Research of the pre-launch powered lubrication device of major parts of the engine D-240

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Abstract. In the publication, the issues have been considered concerning combustion engine start wear of mobile machines in case of outside storage in the conditions of low environmental temperature. Based on the analysis of existing methods and constructions of powered lubrication devices for contact surfaces of engines, a design of a combined device has been suggested which unites the functions of hydraulic and heat accumulators. On the basis of the elaborated design, preparatory tests have been conducted in order to evaluate the effectiveness of pre-start oil circulation in the engine D-240, as well as the effectiveness rate of thermoinsulation and the heating device of the hydraulic accumulator. The findings of the survey have shown that the pre-start powered lubrication device for major parts of the engine is effective.

1. Introduction

Winter conditions are a great challenge for the reliability of motive power, the quality of engineering maintenance materials and the production machinery for pre-launch processing [3].

In Siberia, the temperature in winter often drops to the mark -20 °C and lower, which, in the conditions of outside storage of mobile machinery, makes a big problem for the cold launch of diesel engines [2].

In this context, the improvement of diesel engine start characteristics and the creation of effective pre-launch processing methods make an important and multidisciplinary task.

Another important issue of low-temperature exploitation is the decreasing of start engine wear [5].

The analysis of influencing factors of low temperatures on the engine lifetime has shown that the increasing of start wear and the general launch reliability are massively affected by the lubrication retard of major parts of the engine [2].

2. Overview of research methods

In order to solve the problem of start wear in lubrication systems of modern engines, various constructive and exploitation steps are made which provide the powered lubrication of contact surfaces within the first after-launch operation period [1].

These devices and methods can be divided in 3 groups [1]:

1) Devices providing pre-launch lubrication of contact parts of the engine via oil pumps of various types and constructions.

2) Devices, in which hydraulic accumulators are used for the lubricant supply. The oil is accumulated therein while engine is running and then given under pressure right before the launch.

3) Different constructive features of the lubrications system which help decrease the oil supply retard during the launch of the engine (using of gate valves in the lubrication system, increasing of the relieve valve opening pressure etc.).

The considered devices for pre-launch motor oil circulation are only limitedly used in highly boosted diesel engines of specialized machinery.

3. The measurement procedure

According to the analysis of the considered devices for pre-launch motor oil circulation, the most effective and the easiest device is based on hydraulic accumulators [4].

This is why we suggest to design a device for powered pre-launch lubrication of contact elements of the engine D-240 based on the hydraulic accumulator, for the tractor MTZ-80 which is widely used during the winter period.

In order to decrease calorific loss of the motor oil in hydraulic accumulators and to maintain the temperature of service fluid within the period of its interim storage, we suggest to put the device body into a heating jacket and to install an additional heating unit.

The main purpose of the modernization of engine lubrication system (figure 1, 2) is to decrease the time of oil flow to the parts of the engine D-240 during the process of cold launch by means of maintenance of positive oil temperature in the hydraulic accumulator within the period of interim storage as well as by means of pre-launch oil supply from the hydraulic accumulator to the contact parts of the engine.

Thus, the operation time of crankshaft bearings and turbocharges in unfavourable terms (in unlubricated and boundary friction modes) is shortened.

The given device has following features (figure 1, 2):

1. The usage of standard bores in the engine lubrication system allows to install the pre-launch lubrication device without any special adjustments in the engine construction. Thus, the exploited tractors can be upgraded too.
2. The appliance of thermoinsulation for the elaborated device helps enhance the effectiveness of heat conservation of the motor oil within the period of interim storage of machinery; this facilitates the launch in the conditions of low temperatures.
3. The usage of a self-regulated heating unit in the elaborated device provides automatic motor oil heating in the hydraulic accumulator.

The device functions as follows (figure 1). Upon completion of the tractor shift, machine operators open tap 8 and, while the motor is still running, by means of standard oil pump, the heated motor oil is partially pumped from the crankcase into the heat accumulator (about 60-70% of the total liquid volume in the oil crankcase), where, in the period of interim machinery storage, the motor oil warmth is accumulated.

Launching the engine, we open tap 8 and, under the effect of the additional air pressure (0.3-0.5 MPa) within the hydraulic accumulator (by means of a pneumatic pump, a receiver), a part of the motor oil is directed into the oil passage and completes the pre-launch oil circulation during 20-40 s; the rest of the motor oil flows through additional hosepipes and a drain hole directly into the engine crankcase.

