7th Research/Expert Conference with International Participations
"QUALITY 2011", Neum, B&H, June 01 – 04, 2011

CHEMICAL TANKER CARGO TANKS INERTING PROCESS WITH NITROGEN GENERATOR

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SUMMARY
Ecology and protection of the environment are one of the most important topics of general interest and scientific research. Given that they are primarily dealt with issues of pollution from land, are increasingly demanding more and paying attention to pollution from ship's. Tankers carrying crude oil, its derivatives and other hazardous chemicals can get into risky situations if they do not take into account the system and the content of the atmosphere above the cargo tanks of cargo to be transported. Charged with the explosive release of hydrocarbon vapours, and if in such an atmosphere he found enough energy ignition source can explode. Cargo unloading is one of the most dangerous operation due to the formation of explosive mixtures made by mixing steam with oxygen from the air. Danger of explosion can be avoided and removal of all the sources of ignition from the danger zone. In order to completely prevent the danger of explosion, was introduced in the control of the atmosphere in the tank by means of inert gas in the way that inerting reduces the oxygen content below the threshold of support combustion. The paper [1]analyzes the entire process of inerting the cargo tanks with a nitrogen generator as very effective mean to increase safety and environment protection.
Keywords: explosive steams, inert gas, cargo tanks, chemical tanker

1. INTRODUCTION

In marine applications and Marine Engineering in general, inert gases, the gases are considered low in oxygen that is used to fill the empty spaces in and around the cargo tanks for protection against explosion. Ventilation and venting tanks of liquid cargo is very important during loading, transport and unloading cargo, and can be divided into the following functions:

- maintaining a positive or negative pressure during the voyage of the ship (drop small amounts of a mixture of air and steam),

[1] *The results presented in the paper have been derived from the scientific research project „New Technologies in Diagnosis and Control of Marine Propulsion Systems" supported by the Ministry of Science, Education and Sports of the Republic of Croatia.*

- maintaining a positive or negative pressure during the loading or unloading cargo (release a large amounts of a mixture of air and steam)

It is important to note that the gauge pressure must not be higher than 0.2 bar of atmospheric pressure, a negative pressure must not be lower than 0.07 bar of atmospheric pressure [1]. Ventilation of tanks and venting during loading and unloading can be used open tubes placed at a height of not less than 4 m above the deck. Instead of open tubes special ventilation valve (P / V valves - Pressure / Vacuum) can be used, through which the flow rate must not be less than 30 m/s. In this case, the height above the deck shall not be less than 1.8 m. The SOLAS Convention requires that the inert gas to be brought to the cargo tanks in an amount sufficient to at least 125% of the maximum total capacity of cargo pumps, the unloading of cargo, expressed in volume. When designing these systems it is necessary to provide sufficient space around the unit for their cleaning and maintenance, it is necessary to pay attention to the selection of appropriate materials, shelter tubes for drainage, etc. The effort of the fan should be sufficient to overcome pressure drop in the water purifier, water seals and the flow through piping to cargo tanks.

2. INERT GAS GENERATOR

Separation of nitrogen from other gases from the air takes place by passing compressed air through the porous fibres (see figure 1.). These fibres are manufactured from synthetic materials exposed to the influence of temperature, pressure and special solvents. Depending on the required amount of nitrogen extracted, the fibres are grouped in bundles that are placed in a metal casing [4]. Passing compressed air through porous fibres, gases from which the air contains, diffuses through the fibres at different speeds, depending on their molecular structure. Oxygen diffuses through the fibres with greater speed than nitrogen ant therefore more quickly leaving the inside of fibres under high pressure and moved out of porous fibres, inside a metal casing.

