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# The Model Test Stand on Diesel Engine Cooling System with Elevated Coolant Temperature Analysis

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## Abstract:

In the paper a model take a look at stand designed and built the use of authentic components of diesel engine 4CT90 is presented. The stand provides running situations as near as feasible to the exploitation conditions of the engine cooling device. This applies both to the intensity of warmth in the cylinders of the engine, the temperature uniformity alongside the cylinder axis, in addition to variable-pace water pump. This concept executed on the model stand were geared toward checking the operation of the cooling depth manipulate with various degrees of filling of the cooling gadget and develop a manage method of the cooling gadget before trying out on the dynamometer stand. Further device operation at increased cooling liquid pressure for the possibility of acquiring the improved coolant temperature have been checked. The impact of operating conditions on the level of the temperature was also analysed.

On this paper, the characteristics decided on for two values of pressure, for zero.15 MPa and zero.2 MPa, and for 2 distinctive values of the degree of filling of the cooling liquid have been offered. at some stage in the warming-up and continuous heating of the cylinder and the cylinder head by means of electrical heaters, temperature and overpressure courses before and after the liquid radiator, temperature earlier than the inlet and outlet of the liquid from the engine and the temperature at decided on points in the engine water jacket are detailed. The results of measurements of the coolant pump drift at exclusive velocity water pump have been additionally presented in this paper.

**Keywords:** Combustion engines, engine cooling, test stand, coolant temperature.

## 1.Introduction:

The effective control of electricity and coffee stage of toxic emission are linked with strength conversion and are the maximum critical challenges of today's civilization. Evolution of civilization as well as situations of humans life depend on assets of power and effective exploitation. It includes strength used for propulsion of wheeled cars, which can be the essential approach of shipping in urban regions. Internal combustion engines, which are characterized via low performance, are nevertheless commonly used for car propulsion. Despite the fact that ongoing on the advent of opportunity propulsion, because of technical difficulties, the application of them is a matter of the destiny.

For this reason, research remains finished on the development of inner combustion engines inside the course of growing performance and decreasing poisonous components [3]. Within the internal combustion engines, the most famous and broadly used technique of cooling is the cooling liquid that provides extra uniform temperature around the combustion chamber than direct cooling air. but, on this first case, the most temperature is restricted by the homes of the cooling water [1, 4].

On this paper are supplied research consequences the liquid cooling device of the inner combustion engine, executed at the version test stand. First research of the cooling machine on the version stand and most effective later on the dynamometer stand become executed, due to the fact a examine carried on a jogging engine will be dangerous for the research item, which can without difficulty leads to overheat and capture.

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Harm ought to happen additionally at some point of the test devices running, at multiplied temperature of the coolant. Further, for the duration of studies of entire engines, gasoline is consumed and fumes are emitted. Consequently, for the research and test of latest concepts and answer, favourable is to design and construct a check version stand, which shall we avoid those troubles. To the check cooling gadget of elevated coolant temperature, the take a look at model stand became built, in which temperature modifications are performed by using electric heaters. This test stand additionally permits easy to govern of devices and cooling systems gadgets and allows the experimental preference of manage parameters of structures with excessive temperature [5].

## 2.Model test stand:

The investigation of the cooling system of accelerated coolant temperature at the version stand organized and built using original additives and devices of diesel engine 4CT90. The check stand guarantees running situations as near as feasible to the situations of everyday operation of the engine cooling machine. this applies both to the depth of warmth era in the cylinders of the engine, the temperature distribution along the axis of the cylinder, as well as variable-speed water pump. The check stand turned into made using the following motor gadgets: the cylinder block and head with heaters, water pump driven by using an electric powered motor and additionally radiator with enthusiasts. To force the water pump electric motor with a programmable inverter was used. The scheme of the check stand is shown in Fig. 1. The basic issue of the check stand and the source of heat transferred to the cooling gadget was cylinder block with head of engine 4CT90. In each cylinder with three cylindrical immersion heater with one-of-a-kind electrical strength within the metallic cylinders become placed. The heating elements adhered closely to the walls of the engine cylinders (Fig. 3) [6].

