

NON-CONVENTIONAL ENERGETIC SYSTEM FOR SHIPS

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Abstract

The paper describes a possibility of implementation of a non-conventional energetic system for ships. The described system is a source of heat at three levels, cool, refined electric energy and mechanical energy. Individual secondary energies are acquired by means of transformation of primary chemically bound energy in fuel. Primary energy is transformed by means of a combustion engine used as a driving unit of ships designed for transportation of passengers and goods. The paper contains a brief illustration of efficiency criterion by means of Carnot circulation for non-conventional system using energy and, consequently, exergy produced by means of a combustion engine. Mechanical energy can be used to drive a ship and its equipment. Exergy as a source of heat and cool for technological equipment of a ship. The implementation of a non-conventional system of a ship offers more possibilities for effective usage and increases energetic evaluation of the combustion engine in this means of transport.

Keywords: *non-conventional energetic system, ships, three levels system, ICE*

1. Introduction

The present tendency leading to higher prices for primary energy forces a society to transform energy in a more efficient way or to design sets of machinery using energy at lower thermal potential levels. Such sets of machinery can lower energy consumption in industries and transport.

To deal with the above mentioned issue is important from the point of view of maintaining both economic and commercial balance. Apart from those criteria it is also necessary to bear in mind ecology and the need to create a system providing enough energy also in the future. Energetic machinery and equipment applied in means of transport have a significant influence on the creation of such a system. Included in the group are combustion engines either with continuous or discontinuous transformation of primary fuel.

One area of the current development of existing combustion engines focuses on application possibilities of using exergy generated by energetic machinery. In compliance with the development there is a possibility of implementing a newly designed non-conventional energetic system for energetic equipment of ships.

2. Ship energetic equipment and non – conventional energetic system

Ship energetic equipment is a complex system of functionally interrelated energetic equipment: engines, generators, machines, mechanisms, heat exchangers and sets by means of which various kinds of energies needed for safe, efficient and ecological operation of a ship according to its type and design are generated, changed, transmitted and used.

The need of mechanical energy and thermal (cold) energy on the ship deck can be covered within the above percentage division by means of the non-conventional energetic system. The need of individual flows can be related to a particular type of ship. The non-conventional energetic system provides energy necessary for transportation operations on a

cargo ship and ergonomic requirements on a ship designed for transportation of passengers. In this way the use of energy from primary fuel is increased, which has a favorable influence on the assessment of the ship energetic system.

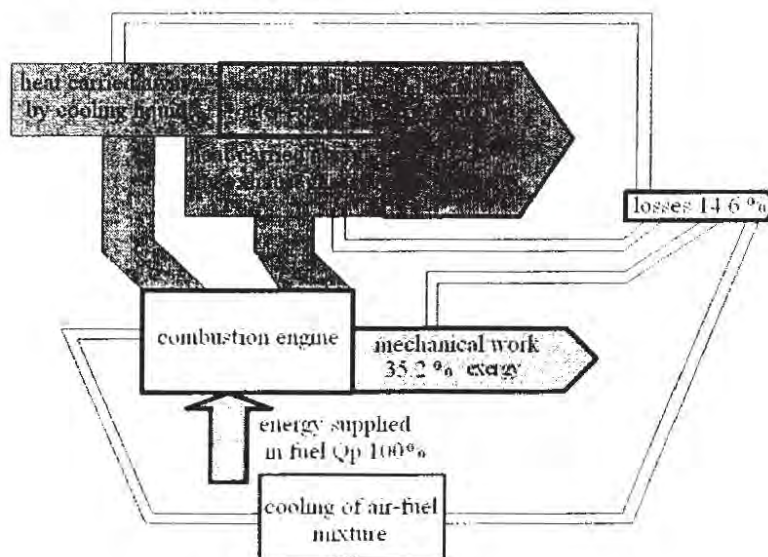


Fig. 1. Energetic flows

Mechanical energy is generated from the crankshaft of the combustion engine. From there it can be supplied to other equipment.

Thermal energy from expanding exhaust gases can be used for building a pneumatic connection between a turbo blower and combustion engine and for preparation of warm service water.

Cooling process is achieved by means of building a set consisting of the combustion engine and absorption cooling equipment where the work substance of the absorption cooling equipment flows directly in the combustion engine block and directly uses the thermal gradient of the combustion engine cooling system. Chambers of the cooling jacket directly become an expeller of the cooling absorption equipment. Cold can also be used for defining the constant temperature of cooling air for the combustion engine, which has a favorable influence on the process of combustion.

The system created in the above mentioned way is a source of heat at three thermally potential levels:

- High potential.
- Central potential.
- Low potential.

