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Engineering

Conference Details

Format: Conference

eISSN: 2545-2843

First Published: 30 Sep 2018 Publication timeframe: 1 time per

year Languages: English

3 Open Access

Methods of Energy Efficiency Improvement by Modernisation of Hydraulic Installations at a Fishing Cutter at the Baltic Sea Marcin Szczepanek, Przemysław Rajewski, Dalibor Barta and

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Volume & Issue: Volume 1 (2018) - Issue 1 (October 2018)

Page range: 561 - 566

DOI: https://doi.org/10.2478/ntpe-2018-0070

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AT A FISHING CUTTER AT THE BALTIC SEA DOI 10.2478/ntpe-2018-0070 2018 Volume 1

Dr. Eng. Marcin Szczepanek Issue 1 Dr. Eng. Przemysław Rajewski pp. 561-566 Maritime University of Szczecin, Poland Doc. Ing. Dalibor Barta, PhD. University of Zilina, Slovak Republic Assoc. Prof. Iwona Michalska-Pożoga

Technical University of Koszalin, Poland Abstract. The Energy Efficiency Design Index (EEDI) became mandatory for new ships as well as the Ship Energy Efficiency Management Plan (SEEMP) for all ships due to the MEPC 62 (July 2011) along with the adoption of amendments to MARPOL Annex VI by the Parties to the MARPOL Annex VI. This was the first legally binding climate change treaty to be adopted since the Kyoto Protocol. The Ship Energy Efficiency Management Plan (SEEMP), which has been obligatory since 2013, did not to cover fishing cutters but triggered the implementation of energy efficiency audits due to fishing limits, high fuel prices, and free freight market. All the above caused that ship-owners started seeking ways for saving money and keep their business profitable. Apart from energy recovery installations, fishing vessels have been furnished with the latest technologies aimed at the reduction of energy consumption and at making ships greener. A research team of the Maritime University of Szczecin conducted energy efficiency audits on several fishing vessels operated on the Baltic Sea and stated that up to 40% of the energy is used during fishing operations by hydraulic devices installed at the fishing vessels. The paper presents the

measurement results of energy consumption in typical operational states based on a selected fishing cutter operating at the Baltic Sea. The paper includes also the recommendations in terms modernization of hydraulic installations and the changes of control methods for devices with hydraulic drive. The calculations are also presented herein and they prove that it is possible to reduce energy consumption by a fishing cutter even by 20% while maintaining the unchanged operating parameters of the hydraulic Keywords: fishing cutters, hydraulic installations, energy efficiency INTRODUCTION The development of an energy audit programme, dedicated for this specific vessels' group, aims at the improvement of energy efficiency for fishing vessels' operation by presenting to fishermen solutions reducing energy input while operating vessels. Shipowners, depending on their financial capability and investment policy, may select the simplest, operational solutions that do not require funding or more complex solutions requiring significant financial resources, but also considerably improving the vessels' energy efficiency. The first step towards adopting

 to identify areas where new developed technology may reduce cost. to project the information without omitting anyone, to the buyer so that he can make a decision based on cost and profit.

an exercise in energy efficiency on ships and to harvest the resultant savings is an energy audit. Energy audit basically consists of identifying core areas where conservation of energy can be done and then developing a programme for the same. The objectives of conducting an

- to identify areas where there is a loss of energy due to reduced efficiency or incorrect

operation, and cost savings resulting from having them corrected.

New Trends in Production Engineering - Volume 1, issue 1, 2018 - to improve the energy efficiency of the ship by saving fuel and also to reduce global warming by emission control and help go green.

