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CONTROL SYSTEMS, MONITORING AND DIAGNOSIS OF INTELLIGENT PROPULSION ENGINES FOR SHIPS

BOCANETE, P[aul]; MITU, D[aniela] E[lena]; BEJAN, R[amona] & SIVRIU, G[eorgiana] R[odica]

Abstract: *This paper aims to present the concept of intelligent engine propulsion ships. The first step towards achieving intelligent engine was the shift from conventional engines to electric-controlled engine (ME). The concept involves an electric motor servo-controlled hydraulic drive system of fuel injection and exhaust valves. An important step in achieving this transition was the common battery system with fuel injection, electronically controlled, brought the company Sulzer RT-flex engines through.*
Increasing demands on the performance of ships, prevention of environmental pollution issues, and safety issues have led to an increasing concentration of concerns over the concept of total vessel and the interaction between different systems and equipment installed on board.
Key words: *smart engine, CoCoS-EDS, PREMET*

1. INTRODUCTION

Currently we are witnessing a major step in the development of naval propulsion technology by introducing electrically controlled injection system.
Since the early 1990s, the Danish development department MBD Group of MAN B & W Diesel A / S has started developing new technologies for marine diesel engines in its testing laboratories in Copenhagen. Soon, this research has been called intelligent engine development and research model was tested on 4T50MX.

The first generation of smart motor systems developed between 1993 and 1997, the second generation came into service in mid 2000 and the third generation is being tested.

Computer systems such as satellite navigation, satellite communications, or electronic control systems of cargo operation, recently broke aboard seagoing vessels. However, traditionally, in shipbuilding there has been reluctant to integrate electronic components as essential parts of main engines, except the use of electronic speed controllers.

This situation will change in coming years, as happened in recent years in the automobile industry. Need for flexibility to cope with limits on exhaust emissions and increasing demand on the operating level of trust will lead to electronic components used in manufacturing marine propulsion engines for ships.

2. INTELLIGENT ENGINE CONCEPT

Danish development department of the company MAN B & W has stepped into a new era of marine propulsion, with what they call intelligent engine. With this new technology diesel propulsion ships, fuel injection, and exhaust valves are controlled by the camshaft, but electronically.

Conventional diesel engines both processes (injection and disposal) are mechanically controlled only. MBD Group in Copenhagen sought an alternative control electron injection and exhaust gas evacuation, removing the limitations imposed by mechanical components.

Almost simultaneously, competing Swiss firm Sulzer, now a member of the Wärtsilä Group, began developing its own technology, which became RT-flex engine today.

Wärtsilä Company continues to expand its research and development programs announced recently, as largest servo system common battery fuel injection has been used successfully on heavy fuel, the engine RTX-3, demonstrating technology, no cam shaft, the test bench in Wintherthur, Switzerland.

ME engine consists of a servo-hydraulic actuation system of fuel injection and exhaust valves. Actuators are controlled by a number of electronic control units that form the engine control system (ECS).

The hydraulic circuit is used, the operating environment, used lubricating oil. The oil is filtered and pressurized by a servo-hydraulic system (Hydraulic Power Supply-HPS).

Release air distributor was replaced by a valve closed / open, controlled electronic, with electronic control unit and the control block of cylinders (Cylinder Control Unit - CCU), control valves release. Engine Control System (ECS) can control and optimize the combustion process at any task, the electronic control of the injectors, as the crankshaft position.

To introduce Electrónico hydraulic servo-mechanisms for controlling fuel injection and exhaust valve actuation, is to make distribution / synchronization processes of injection and exhaust, and engine operation, to be independent of mechanical transmission, providing thus greater flexibility in engine operation.

Servo-hydraulic actuation of the injection pump discharge valve is a servo-hydraulic high pressure, driven by the engine, which provides the energy needed to hydraulically operated fuel injection and exhaust valve actuation on each filter, thus replacing camshaft.

Moreover, air-launch system and cylinder lubrication system were upgraded, being electronically controlled. All these systems are controlled by a redundant computer system.

3. CONTROL SYSTEMS, MONITORING AND DIAGNOSIS OF SMART ENGINE

3.1 Engine performance monitoring programs

During engine operation, some basic parameters can be monitored and evaluated at regular intervals. The analysis of these parameters can appreciate the real operating condition of engine components and influencing state or return.

One of the most important aspects of monitoring engine performance is the exact knowledge of operating parameters. Operational information and recorded data from a device, when properly interpreted, can provide an unbiased view of the operating status of equipment.

Information collected and reported trends in the monitoring program parameters can have numerous applications, from the causes of failure, to modify the procedures for maintenance and operational practices.

