тельного баллона до 10 МПа в модернизированной установке снижается относительно базовой на 28,5%. Показатель эффективности при низшей теплоте сгорания природного газа 45 МДж/кг составляет 13,6.

Дальнейшее увеличение максимального давления заправки накопительного баллона в рассматриваемой конструкции ГПБ сопровождается заметным повышением энергозатрат и ограничено критической температурой ЛКЖ.

Заключение

Реализация рекуперативного принципа работы газоперекачивающего блока является действенным средством повышения эффективности комплекса бездренажного хранения сжиженного природного газа системы питания тепловозного ДВС.

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УДК 689.12-8.004.5.001.5

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EFFECTIVE AND RELIABLE OPERATION OF MARINE DIESEL BY WORKING PROCESS MONITORING

Summary. One of the most important conditions of marine diesel engine effective and safe operation is monitoring main parameters of working process during operation [1,2]. Modern specialized microcontrollers have high efficiency, integrated analog inputs, nonvolatile memory to store programs and data, low power consumption. Thanks to these features it has become possible to design a portable monitoring system enabling to control not only parameters of fuel combustion but also those of fuel injection and gas distribution during engine operation. The system realizes methods of data processing given below.

Introduction. Peak pressure indicators widely used on ships determine only peak values of pressure in cylinders (*Pmax*) or pressure at the end of compression (*Pcomp*) at cut off fuel feed. However, besides *Pmax* and *Pcomp* there are a great deal of parameters; their monitoring during operation gives the possibility to carry out the qualitative control of technical condition and to perform precise adjustment of fuel equipment and gas distribution mechanism.

Towards this end the authors have developed monitoring system DEPAS [3]. The main feature of the system is that it is divided into two separated modules. Real time module makes records and scoping calculations of real time data (it is based on specialized controller CYGNAL, now Silicon Electronics). Calculation module is Windows 98/2000/XP software. Communication between modules is on USB/RS-232 serial interface. The system allows of monitoring 2- and 4-stroke diesel engines in all rpm range with resolution not less than 0.5° crankshaft angle. Nonvolatile memory is to store about 100 indicated datum sets. Duration of continuous work with an internal power source is about 10 hours.

The following methods are realized in the system:

1. Program synchronization of data. The TDC of a piston is calculated by analyzing diagrams of gas pressure in the working cylinder [2,3,4]. Design algorithm of synchronization is based on the fact that in case of clean compression (without combustion) in the cylinder the speed degree of increasing gas pressure is equal to zero: *dP/dFi=0 at* TDC position of the piston (Fig.1).

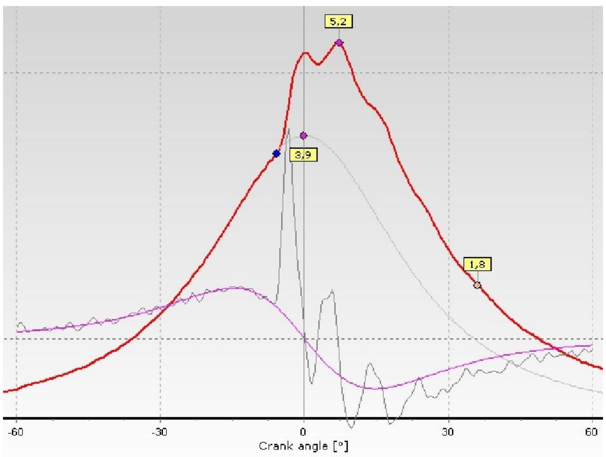

Fig.1. dP_dFi Model. TDC determination

On the loaded diagram of pressure the site of clean compression before the beginning of combustion is allocated. Factors of non-linear mathematical model of a curve *dP/dFi* are calculated by means of minimization method Powel M.J.D [5] .The error of the program does not exceed ±0.5° crankshaft angle.

2. Fuel timing and gas timing as well as estimation of technical condition of separate units are determined by means of contact vibrosensor (Fig.2).

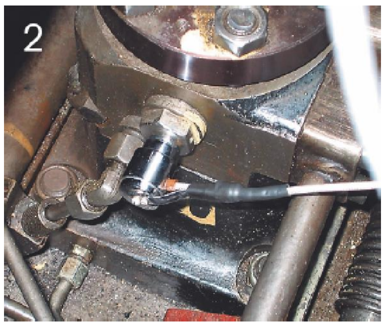

Fig.2. Engine diagnostic example

1 – vibrosensor VS-20 on the top of fuel valve (monitoring of injection vibrodiagram, determination of real fuel injection phases and valves timing);

2 - vibrosensor VS-20 on high pressure fuel pump cutoff point (monitoring of fuel feed vibrdiagram, determination of geometric fuel feed phases);

3 - pressure sensor PS-16 on indicator cock

The most important advantage and the unique feature of the system is that definition of these parameters occurs without fitting any valves into high pressure fuel system and without hard connection to parts of gas distribution mechanism. Vibro sensor is included in standard version fo the system. The vibrosensor has a magnetic basis. It is convenient during diesel engine operation as no tools for its fastening are necessary. DEPAS laboratory [3] was the first employed high-freq vibrosensor in the diesel engine working process monitoring.

