10th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2006, Barcelona-Lloret de Mar, Spain, 11-15 September, 2006

TECHNICAL DIAGNOSTICS OF A SHIP ENGINE

Prof. dr Miodrag Bulatović
mr Jovan Šušić
University of Montenegro, Mechanical faculty
Cetinjski put bb, 81000 Podgorica
Serbija and Montenegro (SCG)

ABSTRACT
Maintenance according to a condition based on measuring and controlling the parameters of the object condition using technical diagnostics, represents the fundament of all contemporary concepts of maintenance and most of all of proactive maintenance.
This paper presents a research that has been performed in the context of a larger research projec.It shows applied methods of diagnostics and instrument characteristics and gives a brief description of their use. Furthermore, the results of measurements, illustrated with the photographs of observed phenomena, are shown in particular, followed by the analysis of these results.
Key words: Maintenance according to a condition, technical diagnostics, endoscopy.

1. DIAGNOSTICS IN FUNCTION OF CONDITION MAINTENANCE
Conditions of an object or a machine are described by a specific group of parameters, for example thickness of a wall, noise, temperature and other characteristics. All these parameters should accomplish the designed function of a goal under certain conditions in a certain amount of time. Changing the parameters leads to a change in the object's function, which usually weakens the object's function at hand.
Qualitative analysis of a diagnostic signal is based on already generated knowledge about specific characteristics and phenomena of various cases and conditions. Condition maintenance is based on the diagnostics of this condition, using the following elements: time pictures either of a condition or analyses of the effectiveness of a system in function of time, control of condition parameters, using technical diagnostic methods.
Maintenance according to a condition by controlling the parameters represents a group of rules for determining a diagnostic regime in a real exploitation process. In addition, it serves the purpose of making decisions about the necessity for a replacement or maintenance activity, based on the information about the real technical condition of the system and its parts.
It is important that measuring of condition parameters happens with or without disassembling the system, which means with or without detaining the system by using the equipment and the facilities for technical diagnostics. Therefore, a tendency exists for the condition diagnostics to always be continuous, without detaining or disassembling the system. Tensions and deformities appearing in mechanical segments of the system usually cause a direct change in cinematic forms, resistance, vibrations, noise, temperature and in other crucial phenomena. Furthermore, they indirectly cause changes in lubricant characteristics, such as appearance of particles as a sign of friction.

2. ENDOSCOPE METHOD OF TECHNICAL DIAGNOSTIC - EQUIPMENT
The use of optic fibres is becoming a commonplace in technical fields, for example in the process of observation of parts difficult to access (usually different kinds of cavities and holes) and in those cases where other techniques of visual control necessitate a very expensive disassembling process. The use of optic fibres is not only important in the fields of diagnostics and control, but its application is currently of a great significance in the process of maintenance, for example for the repair of

machines that can therefore be completed without disassembling them, which in turn makes this process far more economical. The second important factor, which influences the work with optical facilities, is daylight. This sets various limitations during work, depending on the used facilities. Flexible endoscopes with optical fibres (fiberscope) are used in those cases when the distance to the object does not exceed 0,5m.

2.1. Modern boroscope

Inflexible (stiff) boroscopes have a very simple optical system of lenses as oppose to that of fiberscopes. In the case of boroscopes, the picture is very clear. Since the boroscopes do not use coherent sheaths of optical fibres, they are several times cheaper then fibrescopes. The firmness of its construction and the possibility of regulating its length, diameter, angle and visual field as well as its simple usage, make the boroscope a wide-spread tool for visual control.

Boroscopes (fig.1) are easy to maintain due of their firm construction, even after their exposure to different kinds of foulness. It is important to clean the boroscope very carefully after its use. In addition, the boroscopes can be used in high temperatures up to 150ºC.