The assessment and the comparison of energy efficiency in different economy sectors play an increasingly important role in internal and international policies of most countries (IMO 2009, Matuszak et al. 2014). This is due to the desire to increase the level of economy competitiveness, to ensure country energy security and to the improve green image and obtain benefits resulting from the reduction of carbon dioxide. The intention and efforts to reduce the volume of fuel consumed by the Polish fishing vessels contributed to perform energy audits by the scientists of the Maritime University of Szczecin. The research results' analysis of the operational power systems of the Polish fishing fleet (Behrendt C. 2014) allowed for an assessment of energy consumption for particular energy receivers (with respect to 100% chemical energy in fuel) (Fig. 1) (Notti et al. 2012, Schau et al. 2009): main drive 60-75%. fishing gear (hydraulic drive) 10-15% (Schau et al. 2009, Parente et al. 2008).

☐Fishing equipment 7,1% & machinery 41,2% ■ Navigation equipment & 18,7% machinery □Cooling systems 19,8% Fig. 1. Energy consumption scheme on cutter KOŁ 206 during fishing operations. Source: own elaboration During fishing operations, hydraulic devices consume even up to 40% of the energy generated on a ship (Behrendt C. 2014, Basurko et al. 2013). Given the above analysis of the demand on

based on the research results and the measurements carried out at two B 280 fishing cutters, marked as KOŁ 206 and KOŁ 6 (Fig. 2). Both vessels are equipped with developed hydraulic power systems. The systems are used to drive fishing and reloading equipment and machinery

and to provide power to the propulsion system. The vessel is propelled by the H. Cegielski-Sulzer 6AL20/24 engine with 420 kW at 750 rpm with the Zamech ACG 450 singletransmission gear. The engine installed at the front drives the mechanical gear which drives two 3-section gear pumps, and 50kW power generators. The controllable pitch propeller is driven by the propeller shaft coupled with the driving shaft. Additionally, the engine room is equipped with 41.6 kW internal combustion engine, Andrychów SW400. On the main deck, in the stern area on the starboard side, a power generator - John Deere 668FM - is mounted. It generates power fed to the ship-based fish processing plant. The hydraulic pumps provide power to two trawl winches, two net winches, and 2 auxiliary winches. A simplified scheme is

Fig. 2. Propulsion system and power system at KOŁ 206: 1 and 2 - hydraulic pumps for deck equipment, 3 - hydraulic pumps for gear, 4 - power generator ZE400/54, 5 - John Deer power generator unit for RSW units Source: own elaboration

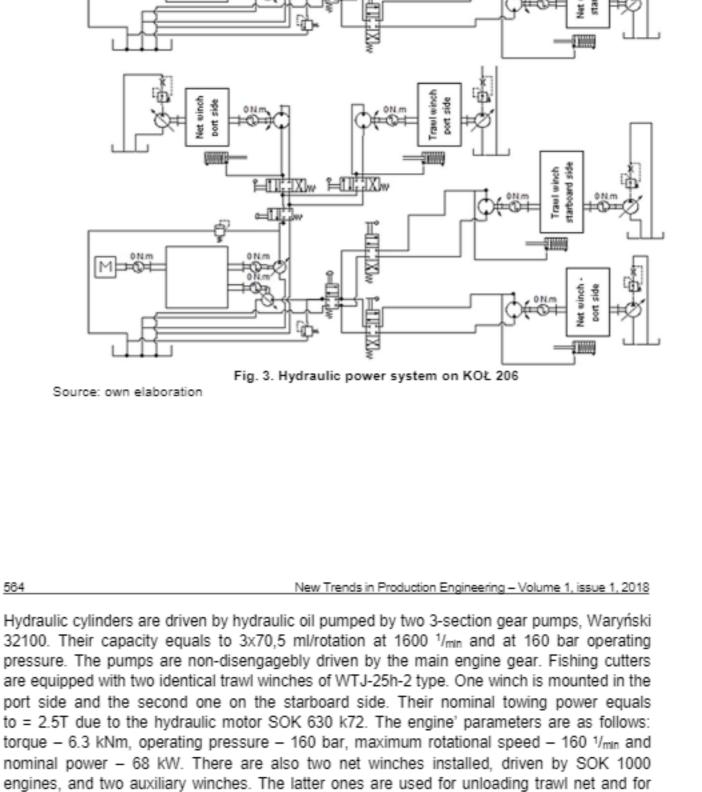


Fig. 4. Trawl winch (on the left) and net winches (on the right) on KOŁ 206. Within 24 hours, 3-4 fishing operations are carried out. During catching fish, the researchers performed a number of measurement on both vessels. They measured the volume of power consumed by the hydraulic pumps and loads of deck winches during fishing operations. Low performance of the system and a significant amount of power consumed by the pumps,