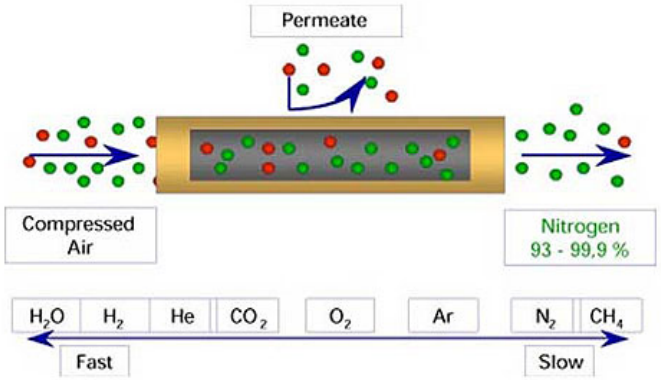

Figure 1. The speed of passage of certain gases through semi-permeable membrane

Process diagram of "SMITH GAS^{TM} MEM nitrogen generator is shown in figure 2.
The quality of compressed air that enters the device for obtaining nitrogen is very important for proper operation the device [4]. To prevent damage to the porous fibre air prior to entering the device must be dried, and it must be separated from any oil droplets. In the event that the air is contaminated with oil, oil will block pores in the fibre and will reduce the effectiveness of the device. Completely blocked and contaminated fibres are destroyed and can not be regenerated so must be replaced. For supplying compressed air for obtaining nitrogen, suitable screw compressors are used. Compared to piston compressors, screw compressors do

not have significant mechanical wear and perform up to 50 000 hours before significant repair under conditions of regular maintenance during working. The device for obtaining nitrogen has no mechanical and chemical weathering.

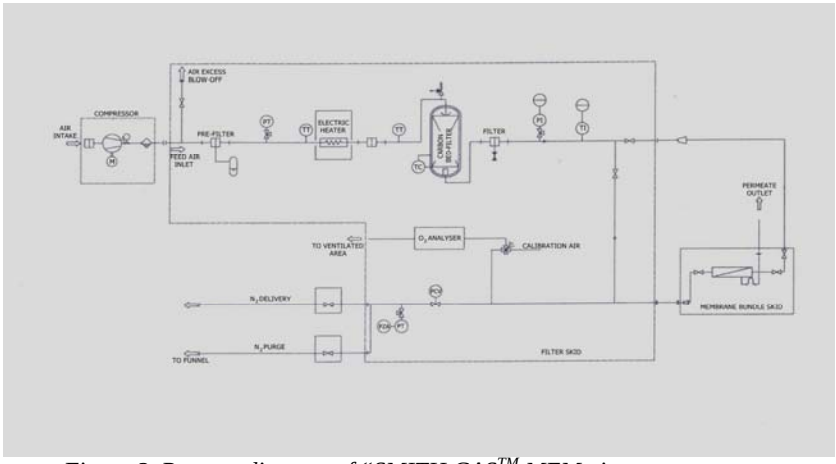

Figure 2. Process diagram of "SMITH GAS^{TM} MEM nitrogen generator

When the correct installation and proper operation, the life time can be up to 30 years. Maintenance cost is extremely low and is reduced to the maintenance of the compressor for supplying compressed air. Compact design allows easy and quick installation to any location on any vessel. Figure 3. shows the plant necessary for the production of inert nitrogen gas using a generator of ¨Aalborg type.

Figure 3. Compressor, Filter skid, Membrane skid

3. DECK SEALING

Deck sealing is a major protection against reverse flow of gas distribution pipelines back to the inert gas generator [3]. Deck seals are produced in three variants, namely:

- wet seal deck - generally, wet deck seal consists of a container partially filled with water and two pipes for the inlet and outlet of inert gas while the two smaller diameter

pipes used for water supply and drainage for sealing. In this type of deck type separators were installed to separate water droplets from the supply of inert gas.

- semi-deck gasket - the main difference compared to the wet deck sealing is the use of venturi tube through which the flow of inert gas to the cargo tanks with drawing water in a special container. In the case of combustion of the cargo tanks, deck seal is filled with water and operates on the same principle as the wet deck seal.
- dry deck seal - this type of deck seal completely eliminates the presence of water in deck seal during normal operation, and uses an automatic valve that is filled with water in case of return flow from the cargo tanks. The disadvantage of this type of deck design is a risk of combustion from the cargo tanks in case of failure of automatic valves. The inert gas is used only one of these types of deck sealing, and seal the deck is installed and mechanical valve as additional security.