The process of charging and discharging of the accumulator is controlled by reference to the standard oil pressure sensor which is situated on the dashboard of the tractor MTZ-80 (figure 3). The results of the conducted tests showed that if the oil temperature in the hydraulic accumulator equals to 40°°C, and the air pressure equals to 0.3 MPa, the oil pressure in the oil passage amounts to 0.22 MPa at the moment of power fluid feed (within the limits of the safe working pressure) and does not change for 40-60 s.

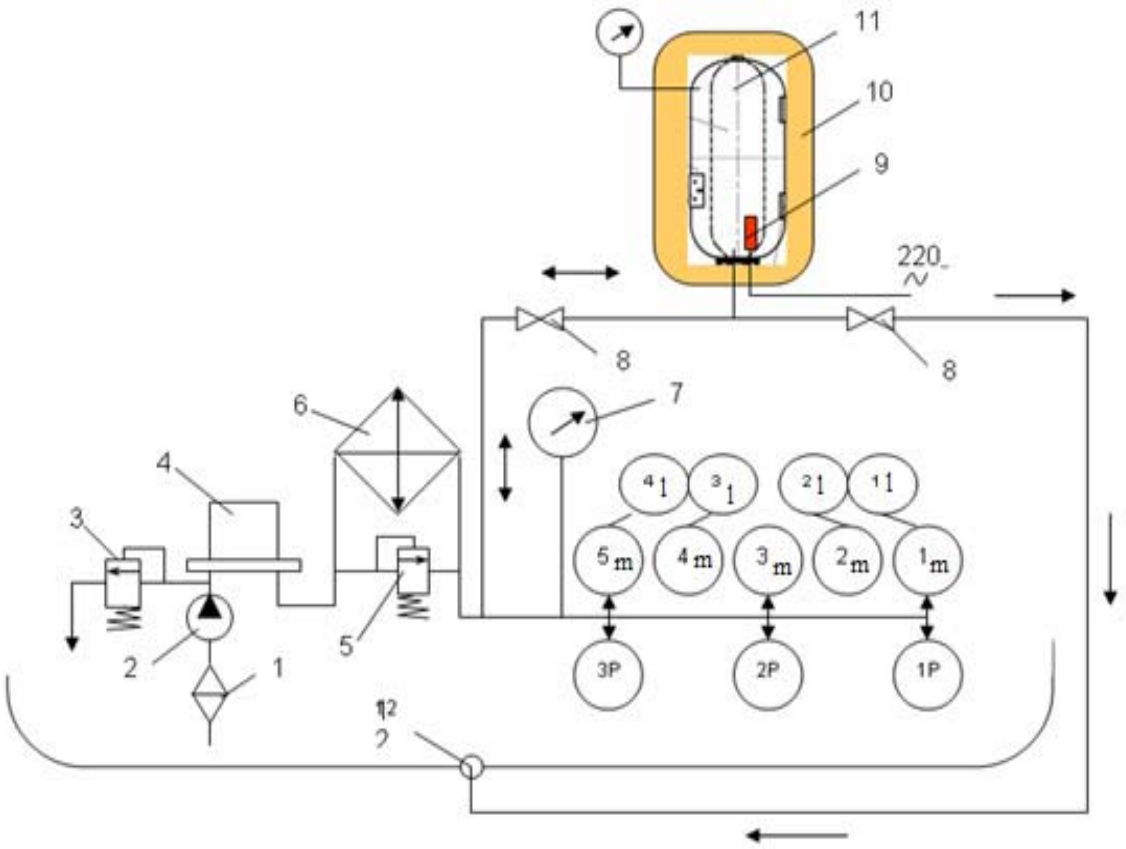

Figure 1. The plan of the pre-launch oil supply device into the lubrication system of the engine D-240:
1 - oil intake; 2 - oil pump; 3 - protection valve; 4 - rotary accelerator; 5 - thermostatic valve of the heat radiator; 6 - heat radiator; 7 - pressure gage indicator; 8 - tap; 9 - oil heater; 10 - thermoinsulation; 11 - hydraulic accumulator; 12 - drain hole of the oil crankcase; m and l - main and large end bearings; P - bearings of the countershaft.

Pre-launch oil circulation helps decrease the feed time of the oil into the contact parts and increase engine lifetime.

In the course of further improvement of the suggested design we have suggested to install a self-regulated heating unit 9 (figure 1) and (figure 4) within the hydraulic accumulator. This heating unit is energized from an external source, in order to maintain the power fluid temperature and, if necessary, to heat up motor oil before launching the engine.

