## Literature

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# COMBINED OPERATION OF THE AIR ENGINE AND ICE OF THE COMBINED POWER PLANT OF A VEHICLE (CPU)

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For modern urban road transport, the use of environmentally friendly, including combined, power plants (PPUs) [1] is becoming relevant, when used in certain vehicle operating modes, it is possible to temporarily abandon the operation of the internal combustion engine (ICE) by replacing it with an alternative one included in the PPU.

Pneumatic motors (PM) when used as part of a CEU have a number of advantages compared to electric ones (simplicity and safety of design, lower weight of equipment when using modern materials, operation in conditions of explosion and fire hazard, absence of harmful electromagnetic radiation, no need to dispose of batteries, etc.) [2].

A combined power plant using a PD and an ICE provides for different layout schemes for placing units. When using a CEU on a vehicle, a combined scheme looks better, in which the PD and the ICE are located in the same housing, but work alternately by changing the operation of the intake, ignition (if available) and power supply systems. With such a scheme, the heat released as a result of the operation of the ICE is used to heat the compressed air and maintain the heat balance. The heat can be used from heated parts of the ICE, cooling and oil systems, exhaust gases, and heat accumulators.

During the operation of the power plant, two operating modes can be distinguished. The first is the PD operating mode at a rotation frequency of 0 - 800 min-1; the second is the ICE operating mode when the shaft rotation frequency reaches 800 min-1 and more. The operation of the automotive power plant in the first mode is advisable when driving in traffic jams typical of urban traffic; in underground parking lots; in places with increased fire hazard, etc.

It is possible to implement mode switching by using an electro-hydraulic valve drive, obtaining the ability to change the stroke rate. For a smooth transition from one mode to another, it is necessary to coordinate the power and torque curves, PM and ICE approximate curves of the two modes (Fig. 1).

Fig. 1 shows the regulation of the PM power due to the air pressure at the inlet from $P_{rep}$=0.7 MPa to $P_{rep}$=1.1 MPa. The higher the air pressure at the inlet, the higher the speed characteristic will be for the PM to switch to the internal combustion engine.

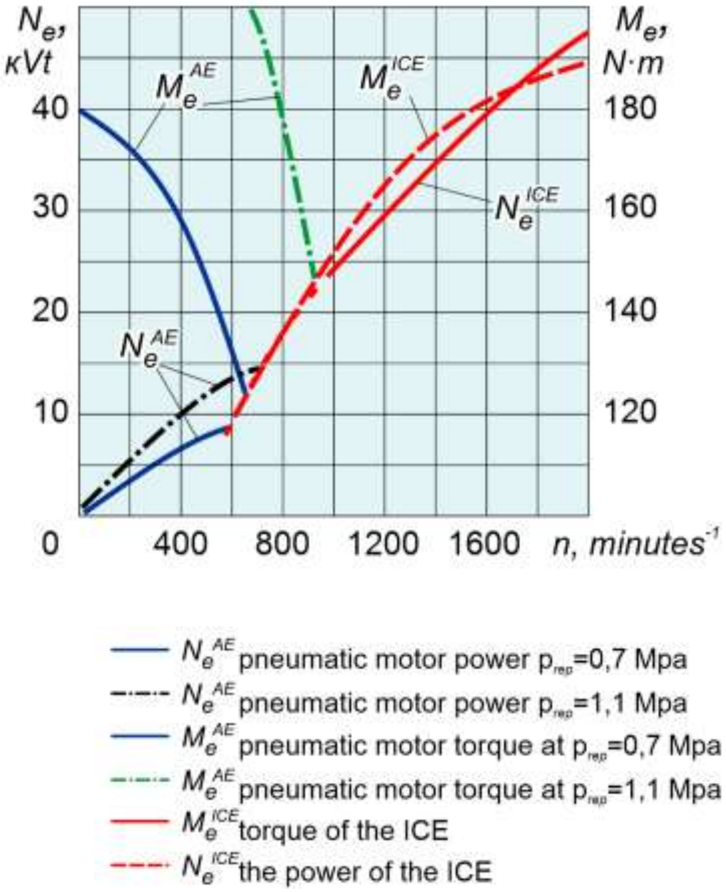

Figure 1 – Joint speed characteristic of a combined power plant with PM and ICE

Piston PM has several possibilities for regulating power and torque. The first method is regulation by the air pressure supplied to the cylinder, the second is by changing the duration of the filling process (from the moment of full expansion to the moment of full filling, (Fig. 2).

Regulation can be carried out by adjusting the reverse compression ratio and changing the polytropic indicators.

The results of the preliminary study are presented below.

