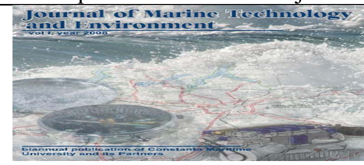
The total thermal power of the heat exchanger:

$$\Phi_{RHE} = \Phi_{SIV} = q_m q_{RHE} = q_m q_{VOH} \text{ [kW]} \quad (13)$$

Energy balance of the installation:

$$\Phi_E + P_C = \Phi_{Cf} \text{ [kW]} \quad (14)$$

The coefficient of performance of the installation:



$$COP = \frac{\Phi e}{P_C} . \qquad (15)$$

The table below presents the results for the three situations.

Table 1. Results for different values of the refrigerating power

	q_m (kg/s)	Pc (Kw)	Φ_{RHE} (Kw)	COP
20 Kw	0,126	4,25	1,21	4,7
25 kW	0,157	5,31	1,51	4,7
30 kW	0,188	6,37	1,81	4,7

As we are focusing on very clear criteria related to the cold production in optimum conditions, the results of the calculations of the most important indicators of the installation give us a clear and detailed picture of the aspects that must be taken into account when it is desired to analyse the efficiency of a refrigeration process.

The following diagrams briefly show the correlation between the parameters as well as the differences that can appear from the energy consumption; all this being visible in the final costs of the installation.

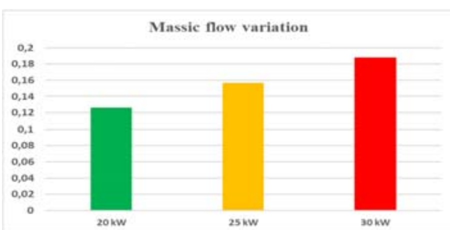


Figure 2 Mass flow variation

It is obvious that if we want to increase the cooling capacity of the installation, under the given temperature conditions, we must increase the refrigerant flow. This results in increased costs by increasing the power absorbed by the circulation pump.

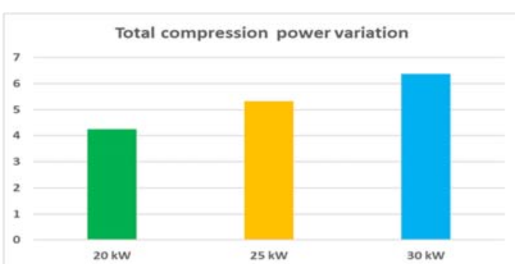


Figure 3 Total compression power variation

The compressor being the key element in such an installation, is manufactured with the option of being able to vary the compressive power with results in the cost of energy. The variation, as a result of the calculations, is a linear one, increasing steadily from 4.25 to 6.37.

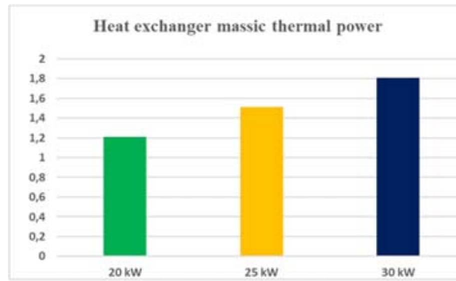


Figure 4 Hex thermal power

The initial temperatures being approximately fixed, the only thing we can do to support the power requirement is to increase the capacity of the exchanger by replacing it with a more performant one. These lead to additional costs that fall into the cost of the installation.

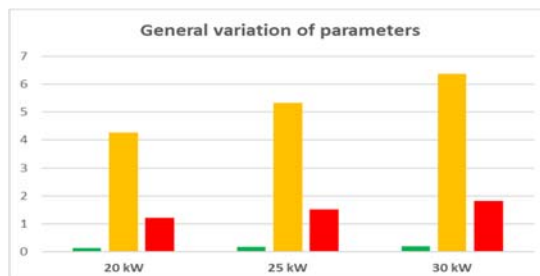
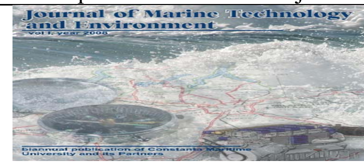


Figure 5 General variation of parameters

Taking into account all the parameters one can observe an increasing variation of them from a quantitative point of view depending on the cooling requirement. The COP represents the most important and decisive parameter in the design, purchase and commissioning of an installation.

Considering that the temperature of the cooled environment is maintained between -3 and -8 degrees Celsius and the sea water temperature has a rather small variation of 25-26 degrees**,** the analysis indicates that the maximum performance under these conditions is reached at a cooling power of 20 kW, the other options being more expensive, both economically and ergonomically.

Besides the fact that the plant is working efficiently when the refrigerant mass flow is low, and the value of compressor input as well, it is convenient to get the value of the mass flow of the refrigerant charge at its lowest value.



5. CONCLUSIONS

By the help of the thermal calculus specific to the one stage vapor compression refrigeration systems met in marine refrigeration , it is possible to assess the performance of the plant , in order to evaluate its energy efficiency. Its performance is given by the COP – which should present values more than 1.

For the present situation, COP is found to be around 4,70, for all three situations Also it is possible to evaluate the consumption of the reciprocating compressor, being known the fact that these type systems have a high energy demand. Respectivly, the most convenient situation is when the energy needed for the compression drive is of 4,25 kW. Also, in for this case was obtained the lowes.

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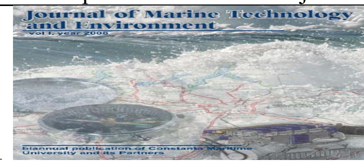

RENEWABLE ENERGY AND DEVICES ONBOARD SHIP

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Abstract: This article presents the scale of pollution in the world has because of the shipping industry.
In the article, the reader will discover, renewable energy device system, used like an alternative source of energy, green energy suitable for container ships, for reducing fuel consumption, environment pollution, costs for ship owners and charters.
We have made some studies about which is the best, optimal and most efficient system suitable for a container ship in order to upgrade it. After a long term of comparisons between systems we consider that if we will install some modern Flettner rotors and an Flettner balloon, in addition to the diesel generators that already exist on the ship, together with an additional electrical engine, we can reduce the fuel consumption, environment pollution and costs.
This article major points are: pollution caused by ships nowadays, modern Flettner rotor, Flettner balloon, choosing the best gas suitable for our Flettner balloon, wiring diagram for the connection of the green source of energy to the main power switchboard of the ship, hybrid propulsion on container ship by using a diesel engine and an electrical engine.
The present article is a piece of a big research on the installation of a hybrid system powered by energy, coming from conventional and unconventional energy sources, on container ships. We propose a propulsion system with a diesel and an electric motor and connection scheme to an automatic computerized generator control system. Finally, we have connecting conventional and unconventional energy sources to the ship main power switchboard.
Key words :pollution, prevention, emissions, ship, renewable, energy.