As a heating device, we chose an electric bar heater with a heat controller, with a capacity of 30 W and the maximum fluid heating temperature 55 °C.

In the process of experiment, the effectiveness of thermoinsulation has been registered in reference to the oil cooling rate in the hydraulic accumulator, as well as the dynamics of the fluid heating by means of a heating unit 9 (figure 1) in the suggested device. As thermoinsulation, we used basalt fiber, penofol, and extruded polystyrene foam (figure 5).

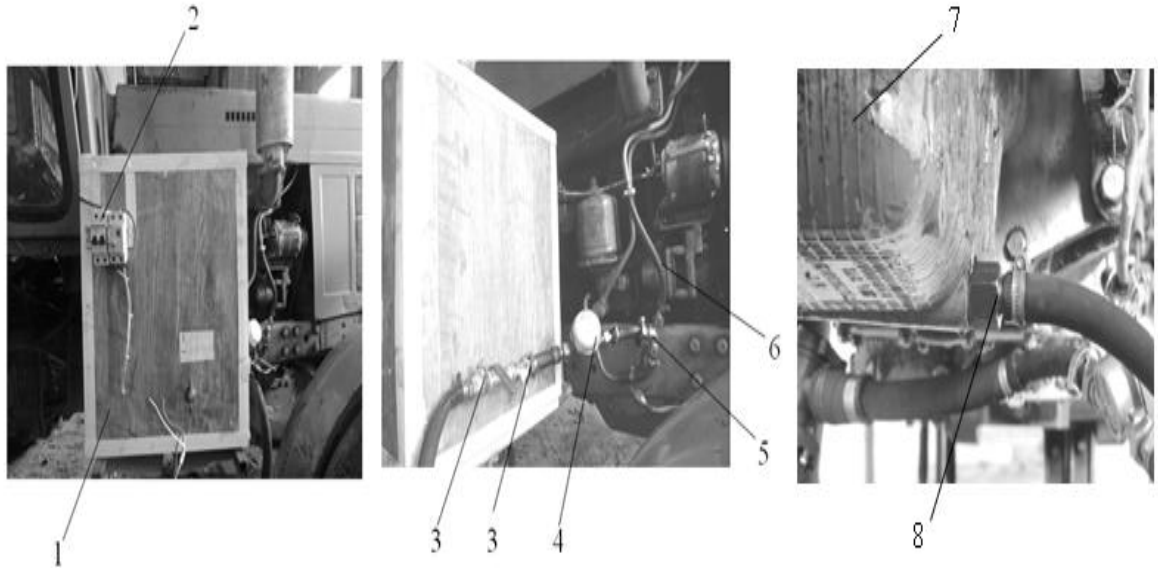

Figure 2. Pre-launch oil supply device into the lubrication system of the engine D-240:
1 - thermoinsulated hydraulic accumulator; 2 - module for the connection of the oil heater with the external network; 3 - tap; 4 - fluid meter; 5 - tee-joint; 6 - main oil passage; 7 - oil crankcase of the engine D-240; 8 - connector of the drain hole.