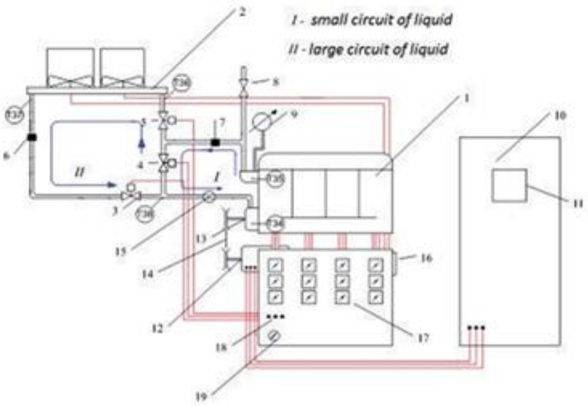


**Fig. 1. Scheme of the pressure cooling system: 1 – cylinder block with head, 2 – cooler, 3, 4, 5 – solenoid valves,6, 7 – electronic manometers, 8 – shutoff valve, 9 – manometer, 10 – inverter, 11 – inverter display and programmer, 12 – electric motor, 13 – water pump, 14 – gear, 15 – flow meter, 16 – fan power switches,17 – set of switches, 18 – small and large circuit switches, 19 – main switch.**

## 3.Analysis of the cooling system on the model stand:

The investigation was carried out on the test stand were aimed at verify the operation of the cooling. Intensity control with varying degree of filling the coolant and to develop a method for controlling the cooling system before testing on the dynamometer.

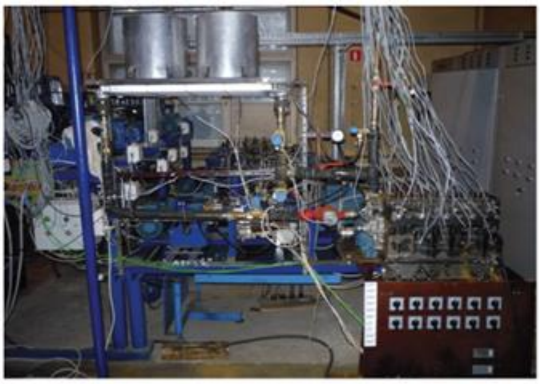

**Fig. 2.Pressure cooling system on the model test stand**

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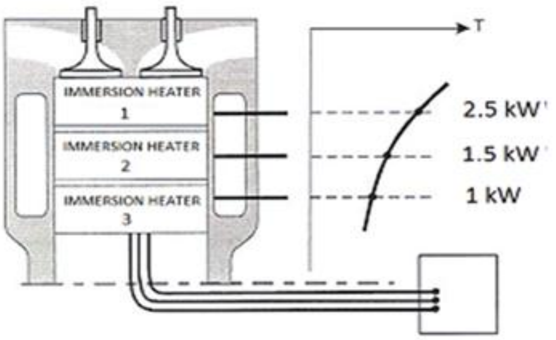


**Fig. 3. Arrangement of immersion heaters inside the engine cylinders [5].**

The studies have been conducted for the overpressure of 0.05 MPa, zero.1 MPa, zero.15 MPa, 0.2 MPa and for variable filling the coolant: 10.5 dm3, 10 dm3, nine. five dm3 i nine dm3, which constitutes about value, respectively 95%, ninety%, 85% i eighty% of liquid filling device in a total volume of 11 dm3. closing ability of the watertight cooling system was containing air [2]. All through the nice and cozy-up and non-stop heating of the cylinder and the cylinder head the usage of electric power edwarmers, temperature and overpressure courses of liquid in the gadget before and after the cooler, the temperature the inlet and outlet of the liquid from the engine and the temperature at selected points inside the engine water jacket have been appointed.

Effects of measurements of coolant pump drift at one-of-a-kind velocity of water pump had been also provided. on this paper, the traits selected for two values of overpressure of 0.15 MPa and 0.2 MPa and for two exclusive values of coolant filling diploma have been presented, because for the lower overpressure fee in the gadget changed into now not feasible to growth the temperature of the coolant above 110°C. Therefore the courses of temperature modifications at some stage in each check have been similar; the guides for one system of warm-up and heating of engine by way of electric warmers were proven. The studies started out with 4 extraordinary volumes at the assumed coolant stress of 0.05 MPa.