1. INTRODUCTION

The present paper focuses on a broader system regarding air pollution research, methods of reducing pollutant emissions produced by naval engines.

Over the past 30 years, the pollution level has been steadily increasing and the chemical structure of the atmosphere has changed due to the large amounts of pollutant emissions such as NO_x, SO_x, CO and other particles resulting from combustion, which lead to destruction of ozone layer, climate change, greenhouse effect or acid rain.

As oil prices continue to rise, the atmosphere is degraded by exhaust gas emissions and the overall degree of pollution of the Earth increases with each passing day, so the solutions for unconventional sources of energies have begun to arouse the interest of the parties involved in maritime transport.

The article entitled "Reducing the container ship emissions by using renewable energy devices system. How to connect a system of renewable energy devices to the main power switchboard of a container ship" is part of the series of works on electricity generating systems using unconventional energy sources on container vessels, less known worldwide.

In 1999 the concept of "Green Ship" was initiated [1]. At first it was a simple environmental protection project, but as time went on it became a powerful concept, summing up the measures that can be taken regarding marine pollution, including ship construction methods, new ship propulsion systems, new systems. energy generators using wind or solar energy, new international regulations with a high degree of obligation and last but not least, changing the concept of transport on the seas and oceans of the globe.

In this paper the authors will present to the reader possibility of navigating on a commercial maritime vessel by using a hybrid system formed from conventional sources of energy- fossil fuels and renewable sources of energy- wind energy and how to connect green energy

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sources with conventional ones, on the main electrical bar of a container ship. Of course, the propulsion of a ship on a route established between two ports cannot be confirmed, only with the help of electricity coming from unconventional sources/green one. Unconventional energy sources can be used at the time of the crossings, thus saving fuel and reducing environmental pollution with gases from the burning of fossil fuels.

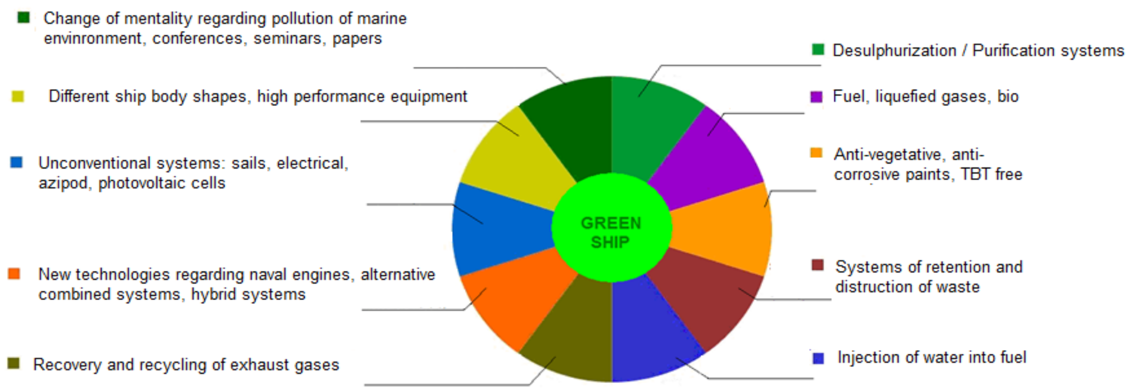

Figure 1 The main sectors and directions of the Green Ship concept

2. POLLUTION CAUSED BY MARITIME SECTOR

2.1 Introduction

The measures taken regarding the pollution of the marine environment are included in international rules valid for all the states that have registered ships. The International Maritime Organization (IMO) makes every effort to ensure that the measures taken cover the entire range of polluting agents and especially of polluted environments, not only of water, but also of air.

The activity of maritime transport means fuel consumption, its combustion to ensure naval propulsion and implicitly the emission of toxic gases of the kind SO_x, NO_x, CO in the atmosphere.

Compared to other modes of transport, pollutant emissions from maritime transport are substantial. Emissions from combustion of fuels depend on its degree and composition. Because the combustion characteristics of fuel oil and diesel are different, their combustion can produce significantly different emissions.

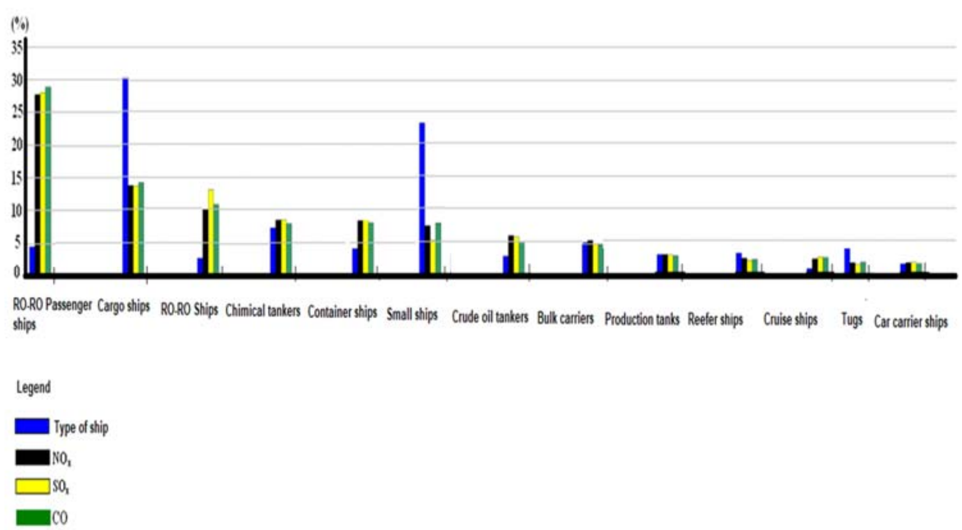

Figure 2 Pollutant emissions in the Baltic Sea from different types of vessels

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Table 1. Approximate emissions of produced by internal combustion naval engines