A scheme of possible application of the ship non-conventional energetic system is illustrated in Fig. 2 and a virtual model can be seen in Fig. 3

Main energetic equipment – main ship engine, ship shafting, auxiliary mechanisms, system of distant control, breakdown and protection systems, diagnostic systems – provide movement of the vessel.

Auxiliary energetic equipment – a system for energetic provision of the ship with different kinds of energy needed for the operation of the main energetic equipment and for operation of equipment not directly connected with movement of the vessel as, for example anchor

mechanisms, winches, loading equipment, lighting, heating, cooling equipment and fire fighting appliances, etc.

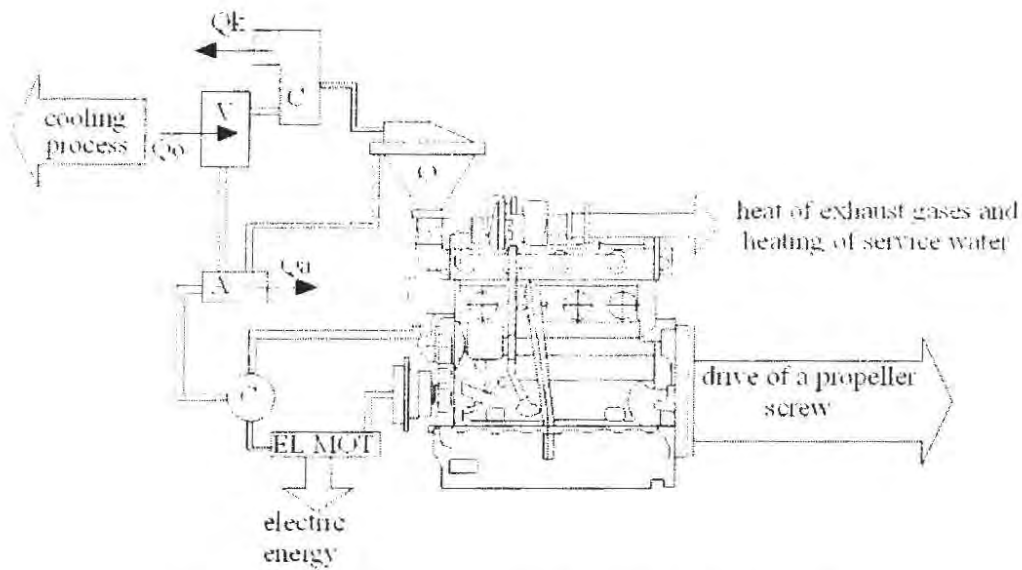


Fig. 2. Scheme of non-conventional energetic system on a ship
 Combustion engine – expeller, A – absorber of cooling equipment, C – condenser of cooling equipment, V – evaporator of cooling equipment. C – pump, O – evaporation dish, Q_e , Q_a , Q_c – thermal flows to provide operation of absorption equipment

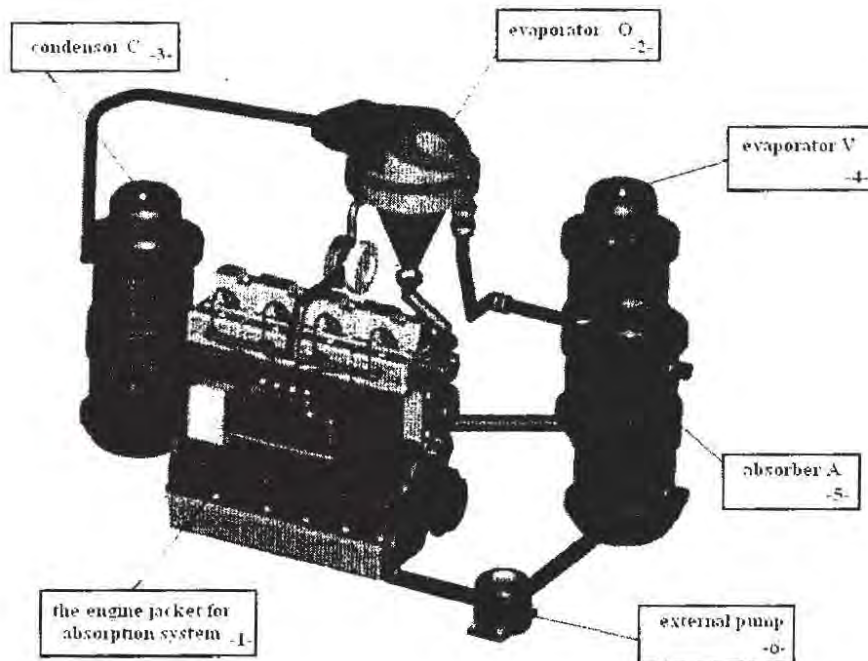


Fig. 3. Virtual model of basic parts of ship non-conventional energetic system

Electroenergetic equipment is used for generation and distribution of electric energy. The greatest amount of energy is consumed, apart from ship engines, by ventilators, pumps and deck mechanisms. In this group are also electric generators (basic, reversible, breakdown), main and local distributors, special equipment (transformers, rectifiers, converters, etc.) and electric distributions.