Maintaining this type of low overpressure at a steady level was very difficult. almost overpressure inside zero.04–zero.1/2 MPa for all tiers of filling of the coolant became maintained, however the maximum temperature finished at the very best filled (ninety five% of the volume of liquid) was temperature 87°C and for the least filling (80%) obtained a temperature of approximately 112.5°C. At an overpressure of zero.1 MPa reached common temperature values was now not too excessive: for ninety five% of the liquid filling the average temperature become approximately 102°C, even as for 80% of the filling it changed into slightly higher – at the extent of 112°C. Subsequent assessments at an overpressure of zero.15 MPa became executed. Warming up the machine on a small circuit lasted about 25 minutes. After obtaining assumed overpressure, large circuit for about 3 seconds turned into turn on, that the temperature dropped by about 20°C, at the same time as the overpressure of approximately 0.02 MPa and became maintained in the variety zero.

A hundred thirty five–0.16 MPa (Fig. 4). For the subsequent cycle exactly the equal steps had been made until the moment, when after switching on the huge gadget, strain drop turned into not observed. Then the fan No. 1 become became on, and after some time the fan No. 2. The switching frequency among small and massive circuit became on average 3 minutes. Working time at the massive circuit was approximately three-four s. During maintaining a stable heating of the system, the maximum temperature of the liquid at the outlet from the engine at the level 120°C for all the volume of liquid coolant (liquid filling), with a decrease of the temperature to 80°C during the intensive cooling was obtained (Fig. 5). However, individual characteristics differed significantly course minimum and maximum values of temperatures that resulted from the maintenance of overpressure in the cooling system as

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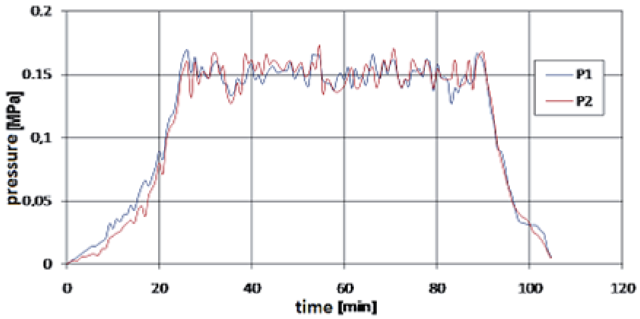
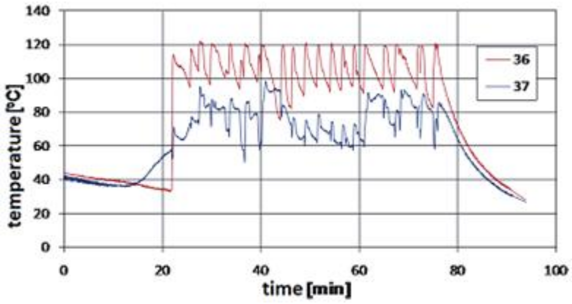



**Fig. 4. Course of overpressure coolant in the cooling system during the measurements at a pressure of 0.15 MPa and 90% filling of the liquid. Designations circuits: P1 – small circuit, P2 – large circulation**

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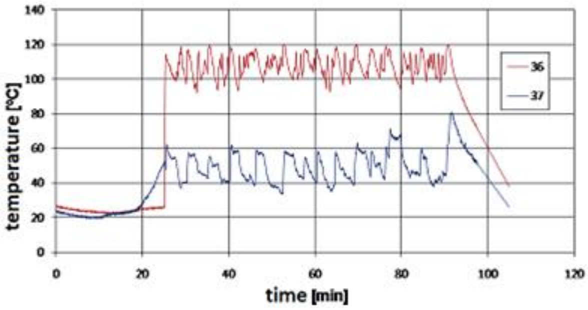


**b)**

**Fig. 5. Course of temperature coolant in the cooling system during the measurements at a pressure of 0.15 MPa and 90% (a) and 80% (b) filling of the liquid. Designations thermocouples: 36 – liquid inlet to the radiator, 37 – liquid outlet of the radiator**