NO_x	Engine < 6000 kW	Engine 6000-15000 kW	Engine>15000 kW
	(tones/year/ship)	(tones/year/ship)	(tones/year/ship)
On sea	231	760	1903
At berth	3	7	19
During manoeuvres	0	1	2
Total emisions	234	768	1924

Table 2. Approximate emissions of produced by internal combustion naval engines

SO_2	Engine < 6000kW	Engine6000-15000kW	Engine>15000 kW
	(tones/year/ship)	(tones/year/ship)	(tones/year/ship)
On sea	169	557	1395
At berth	2	5	14
During manoeuvres	0	1	2
Total emisions	**171**	**563**	**1411**

2.2 Impact of polluting gases on the environment

SO_x-has a local but also regional impact.
SO_x- contributes to acid deposition, which affects soil and water quality.
SO_x- - are known as precursors for the formation of particle matter.
NO_x - reacts with ammonia to form nitric acid vapors and particles that can penetrate deep into lung tissue, damaging it, causing premature death in extreme cases. From the reaction with volatile organic compounds, in the presence of sunlight, ozone can cause adverse effects, such as lung tissue deterioration and reduced lung function. Ozone can be carried by the wind and can have negative impacts on human health, far from the location of the sources that produced it.

2.3 Impact of greenhouse gases on the environment

The increase of the CO_2 in the atmosphere contributes to the development of greenhouse gases, which leads to radical climate change, most of which have a direct effect on the global temperature rise.

Another greenhouse gas is CH_4 .It has the same effects as those of CO_2, but with a potential negative impact 25 times greater than CO_2 in the next 100 years.
CO_2 emissions from maritime transport account for one fifth of road transport emissions. NO_x emissions and the particular matters are almost equal, and the emissions of SO_x in maritime transport are substantially higher than those of road transport by a factor of 1.6 to 2.7.
From the graph above we can see that in 2011:

- Over 85% of the emissions came from container ships and oil tankers;
- Container ships have a short time in ports, but with very high emissions.

3. UPGRADE A CONTAINER SHIP WITH GREEN ENERGY SOURCES

3.1. Introduction

I have chosen a container ship, to upgrade him which green energy sources to transform into a hybrid system of energy sources. Like green energy sources, suitable for a container ship I have chosen 4 Flettner rotor which are situated on the main deck and a Flettner balloon which is on the top of the ship, floating. Also I have added an electrical motor, which has the role to be used together with green sources during ocean passage. The green sources can be also used with the diesel engine.

All the generators, on fossil fuel and green renewable energy will be commanded by an intelligent automatic program, which will try to use fossil fuel as less as possible.

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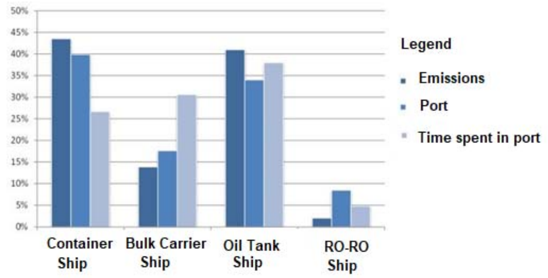

Figure 3 Chart of emissions from ports by type of ship in 2011

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3.1 Modern Flettner rotors

Flettner rotors are one of the various equipments needed to capture and harness wind energy.
In this paper, I use four modern Flettner rotors.

Table 3. Technical characteristics of the modern Flettner rotor

Technical characteristics	
Model	24 x 4
Rotor	
Height x diameter (m)	24 x 4
Material	Fiberglass reinforced plastic / carbon Fiber reinforced polymer
Rotor speed (rpm)	0-225, variable
Structure	
Tower	Cylindrical - of steel
Foundation height (m)	2,5
Weight(t)	34
Components	
Electrical engine	90kW, 50/60 Hz IE4,IP55
Ambiental conditions	
Operating temperature	+50 - -30 C
Wind speed required for operation	0-25 m/s
Wind resistance	70 m/s

Table 4. Power generated by one modern Flettner rotor, at various wind speeds and a ship speed of 19 Nd

Ship speed: 19 Nd		
True wind power (m/s)	True wind direction	Generated power (kW)
10	60-130 si 230-300	500
22	105-135 si 225-255	2000

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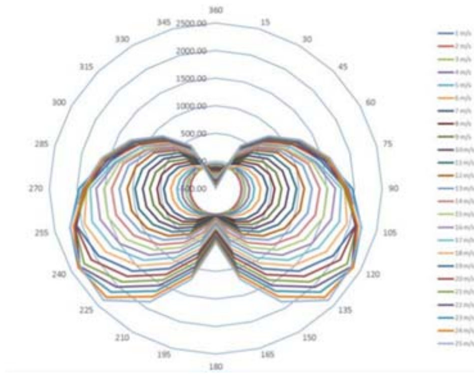

Figure 4 Polar diagram with the net output power (kW) generated by the modern Flettner rotor, at various wind speeds, the speed of the ship remaining constant at 19 Nd.

3.1 Flettner balloon

3.3.1 Introduction

The Flettner balloon is a generator of electricity, filled with a gas lighter than air - which rotates around a horizontal axis and sends electricity using cables.

The generated electricity can be used immediately or stored in a battery. The Flettner balloon is a device that generates high altitude electricity. It rotates around a horizontal axis in response to the wind, effectively generating clean, renewable electricity at a lower cost than all competing systems.

The balloon has at each end of the rotor a direct output connection with cables. Outside the generator at each end of the rotor there are wind stabilizers in the form of conical wheels. The deviation is caused by the Magnus force. It is in the rotational direction of the rotor and results from the pressure differences created during the rotation process. The Magnus effect is maximum when the wind direction is perpendicular to the rotor axis of the rotor. Magnus effect associated with rotor rotation, provides additional lift and stabilizes rotor position. The wind causes the balloon to rotate: the movement is converted into electricity and then transferred downwards.

3.3.2 The power generated by the Flettner balloon

From the researches it was found that the Flettner balloon, located at 300 m altitude can generate about 1000 kW/h.

In order for the Flettner balloon to float he must be field up with an gas which is lighter than air.

To do this I had to choose between two gases: helium and hydrogen.