being in operation during travelling to the fishery and back to the port, proved that it is necessary to seek for solutions aimed at the improvement of the energy efficiency for that

The authors analyzed two structural changes in terms of options allowing to save fuel and to

It was calculated that if 3-section gear pumps are replaced by multi-piston pumps, then the power required to drive them is significantly lower (Thanasansakorn and Manomayidthikarn,

multi-piston pumps are installed as a part of a hydraulic power system;

other, supporting operations. They are driven by SOK 630 motors (Behrendt, 2014). Figure 4 presents the distribution of the net winches on KOŁ 206. Approximate operating times of

trawl net laying out – operating time for the net winch and two trawl winches around 30 min;

 trawl pulling – operating time for two trawl winches – around 30 min; trawl net pulling – operating time for the net winch – around 30 min.

Warynski standard pump

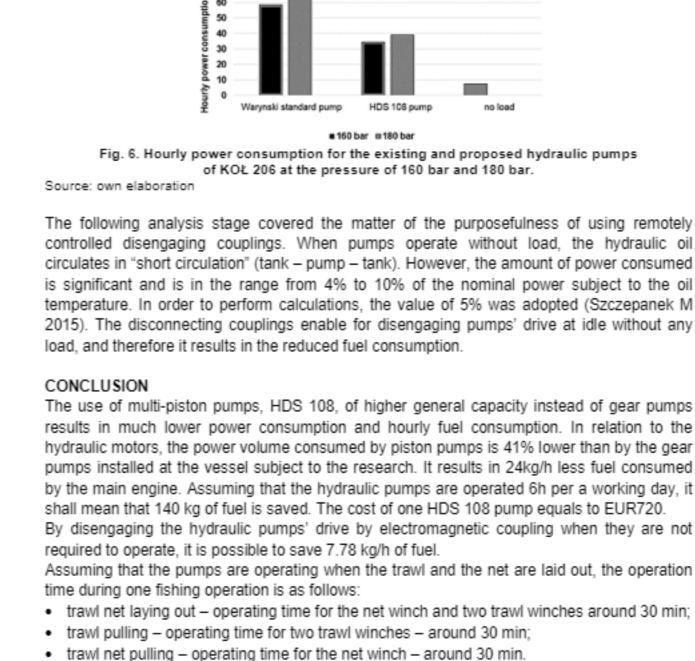
Power consumption for hydraulic pumps

HDS 108 pump

■160 bar ■180 bar Fig. 5. Power consumed by hydraulic pumps at operating pressure of 160 bar and maximum pressure of 180 bar.

Hourly power consumption for hydraulic pumps

2015, Behrendt, 2014) The calculation results are presented in Figure 5 and Figure 6.



fuel consumption, would amount to EUR98. Given the above and the purchase cost including installation services for a coupling equaled to EUR20,000, the investment shall return in two years if fishing operations are performed 100 days per year. Calculated savings by modernisation 140 120 Gear pump replaced by multi-piston pump Installation of electromagnetic

> EUR/working day Fig. 7. Calculated savings in terms of fuel consumption after modernization.

