MARINE GAS ENGINE MARINE GAS ENGINES APPLICATION SPEAKING OF 6TH MARPOL ANNEX

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Abstract

The International Maritime Organization set up a global strategy for reducing emission of sulphur from marine fuels, from 4.5% to 0.5% by the end of the year 2020. In order to such strategy, ship-owners need to fulfil increasing demands according to reduce pollution. New regulations, force ship-owners to reduce production of pollution, but as the devices create to remove some part of pollution are very expensive in use, began to search for cheaper and more effective solutions.

The main aim of this article is to present superiority of using gas fuel over liquid fuel on ships. The construction of marine engines, run by a gas fuel is in the scope of interest of scientist's research during the last couple of years. This branch of technology develops very dynamic recently, according to savings that can be reach while using gas engines on ships. Apart of cost reduction, new types of marine engines are able to cope with more and more restrictive regulations that are published in international convention MARPOL. Such restriction became the reason for the biggest, international corporations, specialists in engines production, to carry on long-term researches on new ways to power ship engines. One of the world's greatest engine producer is British Rolls-Royce that became pioneer and built the first gas engine.

New power unit, Bergen B-gas B35:40V is the one of the most modern type of such engine in the world. The solid construction of this engine was based on engine B32. It became very efficiently because of many rationalizations in maintenance and exploitation. Two main priorities, while developing conception for this model, were minimization of fuel consumption and operating simplification.

The authors of these article present advantages of using marine engines powered by gas, according to the international MARPOL regulations that became very restrictive in order to protect marine environment. As the examples were used products of Rolls-Royce Company.

Keywords: *combustion engines, air pollution, environmental protection*

1. Introduction

From the down of time machine drives have been serious issue in the building process of any mechanical appliance. Steam engine invention revolutionized human point of view on industry of that time especially in relation to means of transport. Before it was power of horses, overtime it became horsepower. Since then many years have passed and old steam engines, due to long-standing researches, evolved into modern propulsions. Nowadays predominantly only internal combustion engines are in use, so today it is highly uncommon to encounter working steam engine or any other type of propulsion invented so far, as they haven't found widespread application. Modern IC(internal combustion) engines these days found their application in every mean of transport; firstly land, later on air and finally maritime. Moreover they are also widely exploit in power generation onshore for example electrical power and heating plant in Wejherowo use the

engines primarily designed for marine propulsion. Marine engines can be divided in view of many factors, starting from designation, exploitation and service cost, fuel consumption, eventually ending with fuel type appliance and air pollution which are the consideration of this article authors.

Fig. 1. Photography of demonstration against coal-burning plants

2. Natural gas as an example of ecological and economical fuel

With growing ecological awareness there are set up strict regulations in order to protect environment. 6th MARPOL Annex is the document that determines the admissible air pollution that every vessel can produce. To face the demands ship owners need to reduce exhaust to required level.

Marine engine producers are constantly forced to fulfil increasing demands of today customers that requires inventing cheaper in operation and more efficient units. There are many different ways to face their expectation that usually requires a lot of funds.

Authors of the article present advantages of marine engines powered by gas fuel as the best solution to fulfil highly requirements established both by convention regulations and constantly developing marine propulsion market. As the example were used products of Rolls-Royce Company.

At first gas fuel is far more superior to heavy fuel oil considering ecological aspect. The level of NOx or SO_x particles emission is much lower when using gas fuel, so that producer can save a lot of money because it is compliant with the regulation demand without applying additional filters. Moreover Rolls-Royce gas engines are already able to match up upcoming restriction concerning NO_x and SO_x. Secondly Bergen lean-burn gas engines are most efficient piston engines available at the moment. Due to applied technology involving antechamber it uses much less fuel than regular engine at the equally power level.

Another problem is constantly increasing price of heavy fuel oil. IFO 380 for instance has become more expensive since 2005 it become twice as expensive while LNG price has fallen significantly over the last few years.