4. FLAMMABILITY DIAGRAM

Steam oil are mixtures of hydrocarbons. The exact volume fraction of participants depends on the type of crude oil and, a partial reprint of individual participants as well as on temperature. Lower explosive limit is the lowest concentration of explosive steams and gases in which can cause an explosion. Upper explosive limit is the highest concentration of explosive steams and gases of which can cause an explosion.

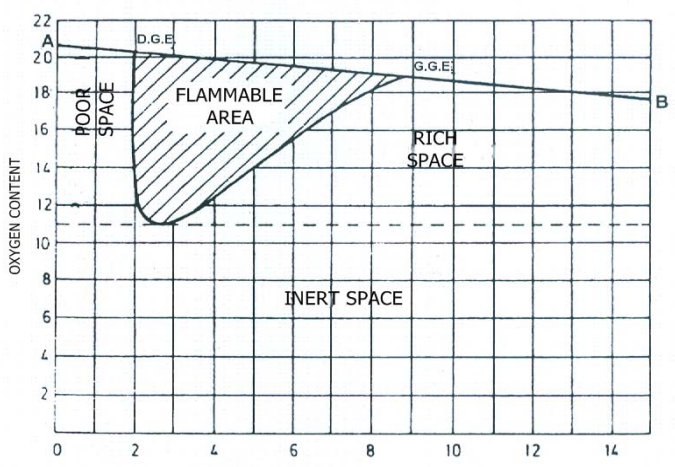

Figure 4. Flammability diagram

If we look at the diagram (figure 4.) we note that the flammability of steam mixtures of crude oil and atmospheric air is the lower explosion limit of 2% of hydrocarbon steams and 20.4% of oxygen. Upper explosion limit is 9% of hydrocarbon steams and 19% of oxygen. A mixture of atmospheric air and steams of crude oil is shown in the diagram with the line AB. If the oxygen content in air is lower than 20.8%, then get directions for mixing, which are parallel to the line AB and lies below it. Lower and upper explosion limits are changed for the mixture of air with lower oxygen content of 20.8% and hydrocarbon vapour by reducing the oxygen content is due to the presence of inert gas in the tank. The introduction of inert gas lower explosive limit slightly increases, while the upper lowers, and there fore reduces the explosive area. When the tank is only 11% oxygen, an explosion can not occur because the explosive mixture is insufficient oxygen to support the explosive combustion. If the atmosphere is thin, less than 2% of hydrocarbon steams, regardless of the content of oxygen, the atmosphere is too poor and can not explode. If the steam concentration is greater than the upper limit of flammability, the mixture is too rich and yet will not explode. For the oxygen

content of less than 11% of the atmosphere in the tank is inert, regardless of the content of hydrocarbon steams. The explosion in the atmosphere is impossible because of insufficient oxygen to support explosive combustion. Unloading is one of the most dangerous operation due to the formation of explosive mixtures made by mixing steam with a cargo of oxygen from the air [2]. Therefore, the landings must be one on a system of inert gas so that inert gas is introduced with a slight overpressure. Fan capacity of inert gas is set at a slight positive pressure, regardless of the amount of cargo. During discharge of liquid cargo pumps, the tanks appear empty space in which air enters from the atmosphere and steam hydrocarbons from petroleum.

5. CONCLUSION

Inert gas system is particularly applicable to all types of tankers for the prevention of fire in the tanks, creating and maintaining a permanent non-flammable atmosphere. SOLAS convention and the rules of classification societies determine the conditions and solutions for the application of inert gas tankers. In the tank with liquid cargo an atmosphere low in oxygen have to be done to prevent explosions. Upper limit of the oxygen content of 8% is not sufficient to support combustion, but for safety reasons, permitted limit is reduced to 5%. In all cases, when there is a danger of oxygen from ambient air be in contact with hazardous cargo in the ships tanks to create an explosive mixture, the air must be replaced with an inert gas.

6. REFERENCES

[1] IMO, Cargo Loading and Securing, 18th July 2003.
[2] DNV: Ships Load and Strength Manual
[3] International Maritime Organization Marine Environment Protection Commitee, MEPC 58/5/1, June 30th 2008.
[4] www.aalborg-industries.com