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INFLUENCE OF DREDGER POWER PLANT TYPE AND DREDGER SIZE ON OUTPUT OF POWER PLANT INSTALLED ON TRAILING SUCTION HOPPER DREDGER

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Abstract

This paper presents results of investigations dealing with influence of parameters characterizing size of trailing suction hopper dredger as well as type of power system on magnitude of total output of combustion engines installed in dredger power plant.

Key words: *Trailing suction hopper dredgers, ship power plants*

1. Introduction

In preliminary design of dredger power plants very important is to know influence of parameters characterizing size of a dredger (specified in owner's assumptions) as well as of type of its power system on magnitude of output of combustion engines installed in dredger power plant, N_{PP} [5]. This paper presents results of the investigations dealing with suction hopper dredgers.

2. General characteristics of trailing suction hopper dredgers

The trailing suction hopper dredgers are characterized by the hydraulic loosening of soil which is then transported into soil hold (hopper) by using specialty pumps adapted for pumping soil-water mixture – dredge pumps. The pumps suck out the mixture through one or two outer suction pipes called strainers. The suction hopper dredgers are always fitted with their own propulsion system which make it possible to move the dredger while carrying out dredging work. Their necessary high maneuvering qualities are usually ensured by two-propeller propulsion system and thrusters. The propulsion system makes transporting the winning to an arbitrary dumping place, possible. Emptying the hold is done by pumping the winning with the use of dredge pumps – out of the hold onto land, or gravitationally - by opening hold bottom doors or diverting valves. [1, 3, 6].

Dredgers of the kind are produced in a wide range of size. The basic parameter characterizing dredger size is its soil hold capacity which is contained within the range of 300÷35 500 m^3. Total output of installed combustion engines is contained within the range of

1000÷38000 kW. Trailing suction hopper dredgers are usually divided into four following size groups (Tab.1) [4, 5 , 6].

Tab. 1. Size groups of trailing suction hopper dredgers and their characteristic parameters

Dredger size	Soil hopper capacity	Total output of combustion engines	Saling speed	Maximum distance between loading and unloading places
	m^3	kW	knots	nm
Small	< 4000	1000 - 6000	7 - 13	8 - 10
Medium	4000 - 9000	5500 - 13500	11 – 15	15 - 20
Large	9000 - 17000	13000 - 20000	14 - 16	20 - 40
Very large	> 17000	20000 - 38000	15 - 18	do 150

A fundamental difference between transport ships and dredgers is number of main consumers. On transport ships whose main task is to carry goods, propellers are the only main power consumers. On trailing suction hopper dredgers the main consumers are the following [5]:

— consumers connected with propelling the dredger, its positioning and maneuvering (main propellers, tunnel thrusters);

— consumers connected with soil loosening and transporting (dredge pumps, jet pumps).

Total number of kinds of main consumers is equal to four.

3. Characteristics of power plant of trailing suction hopper dredgers

Classification of solutions of dredger power plant depends on an assumed criterion of classification. In [5] the following distinguishing criterion has been proposed : a manner of driving the main consumers , expressed by number of main engines or - equivalent to them - main multi-engine systems . Solutions of power systems of suction hopper dredgers should be considered within the following types :

- ***Type I*** – covering systems in which is installed only one main engine or -equivalent to it - main multi-engine system providing drive for all main consumers used on the dredger;
- ***Type II*** – covering systems with two main engines or - equivalent to it - two main multi-engine systems;
- ***Type III*** – covering systems with three main engines (or three multi-engine systems); main ship propellers and dredge pumps are driven by separate engines and one common engine drives jet pumps and thrusters;
- ***Type IV*** – covering systems with four main engines (or four multi-engine systems). The type is characterized by a combustion engine (or engines) for driving each main consumer separately.

4. Regression functions which characterize power system

The soil hold capacity V_{SH} [m^3] was selected to serve as an independent variable characterizing size of suction hopper dredger. Regression analysis was performed with the use of the least squares method and Statistica software. Significance of the obtained expressions were checked by using F - test. The tests of the expression $N_{PP} = f(V_{SH})$ were made for four, above described types of power systems .

Empirical data used in the investigations , were taken from the database DRAGA [2]. It contains a.o. detail technical characteristics of 270 dredgers including 119 suction hopper dredgers. The data deal with the units built in the years 1970 – 2012. Out of 119 dredgers, 71 belong to the group of dredgers with the power system of the type I, 16 to that of the type II, 14 to that of the type III and 18 to that of the type IV.