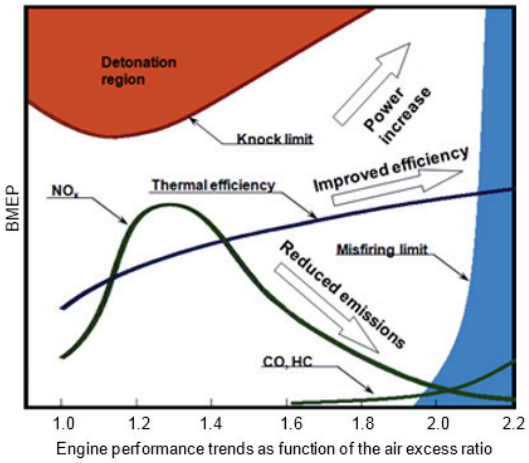

Fig. 2. Lean burn concept & advantages

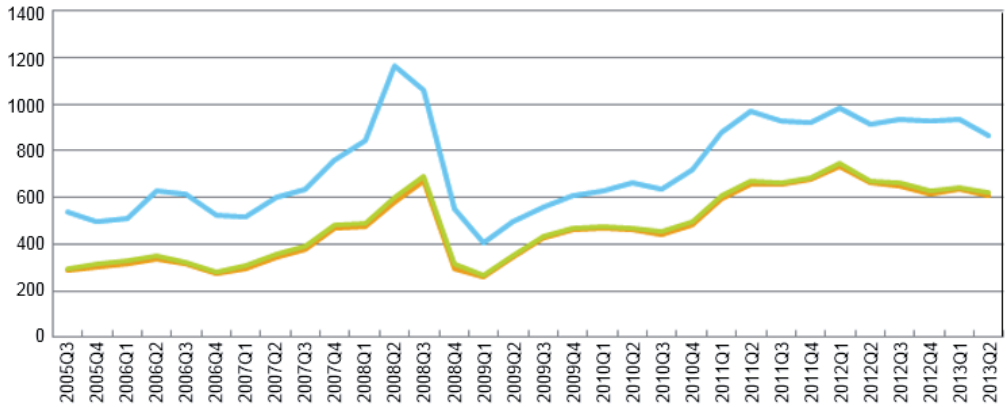

Fig. 3. TI008: Marine bunker fuel spot prices USD per tonne (average unit value, FOB – Singapore)

The fuel cost is very important issue for every ship-owner all over the world. It accounts for 70 percent of whole operation cost, so it is really important to make it as cheap as it is possible. Another problem is LNG transport and refer to economical aspect. The shipment of LNG is kept in big heat-insulated tanks that have to sustain the temperature of about -163ºC. By dint of the long distance that the ship has to travel and unavoidable shipment temperature rise part of the cargo evaporates. It is forbidden to release it directly to atmosphere so there are applied systems of natural gas re-liquefaction on gas tankers. However most gas engines can already use the evaporated LNG to supply marine power plant that is much cheaper solution than re-liquefaction of natural gas and allows ship owners to save a lot of money.

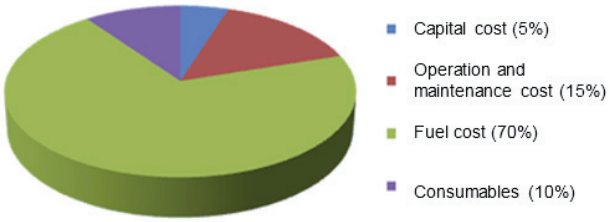

Fig. 4. Overview - Operating cost

Fig. 5. Natural gas price

3. MARPOL convention– response for maritime pollution

The International Convention for the Prevention of Pollution from Ships (from MAR – maritime and POL – pollution) was created in 1973 and has been modified up till now. MARPOL is one of the most important international marine environmental conventions. It contains 6 annexes with list of laws, responsibilities of ship crew and design guidelines. Every annex was designed to minimize pollution of the seas, including dumping, oil and exhaust pollution.