The ship non-conventional energetic system can be on the basis of the above classification included in the group of auxiliary energetic equipment. Owing to the level of

automation, it is a remote control system with a permanent service in a centrally controlled work place and with a periodic check in the machinery space. It can also be classified as a combined system, mainly from the point of view of thermodynamic principle of work – when energy from one cycle enters directly another cycle. Combined sets of machines are built to increase the total efficiency of fuel energy usage.

The presented non-conventional energetic system is a qualitatively new, higher model in ship energetics. It outlines new possible technologies and procedures in solutions of energetic systems of ships.

3. Non – conventional energetic system

The piston combustion engine with discontinuous burning transforms primary energy chemically bound in fuel within the framework of the equation of thermal balance whose simplified expression can be written in the form of the relation

$$Q_p = Q_e + Q_{ch} + Q_{vyf} + Q_{ol} + Q_{\dots} \quad (1)$$

where the symbols are used to denote the following:

- Q_p - heat (energy) supplied in fuel,
- Q_{ch} - heat (energy) taken away by cooling,
- Q_{vyf} - heat (energy) taken away by exhaust gases,
- Q_{ol} - heat (energy) taken away by oil,
- other heat (energy).

Individual flows of energy can be schematically illustrated – Fig. 4

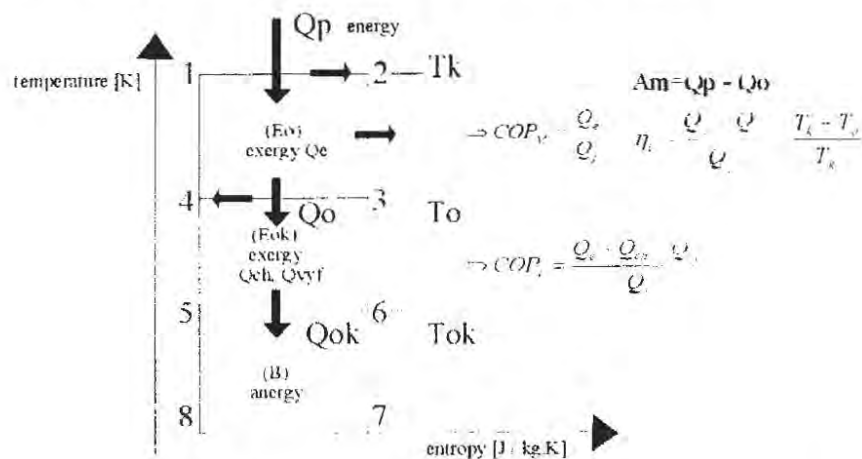


Fig. 4. Assessment of ship non-conventional energetic system by means of illustration in Carnot circulation

$$COP_M = \frac{Q_e}{Q_p} < COP_S = \frac{Q_e + Q_{ch} + Q_{vyf}}{Q_p} \quad (2)$$

4. Assessment criterion of the ship non – conventional energetic system

In general, energetic efficiency of systems with thermal equipment can be determined from the relation:

$$ef = \frac{\sum E_u}{\sum E_v} \quad (3)$$

E_u (J.s⁻¹) energy in individual thermal flows,

E_v (J.s⁻¹) energy in fuel.

To express such energetic efficiency, assessments carried out by means of output numbers COP and a degree of use of primary energy PER are used at present.

The value of COP number is given by effective output per unit of supply of the given equipment. The COP value is a function of thermodynamic properties of the used work substances, designing parameters as well as a concrete design of the system. Energetic efficiency defined in this way then expresses energetic demand of the assessed system. The higher COP value the system reaches the less primary energy it needs to provide the necessary input energetic flows in the ship system.

The degree of use of primary energy PER can be generally characterized as a reversed value of the output number.

5. Conclusion

The application of the non-conventional energetic system is connected with a number of constructional requirements which are at the stage of initial research. The assessment of the previous part is therefore related only to energetic flows. The relations presented in Fig. 4 are focused to the combustion engine as an energetic source. They do not include influence of flows of energy in individual equipment which form the ship non-conventional energetic system – Fig. 2. Their complex expression and use depend on a concrete implementation of a particular ship.

The non-conventional energetic system can be referred to as a tool through which an objective of lower energetic demand in transport can be achieved. It can also contribute to provide sufficient amount of energy in the future.

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