Results of the calculations are given in Tab. 2 and Fig. 1, whereas Tab. 3 provides allowable intervals of value of the independent variable V_{SH} appearing in the expressions presented in Tab. 2.

As the regression functions for the power systems of the type III and IV are close to each other it was decided to consider them jointly.

Tab. 3. Regression functions which determine total output of combustion engines, N_{PP}, installed on suction hopper dredgers

Power plant type	Form of function	Statistical estimation parameters				
		σ_N	R	F	F_{kr}	m
I	$N_{PP} = 1{,}143 \cdot V_{SH} + 1418{,}4$	323,48	0,975	1345,4	4,01	71
II	$N_{PP} = 1{,}609 \cdot V_{SH} + 361{,}2$	1358,55	0,876	46,31	4,60	16
III i IV	$N_{PP} = 1{,}926 \cdot V_{SH} - 33{,}6$	434,91	0,950	278,7	4,17	32

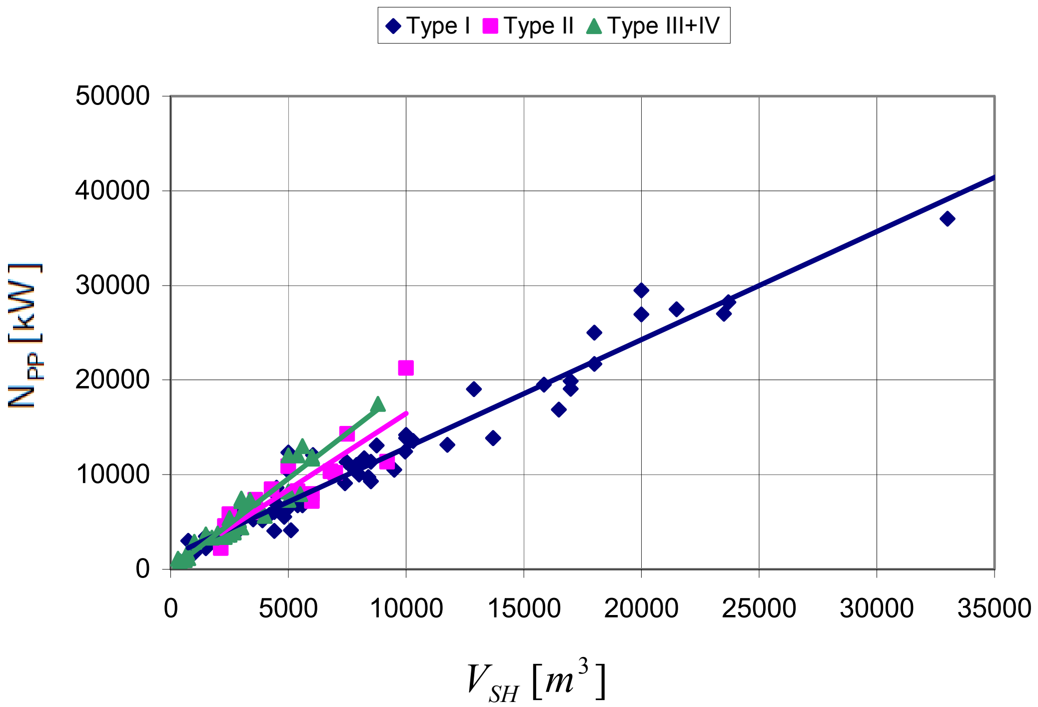

Fig.1. Regression functions $N_{PP} = f(V_{SH})$ for various types of power system on suction hopper dredgers

Tab. 3. Allowable intervals of V_{SH} value , depending on type of power system

Power plant type	V_{SH}
	m^3
I	750 - 35500
II	2000 - 10000
III and IV	300 - 8800

5. Summary

The presented results of the investigations confirmed that dredger size and type significantly influences output of power plant on suction hopper dredger. From analysis of the results may be drawn the conclusion that the power systems of the type III and IV do not practically differ from each other from the point of view of energy and therefore they may be considered jointly.

All the above presented regression functions reflect design reality of suction hopper dredgers and may be used at preliminary design stages as well as they may be useful for verifying results of design calculations obtained by means of other methods.

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