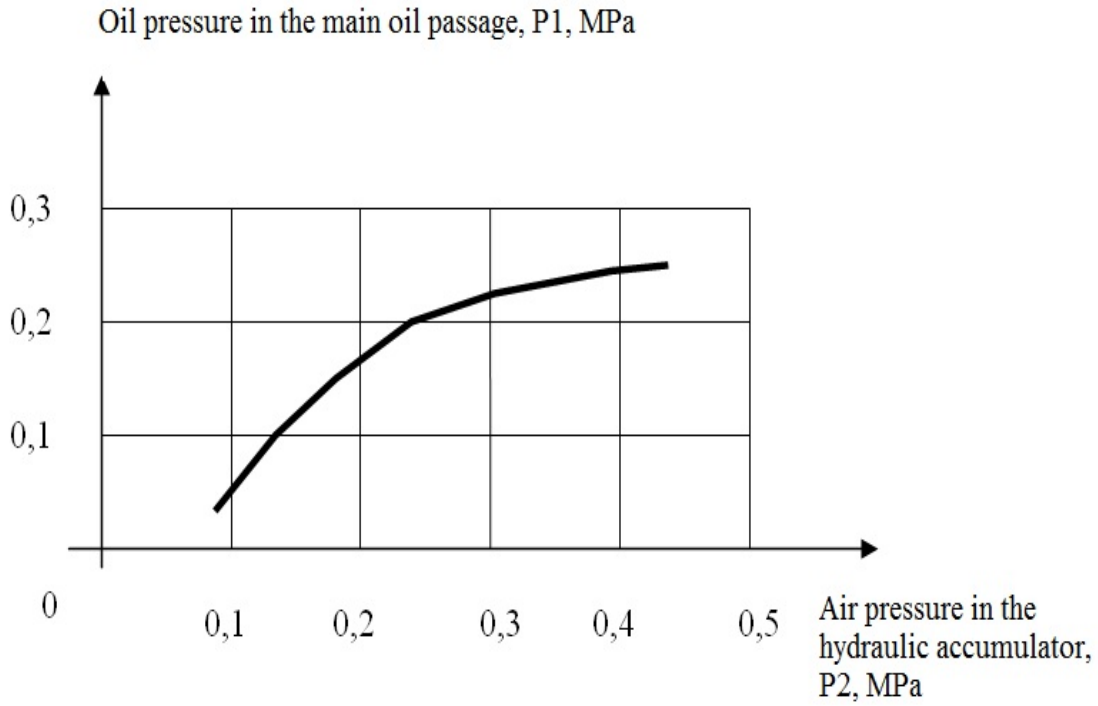

Figure 3. Dependence of the pressure in the main oil passage from the air pressure in the hydraulic accumulator (motor oil temperature in the hydraulic accumulator equals to 38-42 °C, the environmental temperature equals to -18 ... - 24 °C, motor oil grade is M-10G_2).

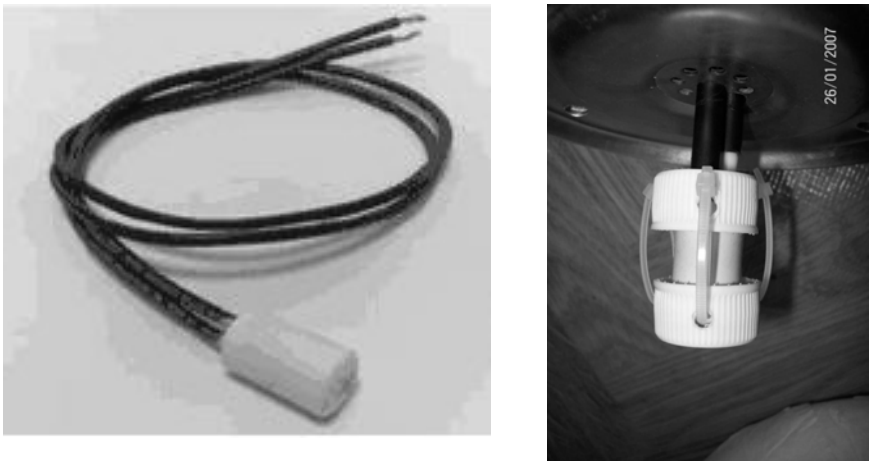

Figure 4. Self-regulated heating unit with a capacity of 30 W.

Figure 5. Thermoinsulated hydraulic accumulator:
1 - basalt fiber; 2 - penofol; 3 - extruded polystyrene foam.

4. Results and Discussion

An average motor oil cooling rate in the heat accumulator amounted to 1.5-2 °C per hour (figure 6) by the environmental temperature of -18 ... -23 °C; the motor oil heating rate in the heat accumulator by means of an electric heating device amounted to 3-5 °C per hour (figure 7), which proves the effectiveness of the elaborated device.

5. Conclusion

Based on the results of the tests, following preliminary conclusions have been made concerning the effectiveness of the pre-launch lubrication device:

1) The device provides a sufficient lubricant material supply to the crankshaft bearings before the launch of the engine, help decrease the oil feed time to the parts during a cold launch, as well as prevent their start wear.