6th MARPOL annex contains laws about air pollution from ships. It entered into force on 19 May 2005 and at the same time, the surge entering the first emission standards name Tier I. It contains limit of NO_x and SO_x emission with attention for rated ship engine speed. It has reduced air pollution by 46%.

Update for first emission standard enter into force in 2011 and it was called Tier II. To face up a new regulation many ships were allowed to install exhaust filters. Next update, Tier III, which will enter in 2016, will be big problem for all ship owners with "classical" power unit for heavy fuel. Bergen gas engines, which have lower emission of NO_x and SO_x particles than it is settled in Tier III will have no problem to fulfil strict regulations of MARPOL.

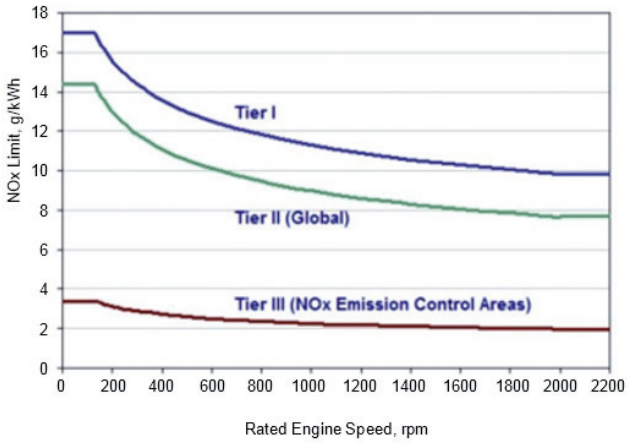

Fig. 6. Tier Regulations

4. Bergen B-gas B35 engine – innovative solution

Rolls-Royce was one of the first company which started research over gas engine for maritime. Their new power unit, engine B35 is one of the most modern type in world. Engine B35 is next generation in Bergen B-series power units. Previous one was diesel engine B32 which achieved worldwide success.

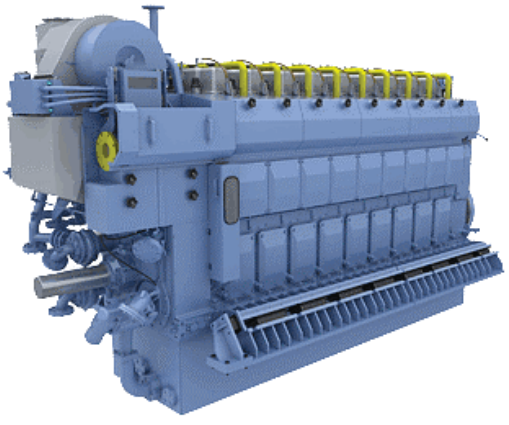

Fig. 7. Bergen B35:40 gas engine

In model B35 Rolls-Royce company used a lot of components from its "bigger brother" for example: main hull and air turbine. Main reason for implementation of Bergen B-gas engines was upcoming update to Marpol convention, Tier III that is about to bring in new limit of NO_x and CO_x emission in exhaust. Through the application of gas, Bergen B35 engine emission is limited exactly to Tier III norms without necessity of using filters.

System of engine B35 working is based on air, which is pressed into air receiver by first step turbo-charger. Later it go to prechamber, where air is mixed with small portion of gas. In cylinder, when piston goes up in compression stroke, dense portion of gas is pressed. This portion allows to make explosion in cylinder. Later exhaust goes through exhaust system into turbo-charger.

What is so impressive about this engine? At first, antechamber with the two-steps combustion system reducing notably consumption. Another advantage is possibility of using a lean fuel mixture. Secondly, turbochargers with variable turbine geometry (VTG) delivering precise airflow and the solid-state ignition with individual cylinder timing and diagnostics that ensures optimum efficiency. This link is extremely effective in process of air flow and overall engine working process. Using this two inventions makes power unit more ecological and cheaper.