3.3.3 Choosing the best gas suitable for our Flettner balloon

Table 5. Comparison between Hydrogen and Helium

	Hydrogen (dihydrogen or molecular hydrogen) 1H; 2H; 3H	**Helium**
Molar volume	**22,42 x 10^{-3} m^3/kmol**	**21 x 10^{-3} m^3/kmol**
Speed of sound	**1270 m/s la 20^{o} C**	**970 m/s la 20 ^{o} C**
Vapour pressure	**-**	**-**
Electronegativity	**2.2**	**-**
Specific heat	**14,304 J/(kg x K)**	**5193 J/(kg x K)**
Electrical conductivity	**-**	**-**
Thermal conductivity	**0,1815 W/(m x K)**	**0,142 W/(m x K)**
First ionisation energy	**1312 kJ/mol**	**2372,3 kJ/mol**
Second ionisation energy	**-**	**5250,5 kJ/mol**

Table 6. Comparison between Hydrogen and Helium

	Hydrogen (dihydrogen or molecular hydrogen) 1H; 2H; 3H	Helium
Symbol	H	He
Atomic number	1	2
Chemical series	Nonmetals	Noble gas
Group, Period, Block from the Periodic Table of Elements	1	18, VIII-A, 1, s
Density	0.0899 kg/	0.1785 kg/
CAS number	1333-74-0	7440-59-7
EINECS number		231-168-5
Self-ignition / flammability point	500 º C	-
Melting point	-259.14 º C	-272.2 º C
Boiling point	-252.87 º C	-268.9 º C
Fusion energy	0,05868kJ/mol	5,23 kJ/mol
Evaporation energy	0,44936kJ/mol	0,0845 kJ/mol
Critical temperature		-268 º C
Critical pressure		2,27 x 10^5 Pa

Table 7. Comparison between Hydrogen and Helium

	Hydrogen (dihydrogen or hydrogen molecular) 1H; 2H; 3H	Helium
Condition	Gaseous	Gaseous (at 26 atm)
	Liquefied	Liquefied
	Grease	Can be found in plasma form
	Solid	
	Metal shapes	
Use	Hydro genetic agent	Filling balloons and airships
	As a protective shield in various atomic hydrogen welds	Filling the weather balloons
	For cooling in the electricity generating industry	For cooling (temperatures under -434ºF)
	In the chemical industry, aerospace, telecommunications, food	To maintain controlled atmospheres
		Used as inert gas
		For gas leak detection
		Used in the rocket industry
		For deep sea diving
		For cooling some nuclear reactors
		For creating hard disks
		In the manufacture and use of solar telescopes
		Cryogenics

Table 8. Comparison between Hydrogen and Helim

	Hydrogen (dihydrogen or molecular hydrogen) 1H; 2H; 3H	Helium
Atomic mass	1,00794 u	4,002602 u
Atomic radius	25(53) pm	128; (31) pm
Radius of convalescence	37 pm	32 pm
Radius van der Waals	120 pm	140 pm
Electronical configuration	1	1
Electrons on the level of energy	1	2
Oxidation number	-1,+1	0
Oxide	Amphoteric	-
Crystalline structure	Hexagonal	Hexagonal

Table 9. Comparison between Hydrogen and Helium

	Hydrogen (dihydrogen or molecular hydrogen) 1H; 2H; 3H	Helium
Hydrogen 2	It is used for nuclear fusion	
Hydrogen 3	Product in nuclear reactors for the creation of hydrogen bombs	
Burning	With ultraviolet flame, not imperceptible to the human eye	

Table 10.Comparison between Hydrogen and Helium

	Hydrogen (dihydrogen or molecular hydrogen) 1H; 2H; 3H	Helium
Properties	The temperature of the flame at which the hydrogen burns can reach 2000 ^{0} C	
		Inert and monoatomic gas
	14.5 times lighter than air	Gas lighter than air
	Hydrogen gas H2	
	Very explosive and combustible substance	
	The most stable isotopes	

Table 11. Comparison between Hydrogen and Helium

	Hydrogen (dihydrogen or molecular hydrogen) 1H; 2H; 3H	Helium
Properties	colourless	colourless
	odorless	odorless
	No taste	No taste
	Vapid	Vapid
	Non-toxic gas	Non-toxic gas
	Very soluble in rare metals	

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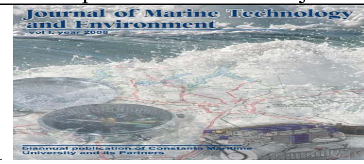

	Soluble in monocrystalline and amorphous metals	
	Water soluble	The least soluble in water compared to other gases
	Low density	Low density
	Highest heating point	Low boiling point
		Low solubility
	Low viscosity	Low viscosity
	At high pressures it is transformed into snow crystals thus forming solid hydrogen	
	The highest thermal conductivity of all gases	High thermal conductivity
		High caloric content

From the tables above we can see that both hydrogen and helium are gases that have been or are used to fill balloons, due to their lower density than air,

$$\rho_H = 0.0899 \frac{kg}{m^3} \quad \text{and} \quad \rho_{He} = 0.1785 \frac{kg}{m^3}.$$

Although hydrogen has a lower density than helium and requires a smaller volume of gas compared to helium to fill and maintain buoyancy of the Flettner Balloon, it is much more dangerous, due to a mixture of hydrogen with air, it creates an explosive gas that would endanger the balloon and even the ship. For this reason, I have chosen the Flettner Balloon to be filled with Helium. The latter being easier than air, giving the balloon a buoyancy in the air and due to its inert gas properties, it can not explode, in the case of mixing the gas in the balloon with the air, in the case of gas leakage from the balloon.

4. PROPULSION SYSTEM WITH A DIESEL AND AN ELECTRIC MOTOR. CONNECTION SCHEME TO AN AUTOMATIC COMPUTERIZED GENERATOR CONTROL SYSTEM

4.1. Introduction

I propose to use two engines one diesel and one electric.

The high-power diesel engine will be able to operate during use of diesel generators but also during the function of modern Flettner rotors and the Flettner balloon. The electric motor will have as the main source of electricity the renewable sources of energy, respectively Flettner rotors installed on the ship's deck and the Flettner balloon and as secondary source diesel generators.

The two engines will not run concurrently, their operation will be done in turn and by using a gearbox with the role of switching the propulsion from the diesel engine to the electric motor.