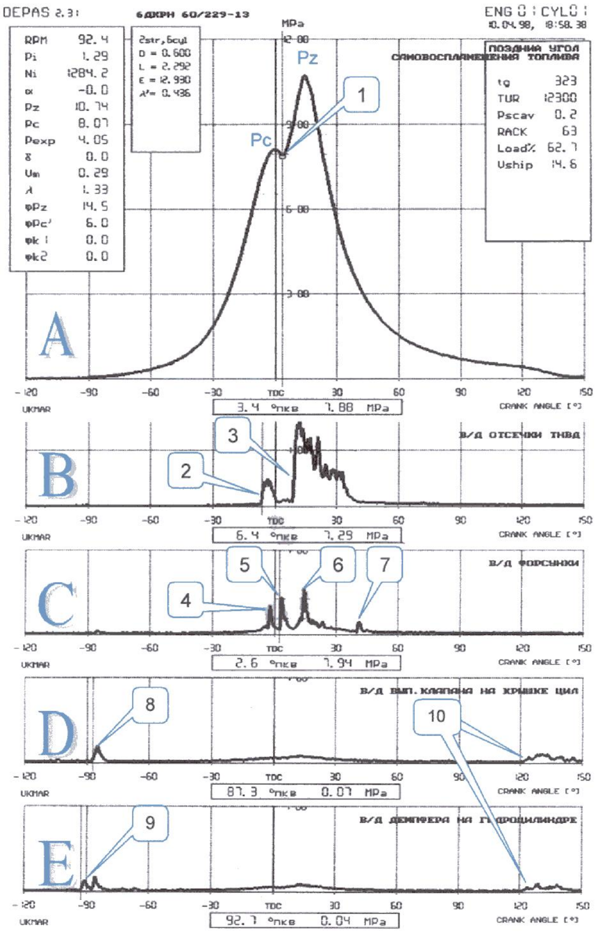

Fig.3. The indicator diagram A and vibrodiagrams B, C, D, E of S60MC MAN-B&W

Analyzing fuel injection equipment and valve timing mechanism vibrodiagrams together with working process indicator diagram significantly broadened the spectrum of monitored parameters. The engine cylinder technical condition diagnosis became possible not only by cylinder gas pressure (as it performed up to now in most diagnostic systems) but also by key data of fuel injection and valve timing.

The example of working process parameter determination is shown on Fig.3. Reference points on diagrams:

1. Point on the indicator diagram corresponds to a moment of the beginning of fuel self-ignition.
2. Geometrical advance angle of fuel feed by HPFP (a plunger is beginning to close the cut-off port).
3. Fuel feed cut off (the low edge of HPFP plunger is starting to open the cut-ff port).
4. Rising of injector circulation valve and termination of fuel circulation ($P \approx 1.0 MPa$).
5. Rising of injector needle (P=25.0±2MPa) - real angle of the fuel injection beginning.
6. Injector needle fit – real angle of the fuel injection termination.
7. Injector circulation valve fit – the beginning of fuel circulation.
8. Angle of complete closing of the exhaust valve – valve plate fit in its seat.
9. Angle of the beginning of damper action at the end of exhaust valve stroke.
10. Increase of a high-frequency noise level while opening the exhaust valve.

Conclusions

1. Monitoring of diesel engine working process is carried out on the following key parameters: MIP, indicated power of a cylinder, Pmax, Pcomp, speed and degree of increase in pressure during fuel combustion, geometrical and real phases of fuel feed and valves timing.

2. Thanks to internal algorithm of TDC determination the hard connection [6] to the flywheel is unnecessary.

3. Fuel timing, valves timing and technical condition of separate units of the engine are determined by means of contact vibrosensor.

4. Use of the monitoring system enables to receive the following advantages during diesel engine operation:

- to save fuel due to precise adjustment of fuel injection equipment and valve timing mechanism;
- to prevent engines thermal and mechanical disbalance by uniform distribution of loading between cylinders;
- to increase reliability and efficiency of diesel engine operation.

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УДК 621.436

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АНАЛИЗ ПАРАМЕТРОВ ТЕПЛОВЫХ ПОТЕРЬ ЭНЕРГЕТИЧЕСКИМ ОБОРУДОВАНИЕМ СУДОВ ПОРТОВОГО ФЛОТА

Введение

В современных условиях особую актуальность приобретет вопрос повышения топливной эффективности транспортных энергетических установок, в частности ЭУ судов портового флота.

1. Формулирование проблемы

1. С целью решения поставленных задач исследования выполнен анализ состава и основных технологических характеристик ЭУ отечественных и зарубежных судов портового флота.

2. Решение проблемы.

В настоящее время отечественный суда портового флота насчитывает в своем составе несколько тысяч судов, состав и характеристики энергетического оборудования которых соответствует их целевому назначению. Преимущественно главная ЭУ судов портового флота выполнена на основе высокооборотных и среднеоборотных дизелей, широкий диапазон агрегатных мощностей которых (10 ÷ 900 кВт) объясняется спецификой использования судов (рис. 1.). На ряде судов используются дизель-электрические ЭУ (проекты №№ 16490, 10380, и др.).

Большинство проектов ЭУ судов портового флота предусматривает наличие в их составе ДГ, используемых как в ходовом, так и в стояночном