One of the most important matter is cheap operation over engine during its work. Rolls-Royce system of maintenance and services is one of the most accurate system all over the world. As an example is presented B35:40V engine, which work in Wejherowo . The engine works as generator set. For first 60 000 work-hours Rolls-Royce has program called Rutine Maintenance Schedule (RMS). This programme provides 2 stages of services divides for 10 parts. In first stage service has place every 500 work-hours. After 2000 work-hours service take place every 1000 work hours to last 60 000 maintenance. Till now Rolls-Royce have built a strong support network across 28 countries, including Poland, that makes easy access to service available.

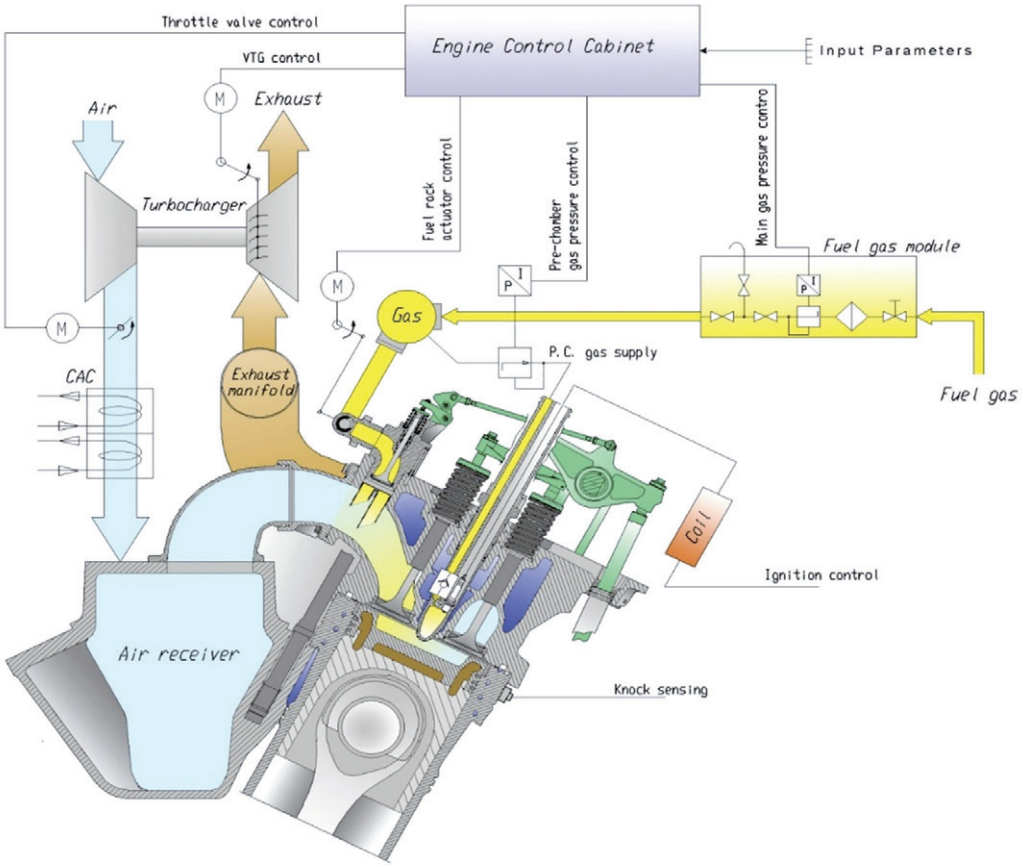

Fig. 8. B35 Engine operations scheme

5. Summary

Heightened regulations and increasing fuel prices are big challenge for designers of new engines. In author's sightseen gas engine can be a solution for all this problems. Gas fuel is relatively cheap and global reserves will last for many decades. What's more this type of engines is environment friendly especially according to exhaust content so that it faces up to all MARPOL regulation, both present and upcoming. Summing up, innovative solutions to modernize a well-known construction and more frequent occurrence of this type of engines on vessels and onshore may be the beginning of surpassing the "classic fuel" engines with the gas ones.

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