The system of diesel generators, modern Flettner rotors, the Flettner balloon, will be controlled by an automatic computerized system. During crossings when unconventional power sources are turned on, we will use the electric motor. The main electricity generators will be the Flettner rotors and the Flettner balloon, but in case the energy produced by them is not sufficient, diesel generators will be introduced at a minimum power, with the role of covering the existing energy deficit. By using the diesel generators at minimum power when needed, we reduce fuel consumption to a minimum, thus reducing pollution and costs.

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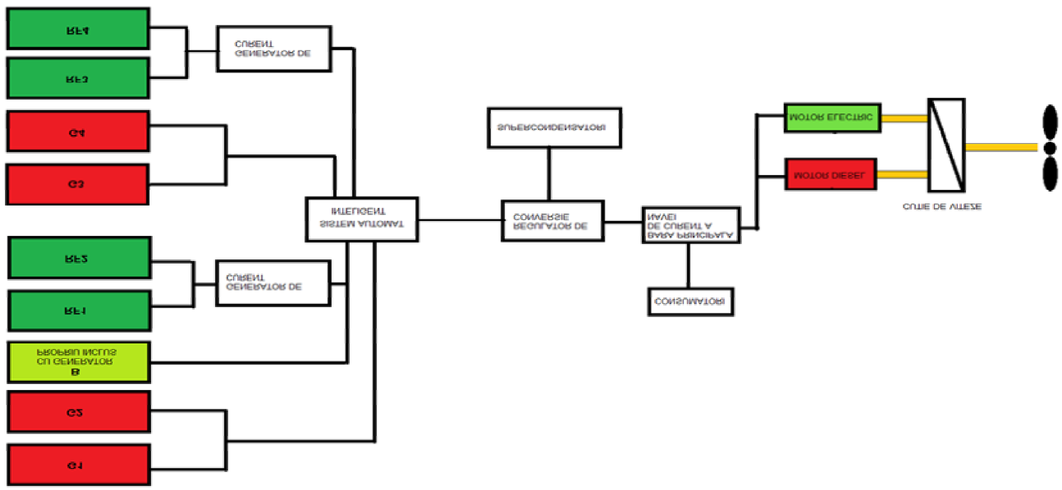

Figure 5 Propulsion system with a diesel and an electric motor and connection scheme to an automatic computerized generator control system

3.1.Diesel engine

The MAN Diesel & Turbo engine is built in such a way that it has low fuel consumption and complies with the new MARPOL marine pollution regulations.

To reduce fuel consumption, the pressure in the combustion chamber was increased, based on the new engine structure.

Another advantage of this engine is that in the options of adjusting the partial load and the small load it uses the increased pressure of the combustion chamber as the main instrument to ensure a low SFOC (specific fuel consumption) at a partial load, the same result, being experienced.

- **Particularities**

Table 13. Particularities of the diesel engine chosen

Particularities			
Engine type		HYUNDAI-MAN B&W, electronically controlled, two-stroke engine, directly reversible, turbocharged diesel engine at constant pressure	
Model		HYUNDAY-MAN B&W 6G80ME-C9,2	
Cylinder nomber		6	
Cylindrical bore		mm	800
SMCR	Out	kW	24680
	Rotation	rpm	72
	MEP	bar	18,3
	P_{max}	bar	185
	Average piston speed	m/s	8,9

Table 12 Particularities of the diesel engine chosen

CSR	Out (kW)	22,212
	Rotations (rpm)	69,5
	MEP (bar)	17,1
Net engine weight	(tons)	945

Engine control system

Figure 6 MAN Diesel & Turbo engine

Components:

- Engine control unit (ECU)
- Engine interface control unit (EICU)
- Cylinder control unit (CCU)
- Auxiliary equipment control unit (ACU)
- Tacho system
- Sensor

Characteristics of the diesel engine:

- Main features: Low NO_x combustion, adjustable with camshafts;
- Variable control of the intake valve; Improved combustion chamber design;
- High pressure increase;
- High mechanical resistance in the engine;
- Development of the turbocharger in two stages;
- Exhaust gas re-circulation;
- Sequential turbocharging;
- Variable turbine geometry;
- Inlet air humidification or water injection;

Emulsification of fuels Secondary features:

- Selective catalytic recovery systems;
- Low sulphur fuels for limiting SO_x;
- Exhaust gas purification systems that use both methods either direct seawater cleaning or closed circuit freshwater washing.

Figure 7 HYUNDAI-MAN B&W engine

3.1 Electrical engine

The electric motor is the most used device for the conversion from electrical energy to mechanical energy, being used for propulsion.

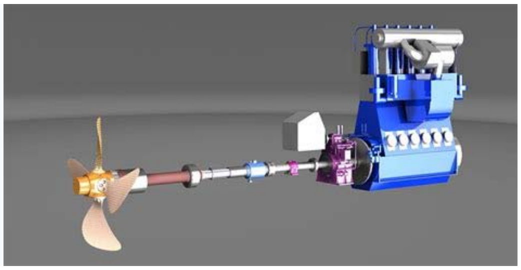

Figure 8 Propulsion with shaft and electric motor

Advantages of an electrical system:

- Increased flexibility;
- Noise and vibration reduction;
- Improved reliability, leading to reduced maintenance costs;
- Low operating costs;
- Fuel economy;
- Low maintenance;
- Reduction of time lost / reduction of time;
- Configurable for maximum system availability / redundancy;
- Zero pollution.

Disadvantages of an electrical system:

- High implementation costs.
- A low level of energy efficiency for high-speed sailing vessels all the time, due to energy losses.

- Costs quite high with the training of the crew with a new system, which requires a great automation

Table 14. Losses of an electrical system

Loss	Components	Fuel (100%)
53%	Engine	47%
4%	Generator	45.12%
1%	Distribution	44.67%
1%	Transformer	44.22%
4%	Propulsion converter	42.45%
4%	Propulsion engine	40.75%

Possible solutions to combat disadvantage

Table 15 Solutions to combat the disadvantages of an electrical system

Loss	Components	Fuel (100%)
43.6%	A variable speed of the engine would lead to a 20% higher energy efficiency	56.9%
4%	Use of high temperature superconductors	54.14%
0.77%	A DC distribution would mean a reduction in losses with 23%	53.72%
3.16%	Using silicon carbide to convert propulsion would mean a reduction in losses with 21%	52.02%
4%	Use of superconductor motors at high temperature	49.94%

5. CONNECTING CONVENTIONAL AND UNCONVENTIONAL ENERGY SOURCES TO THE SHIP MAIN SWITCHBOARD

The ship will be energized as follows:

- On port side:
- Generator 1 (G1 – AC450V 3 PH 60 Hz 2000 KWA);
- Generator 2 (G2 – AC450V 3 PH 60 Hz 2512 KWA);
- Flettner balloon (B – AC450V 3 PH 60 Hz 1000 KVA);
- Flettner rotor 1 (FR1 – AC450V 3 PH 60 Hz 2000 KVA);
- Flettner rotor 2 (FR2 – AC450V 3 PH 60 Hz 2000 KVA);
- On starboard side:
- Generator 3 (G3 – AC450V 3 PH 60 Hz 2512 KWA);
- Generator 4 (G4 – AC450V 3 PH 60 Hz 2512 KWA);
- Flettner rotor 3 (FR3 – AC450V 3 PH 60 Hz 2000 KVA);
- Flettner rotor 4 (FR4 – AC450V 3 PH 60 Hz 2000 KVA);

Both the four modern Fettner rotors installed on the main deck of the ship and the Flettner balloon filled with helium gas situated on top of the ship floating, generates a direct current. In order to be able to link these unconventional energy sources to the main power switchboard of the ship, I had to bring the current to 450V AC and 60Hz. For this we used 5 current inverters: one of 690 / 450V 1500kVA rated with **T1** on the electrical diagram for the Flettner balloon and four of 690 / 450V 2500kVA rated with **T2**, **T3**, **T4**, **T5** for each of the four Flettner rotors **FR1, FR2**, **FR3**, **FR4**.

The line on which the ACB is located is called the force line. ACB is a power switch, with the generator linking to the main bar. ACB is coming from air circuit breaker.

ACONIS 2000 PMS represents Power System Management. It is used for the automatic coupling of the energy sources, being located on the command and control line. ACONIS also has the role of overseeing currents, protection and distribution of tasks.

ACONIS reads the voltage and frequency entering the system and compares it with the voltage and frequency already existing, which are in the line coming out of it. The role of these comparisons is to make a reliable ACB.

PT1A represents a transformer with the role of sending voltage information to the voltmeter, which measures the voltage.

It sends the voltage information and the operating frequency to the synchronization panel and to the meter **HM**, which calculates the operating time.

CT1 and **CT2**, represent current transformers that send the information to the ammeter and to **ACONIS**.

AS1 represents the switch for ammeter, and **VS1** represents the voltmeter switch.

WTD is a connection box, with the purpose of sending the load information to the local ammeter **A** and a power meter **W** from synchronize panel.
SY represents a synchronization module, which takes the information from the main power switchboard and the information from each source separately from each current generator **G1**, **G2**, **G3**, **G4** and from the unconventional power generators **FR1**, **FR2**, **FR3**, **FR4**, **B**, for secure coupling to manual mode in parallel to the main power switchboard.
W1W ⟶ represents the line to the synchronization panel.

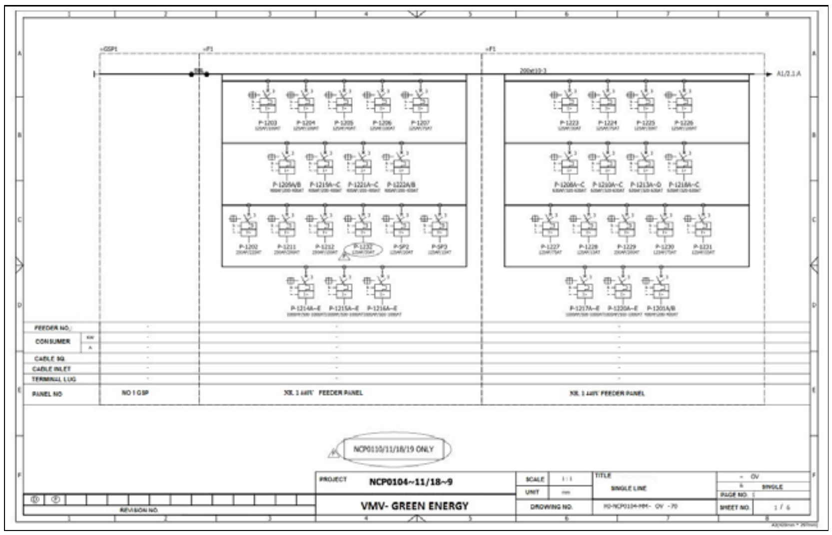

Figure 9 Connecting electrical scheme 1/6 of conventional and unconventional energy sources to the ship main power switchboard

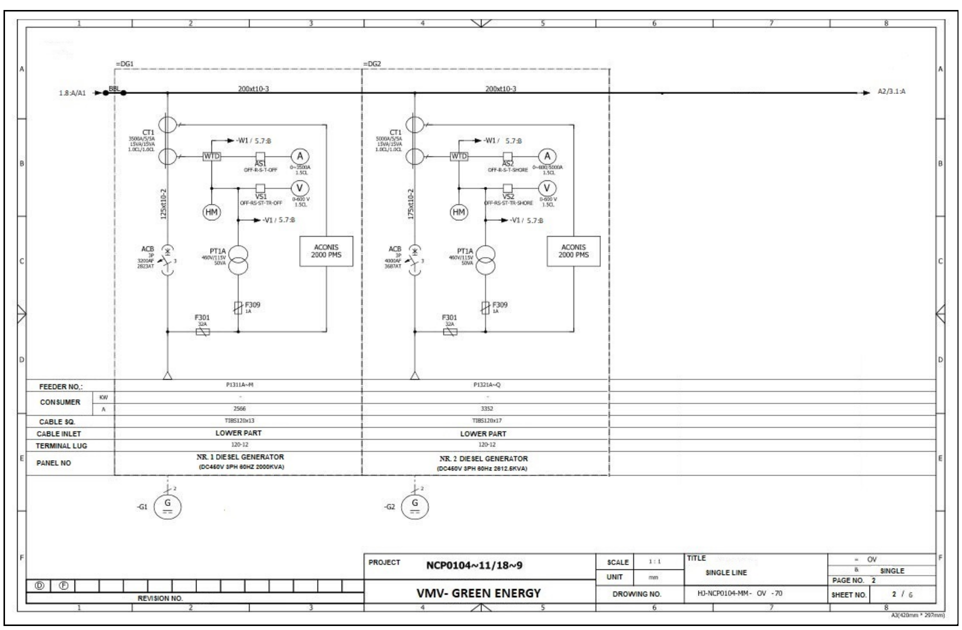

Figure 10 Connecting electrical scheme 2/6 of conventional and unconventional energy sources to the ship main power switchboard