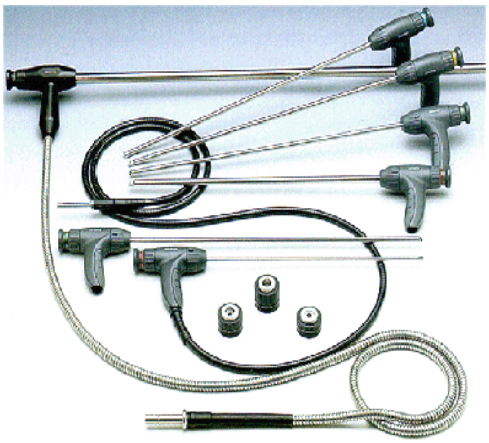

Fig. 1. Boroscope – The use of a boroscope in an aggressive environment

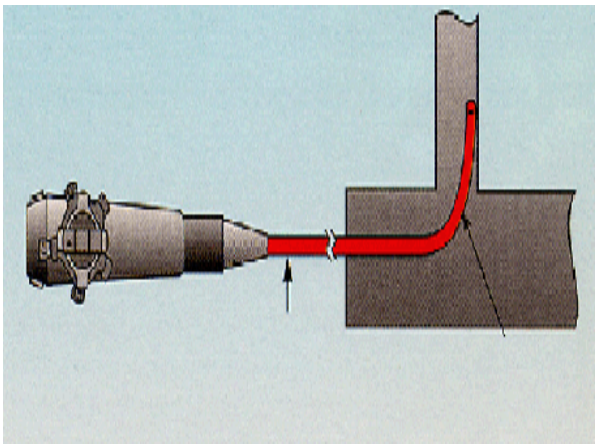

Fig 2. Illustration of fiberscope flexibility

2.2. Fiberscope

The main characteristic of a fiberscope is its flexibility. It is noteworthy that its ability to bend does not have consequences on the quality of picture that it processes. The fiberscope has two sources of light, namely two fibre light conductors – a lens and an ocular conductor. Those light conductors, whose function is picture transmission, are composed of nearly 120.000 fibres, with a diameter 0.009-0.017mm. The picture is formed on highly polished heads of both light conductors that transmit the picture. The fiberscope tips are flexible, which makes not only a direct, but also a lateral view possible (Fig.2). Minimal diameter of the fiberscope is 2 mm. Furthermore, the fiberscope can be connected to a TV screen or a computer monitor.

3. ENDOSCOPIC DIAGNOSTICS OF AN ENGINE CYLINDER

Reliable break down of the cause for the presence of a cooling emulsion in cylinders was not possible without using an endoscope. The main goal is to avoid removing the engine from its carrier, which would significantly lower the costs of repairing the engine. Prior to starting the whole procedure, it is necessary to warm up the emulsion up to 60°C using a circular pump for the cooling emulsion of the engine. After four hours of warming up the engine, the endoscopic examination is performed for the purpose of discovering the place where the emulsion is leaking into cylinders. In order to implement the endoscope diagnostics, it is important to elaborate on the methodology for endoscopic control.

Measurement places place of endoscopic examination in the piston-cylinder group of M845 engine:

- Head of piston
- Cover of cylinder
- Connection between cylinder and head
- Suction and exhaust valve with seats
- Valve seat
- Valve guides

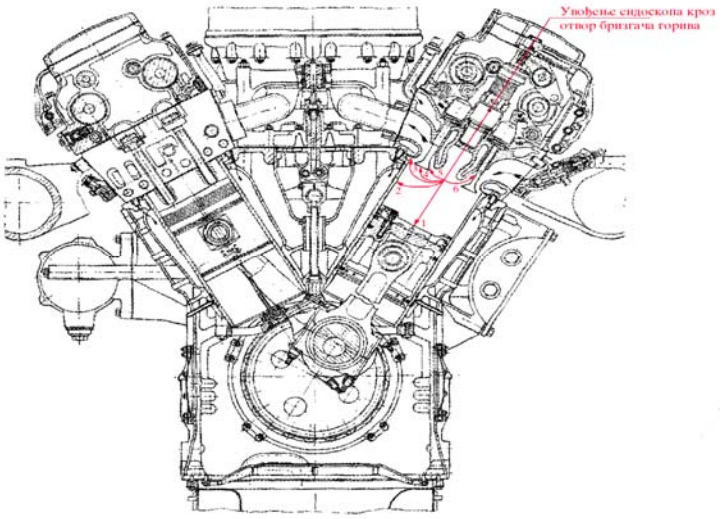

Fig 3. The place of endoscopic examination in the piston-cylinder group of M845 engine

Table 2: Endoscope diagnostic of engine M845 – planing dijagnostic

PISTON-CYLINDER GROUP AND DIVORCING MECHANISM					
Object of the diagnostic	**Possible demage**	**Object of the diagnostic**	**Possible demage**	**Object of the diagnostic**	**Possible demage**
Piston	Deposit of coke	**Surface of cylinder**	Corrosion	**Head of the cylinder**	Corrosion
	Fissure		Longitud. damages		Fissure
	Corrosion		Fissure		Hermetically
	Other type demag		Chanels of link		Other of demage
			Other type demage		
Intake valve (2 pieces)	Corrosion	**Blow out valve (2 pieces)**	Corrosion	**COMPRESOR**	
	Deposit of coke		Deposit of coke	**Compresor**	Situat. difusor
	Seat of valve		Seat of valve		Situat. rotora
	Clearance		Clearance		Clearance
	Haed of valve		Haed of valve		Other of demag
	Other demage		Other		
REFRIGERANT EQUIPMENT					
Refrigerant equipment of oil	Uncleaness	**Refrigerant equipment of emulsia**	Uncleanees Corrosion		
	Chermetics		Chermetics		
	Other demage		Other demage		

This programme of endoscope diagnostics with previously described methodology can be applied on the M845 engine, which is in use on ships.