Constant as possible. When reduced the amount of liquid in the cooling system and increased the air pressure accumulator, these differences were smaller and smaller, at the same time the average temperature of circulation increased, because when temperatures change considerably, achieving the maximum temperature was associated with a simultaneous increase in the intensity of cooling. This was observed as an initial rapid increase in temperature in the cooling system to about 120°C, while the amount of air at low temperature increase was slower. Simultaneously with increasing the amount of air in the system and reducing the amount of liquid the average temperature of the coolant flowing into the engine substantially decreased. At least filling the liquid of about 80%, it was necessary to cool down the liquid in the radiator to 40-60°C for a temperature inside the engine at a maximum level of about 120°C. Therefore, it seems appropriate to adopt 90% filling as optimal filling for the system operating conditions and adopted overpressure. Measurements for the assumed pressure of 0.2 MPa was also carried out at four degrees of filling of the coolant. When the overpressure in the system achieved assumed value, the system was switched to the large circulation and then followed by a decrease overpressure of about 0.05 MPa, and its value ranged 0.15-0.2 MPa, and was slightly lower than the assumed value of the average at 0.2 MPa (Fig. 6).

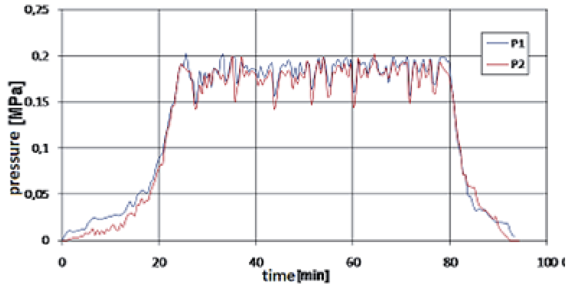


**Fig. 6. Course of overpressure coolant in the cooling system during the measurements at a pressure of 0.2 MPa and 90% filling of the liquid**

On the identical time, an growth inside the intensity of cooling followed with the aid of a lower in temperature of approximately 25°C, however it become viable to acquire a slightly higher maximum temperature one hundred twenty °C (Fig. 7). Switching frequency extended – a massive stream enrolled for about 2 to 3 seconds. at the same time with switching on large circuit, the enthusiasts had been became on for

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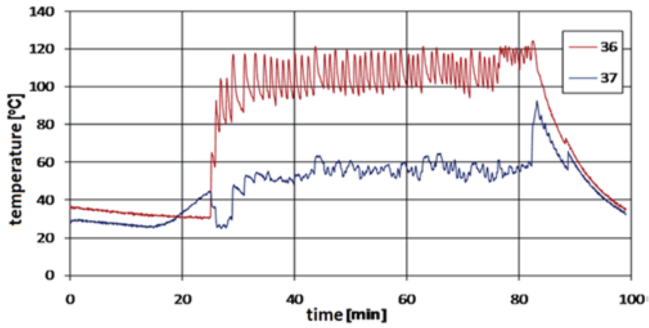
approximately 20 to 25 seconds. based totally on evaluation of consequences of simulation studies, it changed into observed that at a hard and fast overpressure (thinking of deviations) the growth in extent of the cooling machine should growth the temperature of the coolant flowing from the engine. The inspiration got affirmation during the assessments at the model stand, wherein the over pressure of 0.15 MPa, the average temperature upward push. This became not absolutely showed throughout the exams at the version stand at the assumed overpressure zero.2 MPa, which can be justified through the precise control of the cooling machine, inclusive of the too frequent adjustments in the intensity of cooling, as well as periodic super cooling liquid. proof of this low temperature at the outlet of the radiator and the decrease than predicted over pressure within the device. probably too counseled a maximum temperature (one hundred twenty °C), and to a lesser quantity, increased overpressure, which should be in the range of 0.2 MPa □ 0.02 MPa, as it is achieved at a pressure of 0.15 MPa.

In this situation indicates an essential position of control method of the cooling depth on the cooling system work inside the assumed conditions. This hassle must be advanced in similarly studies of the pressure cooling machine. but, this does not undermine the earlier findings of the adoption ofthe 90% coolant filling as great applicable to the pressure of the cooling machine working at an over pressure of 0.2 MPa. Coolant glide rate at some stage in the exams turned into now not constant, due to the fact the temperature of the boiling point of the liquid, inside the pump the water vapour bubbles were fashioned, which resulted in a decrease of efficiency of liquid discharge. at the identical time, it became necessary to alter the velocity of the water pump to the degree of filling of the liquid. For a extent of 95% and ninety% the most uniform drift changed into furnished at the pump speed of 2000 rev/min, at the same time as the filling of 80%, and the water pump speed of 3000 rev/min do not recorded go with the flow of the coolant.