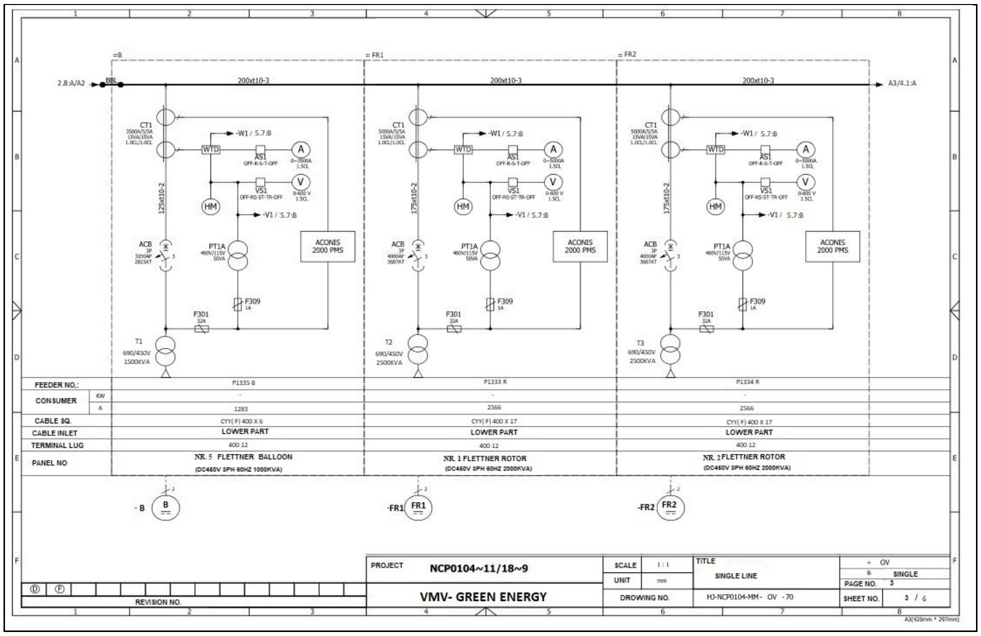

Figure 11 Connecting electrical scheme 3/6 of conventional and unconventional energy sources to the ship main power switchboard

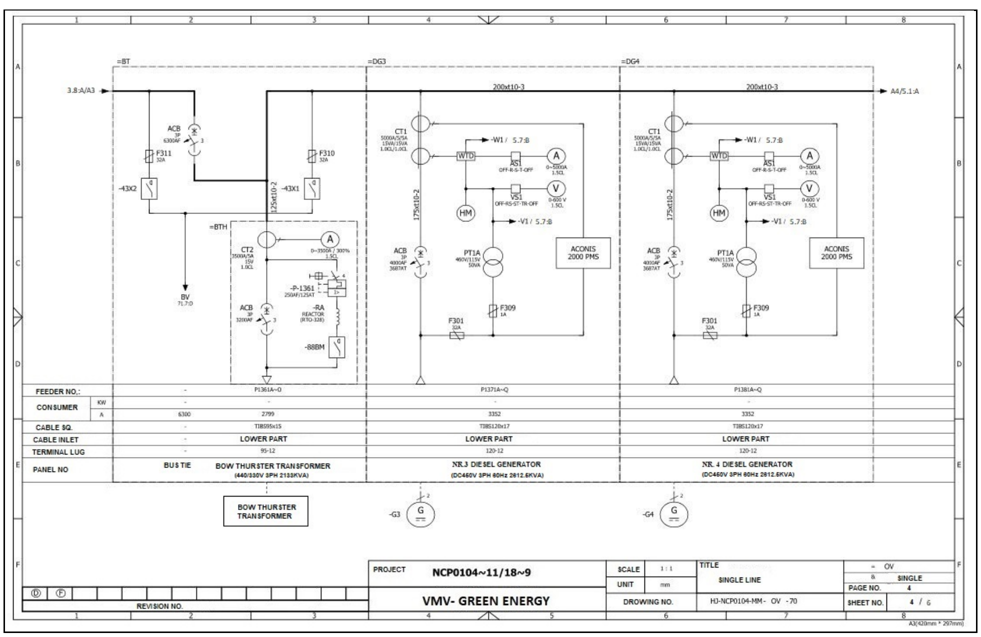

Figure 12 Connecting electrical scheme 4/6 of conventional and unconventional energy sources to the ship main power switchboard

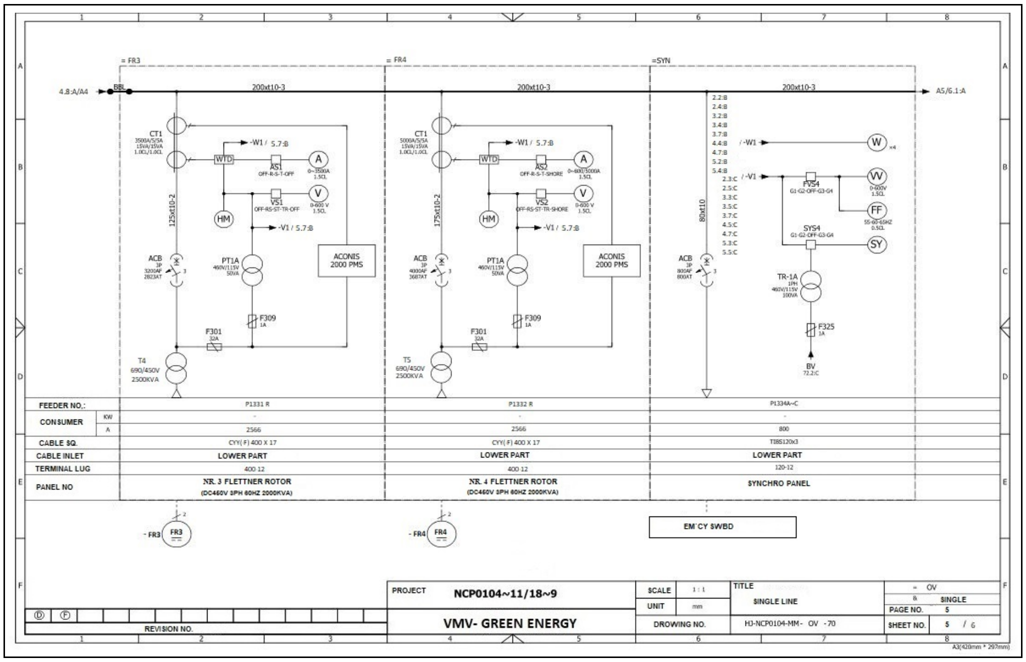

Figure 13 Connecting electrical scheme 5/6 of conventional and unconventional energy sources to the ship main power switchboard