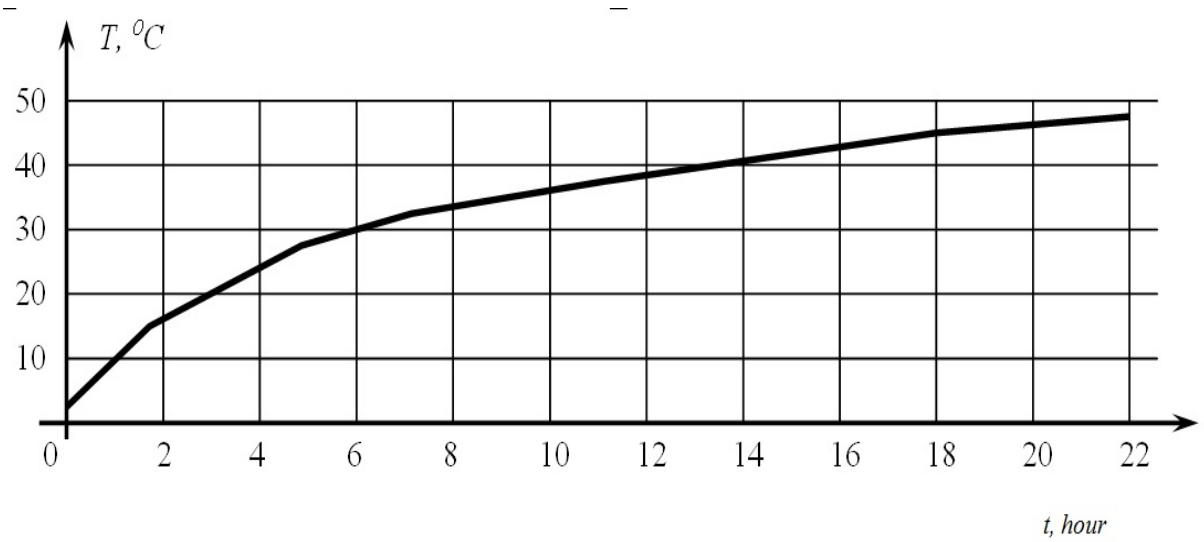

Figure 6. The diagram of the motor oil heating in the hydraulic accumulator (the capacity of the heating unit N=30 W, the environmental temperature T=-20 ... - 25 °C)

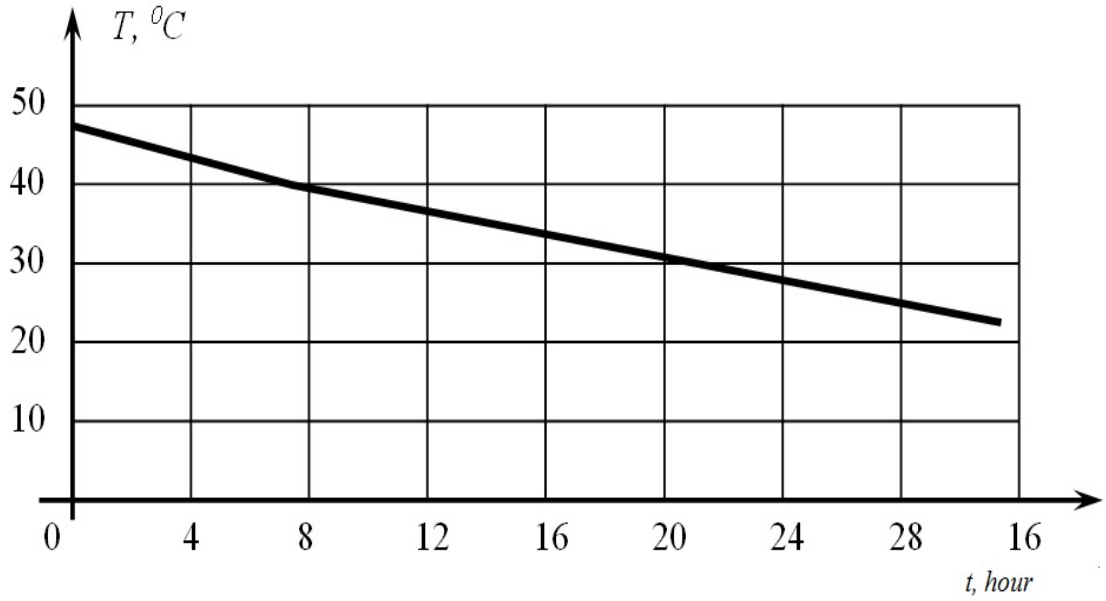

Figure 7. The diagram of motor oil cooling in the hydraulic accumulator (environmental temperature T= -18 ... -23 °C)

2) The device helps maintain the pressure in the lubrication system before the launch within the limits of 0.1-0.2 MPa depending on the initial motor oil temperature in the device and in the engine crankcase, as well as maintain the pressure in the hydraulic accumulator.

3) The usage of thermoinsulation and a heating device increases the effectiveness of the hydraulic accumulator in the pre-launch oil circulation in the conditions of subzero temperatures.

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