The modernisation of the hydraulic system on KOŁ 206 may result in the substantial reduction of consumed fuel, improve the energy efficiency and reduce the operational costs. Due to mounting piston pumps, the fuel savings are comparable to the savings obtained when couplings disengaging the drive for the hydraulic pumps are installed. The cost of replacement of gear pumps with multi-piston pumps is much lower than the cost of assembly of an electromagnetic coupling, and the savings for both solutions are comparable. If both solutions are applied, the power and fuel consumption may be reduced significantly and their added cost

of investment might return even after one year if the vessel is fully and actively operated.

Fuel saving

Source: own elaboration

ACKNOWLEDGEMENTS

MEPC.1/Circ. 683, London.

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With 3-4 fishing operations per day, the pumps operate under a load for 6 hours, while during the remaining 18 hours the operations are performed at the idle. During that time the amount of fuel that might be saved equals to 140 kg. When considering the above and the price of MGO fuel at the level of EUR 670 per a tonne, daily savings, being the result of the reduced

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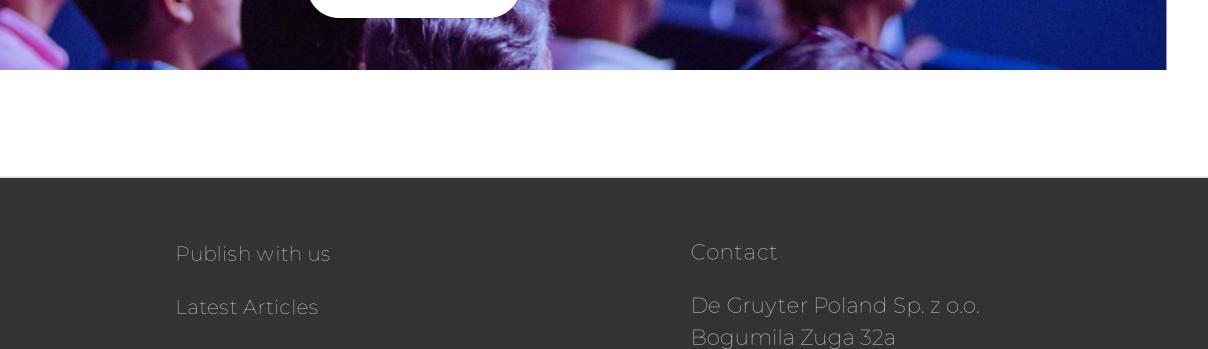
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A general overview of the energy audit process on ships is conducted in the following steps: - data collection: All relevant data for the applicable machine is collected. The data may be collected from mechanical means such as counters, running hour indicators, event logs etc. In case these are not available, the duty engineers and operators are interviewed. - condition evaluation: The condition of the machinery is evaluated and it is determined whether any overhaul or components replacement may improve its performance. - economic alternatives: The audit will also provide an information to the owner about the economic alternatives available and will be helpful to make a decision. audit report: Finally, the energy audit report is created.

electrical equipment 2-15%.

energy audit are as follows:

energy at fishing vessels, it shall be concluded that the intention to reduce energy consumption and EEOIF factor should not focus only on main drive systems since the energy

loss in hydraulic installations may result in the fuel reduction up to 14%. The major number of working machinery and equipment on fishing vessels are equipped with devices with hydraulic as they are user-friendly, easily serviceable, and reliable. On fishing cutters, energy for

hydraulic devices is commonly provided by hydraulic oils pumped by the pumps driven directly from the main engine transmission gear, and less frequently by electric motors. ANALYSIS OF THE METHODS TO REDUCE ENERGY CONSUMED BY HYDRAULIC FISHING EQUIPMENT The scope of research performed by the team of Maritime University of Szczecin included an analysis of the options and methods enabling the improvement of operational efficiency of fishing vessels by the reduction of energy consumed by the working hydraulic equipment. This solution may result in lower operational costs and limited CO2 emission. The analysis was

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presented in Figure 3.

M

fishing gear are as follows:

section of fishing cutters.

specify benefits that might be obtained if:

hydrokinetic couplings are mounted.

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Source: own elaboration