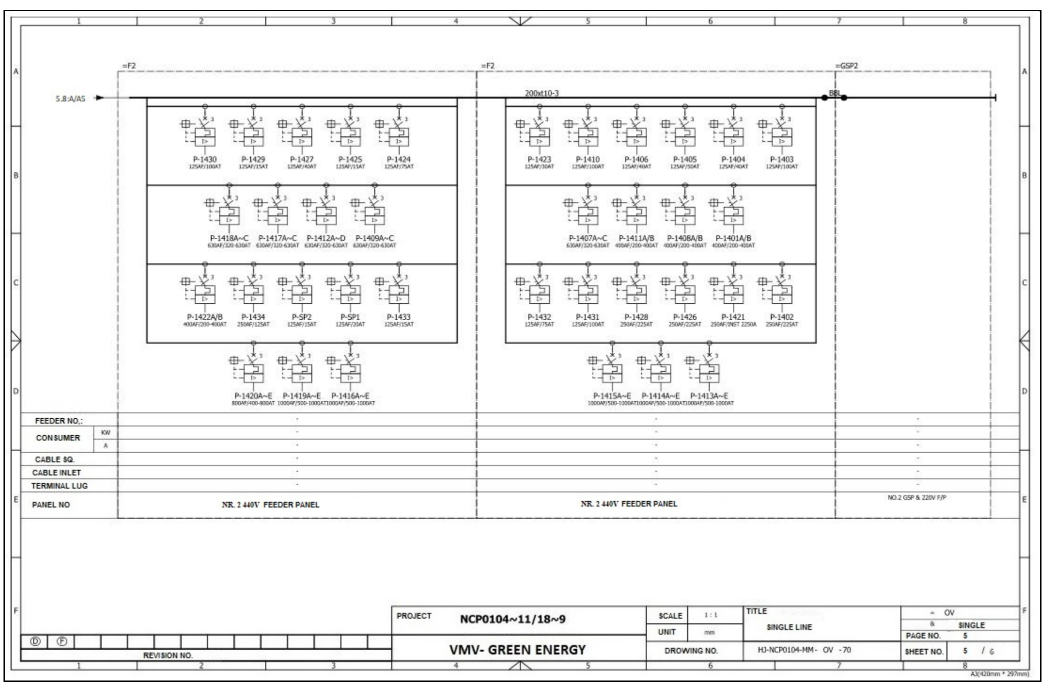

Figure 14 Connecting electrical scheme 6/6 of conventional and unconventional energy sources to the ship main power switchboard

In the picture above (Figure 15) you can see the distribution of electricity on board the ship, in various.

CONDITIONS			Alternative sources of energy	Conventional sources of energy						
			Sea passage	Sea passage	Maneuver: Without thurster	Maneuver: With thurster	During cargo operations	In port	In Em`cy	In fire
Without reefer containers	Generator capacity (kW)		2000	1600	1600	3690	1600	1600	150	150
			RF X 1	SG X 1	SG X 1	SG X 1 + LG X 1	SG X 1	SG X 1	EG X 1	EG X 1
	Total Load (kW)	Before PC	**1032.8**	**1032.8**	**1344.4**	**3011.1**	**1132.2**	**893.3**	**108**	**97.6**
		After PC 1	812.8	812.8	1034	2700.7	860.2	614.1	-	
		After PC 1&2	812.8	812.8	1034	2700.7	860.2	614.1		
		After PC 0&1&2	812.8	812.8	1034	1034	860.2	614.1		
	Generator Load (%)	Before PC	**64.55**	**64.55**	**84.03**	**81.6**	**70.76**	**55.83**	**71.98**	**65.06**
With reefer containers (6 kW x 650 bucaţi= 3900kW)	Generator capacity (kW)		7000	5780	5780	7870	570	5780	-	-
			B x 1 + RF X 3	SG X 1 + LG X 2	SG X 1 + LG X 2	SG X 1 +LG X 3	SG X 1+ LG X 2	SG X 1 + LG X 2		
	Total Load (kW)	Before PC	**4993.4**	**4993.4**	**5305.1**	**6971.7**	**5092.9**	**4853.9**		
		After PC 1	4712.8	4712.8	4934	6600.7	4760.2	4521.3		
		After PC 1&2	812.8	812.8	1034	2700.7	860.2	621.3		
		After PC 0&1&2	812.8	812.8	1034	1034	860.2	621.3		
	Generator Load (%)	Before PC	**86.39**	**86.39**	**91.78**	**88.59**	**88.11**	**83.98**		

Figure15 Alternative and conventional sources of energy distribution

6. CONCLUSIONS

The present article is a piece of a big research on the installation of a hybrid system powered by energy, coming from conventional and unconventional energy sources, on container ships.

Pollution is a threat to our generation and to the generations that it will come. We must reduce it now.

From our point of view, the most plausible types of unconventional energy sources were chosen, forming a hybrid system together with conventional power sources, which are suitable for a container type ship.

Thus, the use of wind energy, green coming from unconventional energy sources has several benefits:

- Reduction of flue gases, in particular nitrogen oxides NO_x, carbon dioxide CO_2 and sulfur dioxide SO_2. Thus, a cleaner environment is achieved
- Reduction of the quantities of fossil fuels used in the production of the propulsion energy by the diesel generator and main engine.
- Reduction of costs for ship owners or charterers,
- with the quantity of fossil fuels consumed by the ship.
- Extending the life of the diesel generators, with the increase of the period of time between periodic revisions or current repairs.

I believe that by adding the electric motor and the green energy sources, we have upgraded the propulsion sources of the container vessel initially chosen. Thus during the operation of the electric motor, but also of the unconventional energy sources, the ship will not pollute.

7. REFERENCES

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