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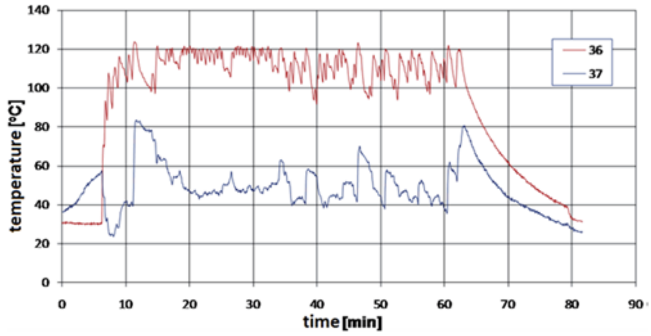


**b)**

**Fig. 7. Course of temperature coolant in the cooling system during the measurements at a pressure of 0.2 MPa and 90% (a) and 80% (b) filling of the liquid**

Therefore, at 85% filling of the liquid pump operated at a speed of 3000 rev/min, while at 80% filling the speed of the water pump was increased to 4000 rev/min, which is of course also affect on average flow rate of the coolant. At the same time, it was found that the reduction of the filling liquid flow uniformity deteriorated. This may be due to a greater amount of water vapour and air in the cooling system (Fig. 8).

## 4.Conclusions:

1) The original cooling system operating at elevated pressure coolant was developed, built and tested. With an average over pressure 0.3MPa in the cooling system, due to evaporation of cooling water, the water temperature at the outlet of the cylinder head, was achieved at 120°C.

2) A result of investigation the cooling system operation, which was increased pressure of the coolant,

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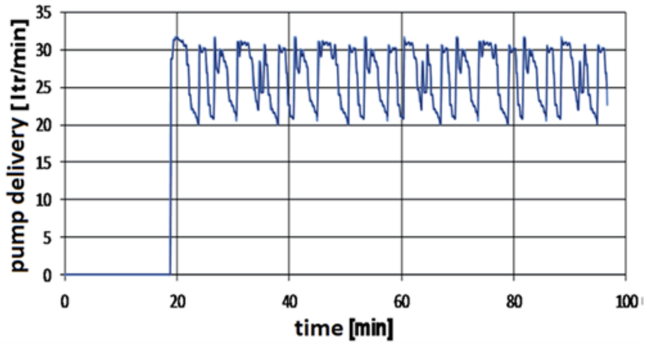
in terms of the possibility of obtaining an elevated coolant temperature and the effects of
the working conditions of the system on this temperature level was verified. It was found that tested cooling system operated correctly, maintaining a sufficiently high pressure and temperature.

3) . The strain was basic control gadget parameter and the temperature was output parameter.

Whilst the stress restriction became surpassed, cooling intensity become increased, and the reduction of the stress the cooling intensity changed into decreased. It become observed, that it become feasible to maintain the stress within the machine and thus temperature of the liquid on the assumed stage for an extended period of time. Cooling intensity become converting by using adjusting drift water pump, coolant glide switching between small and large cooling device and fan beginning installed on the radiators.

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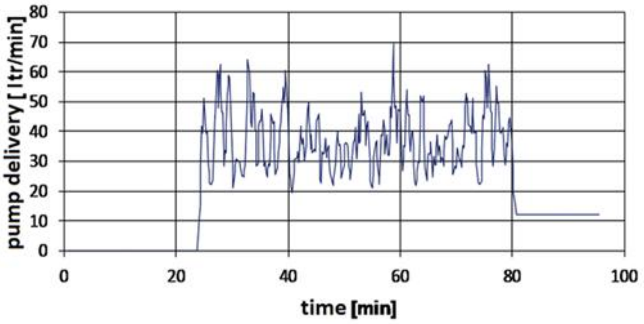


b)

**Fig.8. Course coolant flow during the measurements at a pressure of 0.2 MPa and varying the liquid filling system: a) filling of 95% and a water pump speed n = 2000 rev/min, b) filling of 85% and a water pump speed 3000 rev/min**

4) The experimental results on the model stand showed the desirability of limit the coolant fill to90% so that the rest of the system containing air acted as a pressure accumulator, improving control of system.

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