4. RESULTS OF ENDOSCOPIC DIAGNOSTICS

During endoscope diagnostics of all 12 cylinders of the abovementioned engine the control of possible damages is included, such as:

- leakage of the cooling fluid,
- corrosion,
- mechanical damages,
- damage of galvanic protection,
- deformations,
- deposit of dirt and coke,
- presence of extraneous objects etc

Results of endoscope diagnostic of the M845 engine, built in RF33, and are shown in table 3, with accompanying pictures in the appendices.

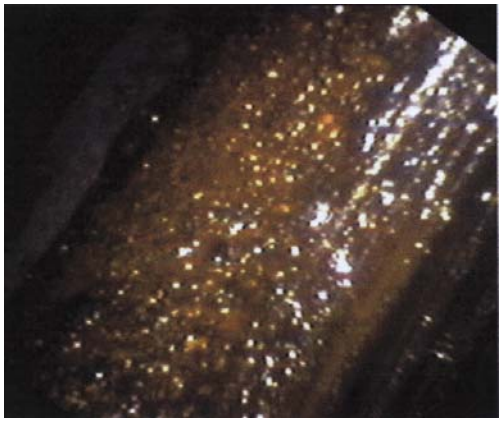

Fig. 4. View of a cylinder head at the place of the oil burner (the presence of corrosion due to water penetration)

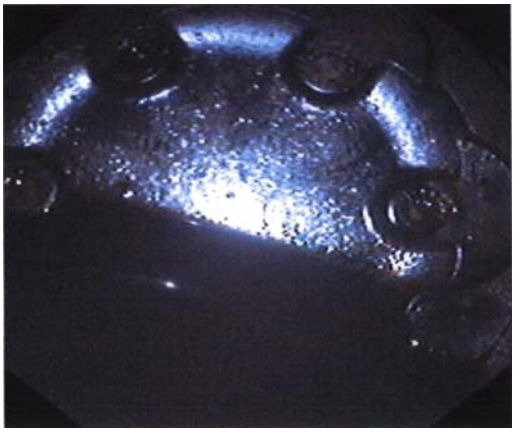

Fig.5.Uncleanliness of piston head – detail (presence of corrosion)

5. ANALYSIS OF RESULTS OF ENDOSCOPIC DIAGNOSTICS

The engine is not functional for further exploitation because the endoscopic diagnostics showed the presence of the cooling emulsion in the A2 cylinder. The leakage of water into the A2 cylinder has been established at the junction between the head and the cover of this cylinder. Every five seconds the formation of water droplets has been registered. The appearance of droplet formation is shown in the appendix 3, Fig. 4. The place of water penetration (junction head/cover of the cylinder), from which the droplets have been formed, is shown in Fig.5.

Time intervals for examinations can be proposed since one is familiar with the construction of the M845 ship engine, which means with those parts that ought to be diagnosed, it's technical and technological characteristics and the conditions in which they work. The following examinations would enable observing damages on the parts of the engine on the basis of which one could adopt the acceptability criteria for damages.

6. CONCLUSIONS

Many parameters of a working process characterise the condition of a technical system. It is important to note that not all parameters of this working process have an equal influence on the system condition.

During endoscopic diagnostics of a ship engine, the control of possible defect and damage phenomena is incorporated, such as: leakage of a cooling fluid, corrosion, mechanical damages, damage of galvanic protection, deformations, deposits of uncleanness and coke as well as the presence of extraneous objects.

On the basis of results acquired with endoscopy and the familiarity with the ship engine construction and its parts that are diagnosed as well as their technical and technological characteristics and the conditions in which they work, one can propose certain maintenance activities and certain time intervals for future examinations.

7. REFERENCES

[1] Project of Ministry of Education, Montenegro, with the title "Technical Diagnostics in Function of Effectivness of Technical Systems", Podgorica, Serbia and Montenegro, 2005/2006.

[2] Bulatovic, M., Vukcevic,M., Incorporation of the Parameters Condition and Probability of Failures in Expert System in Function of Technical Diagnostics, The Third World Congress on Intelligent Manufacturing Processes Systems, Cambridge, Massachusetts, USA, June 28-30, 2000.

[3]. Bulatovic, M., Expert System in Function of Technical Diagnostics, 7 International Research/Expert Conference " Trend in The Development of Machinery And Associated Technology" TMT 2003, Loret de Mar, Barcelona - Spain, 15-17 September, 2003.