On board the research study has been carried out in machine control room was installed equipment monitoring

main engine and auxiliary equipment operation LYNGS MARINE A / S 2000 UMS.

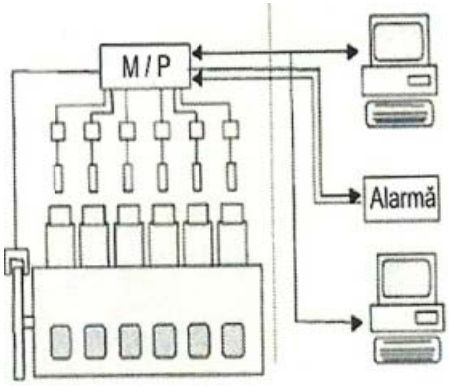

Fig.1. Angular velocity measuring device of the crankshaft (LEMAG)

Monitoring program was installed on your computer electronic computer can be operated easily by the officer on watch. Analyzes equipment parameters monitored, provided by local sensors by comparison with nominal values corresponding normal functioning. At different values, program can trigger the appropriate alarm, indicating also the trend parameter. Monitoring and alarm is recorded on a printer connected to your computer.

For automatic analysis of combustion process in diesel engines, Lehmann & Michels Company has developed a permanent system for monitoring performance marine engines, propellers and auxiliary called LEMAG PREMET online. The system allows measurement of pressure in the engine cylinders, up to 250 bars. This system requires that each be equipped with a pressure sensor. The sensors are mounted on existing valves of the measuring device and pressure indicator cylinder simultaneously.

To measure the angular velocity of crankshaft Lehmann & Michels company developed LEMAG Multiscan sensor device (sensor MS), which is built for each crankshaft, depending on its size, easy installation on existing engines. MS produces sensor signals 360 to each full rotation of the crankshaft. This resolution a high angle of rotation of the crankshaft angular speed allows precise registration, and compensation required if changes occurred.

The pressure on each cylinder is transmitted block of information analysis (LEMAG Engine Information Sampling Kingdom) check if plausible values are measured and correlated with their current position of the crankshaft.

This information is analyzed PREMET online program that provides a wide variety of diagrams, illustrating the real state of engine operation. The automatic analysis of combustion process monitors the following parameters: mean indicated pressure, maximum pressure on the cylinders, indicated power, torsional vibrations, pressure relaxation and evolution parameters.

By using this system, the operator is able to identify any diesel engine failure in their early stage, avoiding damage, costly repairs and delays.

3.2 Preventive diagnostic software engines for intelligent propulsion ships

MAN B & W has developed a computerized system for monitoring engine operation and diagnosis (Computer Controlled Surveillance - Engine Diagnostic System CoCoS-EDS), which is a system monitoring, diagnostics and maintenance of propulsion engines for ships. The main objectives of the CoCoS-EDS system are providing assistance in making decisions on board, or at the company, improving availability and confidence in diesel engines, reducing operating costs and lost motherland and loyalty resulting from engine failure.

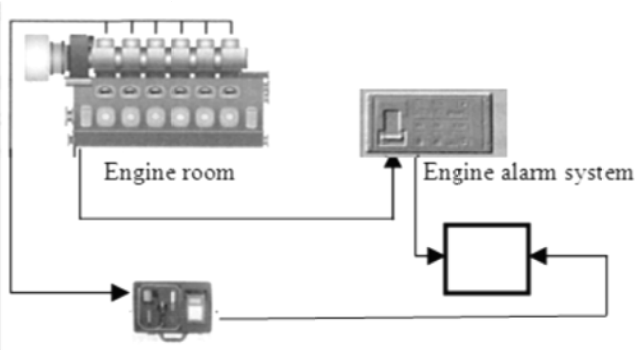

Fig.2. Computer system configuration, monitoring and diagnosis of EDS Cocos (B & W MAN)

CoCoS-EDS system consists of four main categories of programs, as follows:

- Engine Diagnostic System (EDS)
- maintenance planning system (MPS)
- system of stock handling and spare parts ordering (SPO)
- Spare Parts Catalogue (SPC)

In all cases, the system operator reported poor operating condition of the engine, along with diagnosis and remedial action undertaken or proposed triggered, and recommendations on engine operation, to restore normal operating condition, or until necessary repairs can be made.

4. CONCLUSION

Ever-increasing complexity requires new methods of ship design and operation of future ships, through intelligent control architecture that allows distributed, equipment based on increasing automation. Designing future ships will require development of new techniques becoming more sophisticated, for modeling and simulating complex systems to be integrated to achieve total ship concept.

Smart engine, which control important functions is ensured by redundant computers, network focused board, offers great possibilities towards integration equipment on board and realize the concept of total ship.

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