Fig. 2-5 shows the results of calculated tests of the PM with different filling degrees and back pressure. With a change in the filling degree and the back compression degree at a crankshaft speed of 800 min-1 (up to the idling speed of the internal combustion engine), the indicator power Ni of the PM changes from 2.56 kW, 2.29 kW, 2.12 kW and 1.98 kW, and the torque of the PM – Micro from 30.53 Nm to 23.66 Nm.

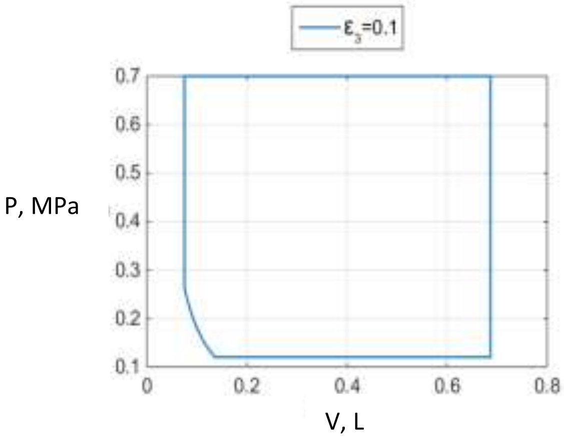

Figure 2 – AE indicator diagram at
$\varepsilon_1=1$ , $\varepsilon_3=0{,}1$

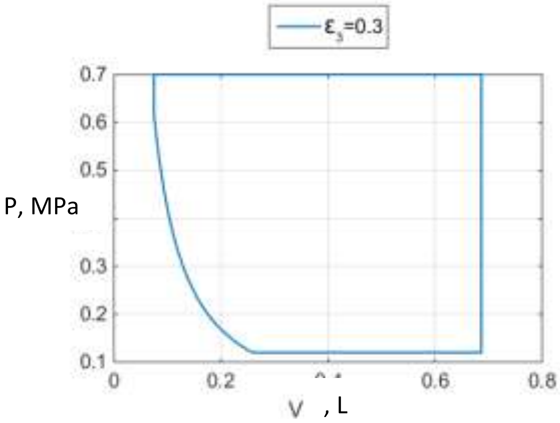

Figure 3 – AE indicator diagram at
$\varepsilon_1=1$, $\varepsilon_3=0{,}3$

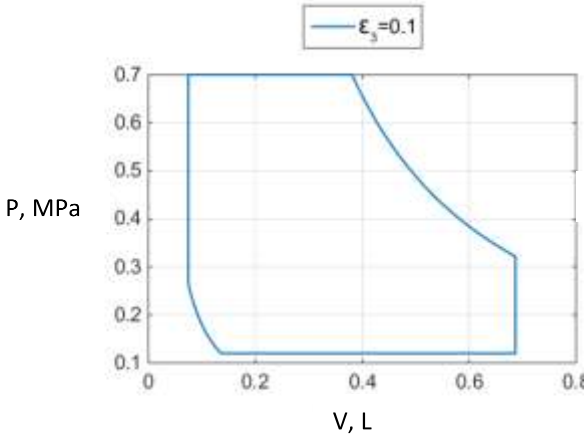

Figure 4 – AE indicator diagram at
$\varepsilon_1=0{,}5$, $\varepsilon_3=0{,}1$

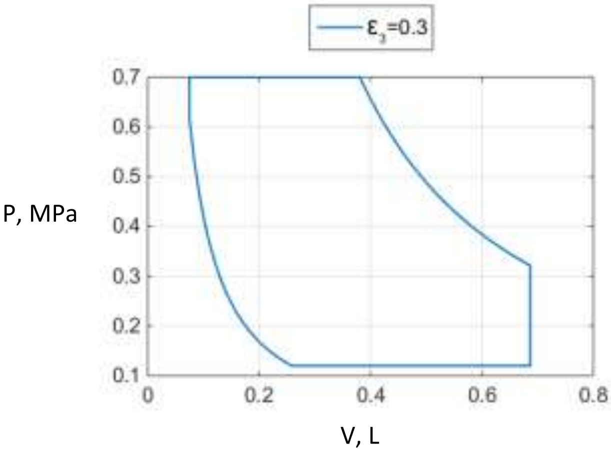

Figure 5– AE indicator diagram at
$\varepsilon_1=0{,}5$, $\varepsilon_3=0{,}3$

During the operation of the PM as part of a combined power plant without heating the compressed air, fuel consumption and toxicity of the exhaust gases are zero.

The reliability of the constructed models is confirmed by conducting a comparative analysis of calculated and experimental data, which were consistent with the results of studies by other authors.

**Conclusions**

The static model of the PM allows you to determine the values of the compressed air pressure at the inlet and the gas distribution phase for matching the power and torque curves when the KEU transitions between the PM and ICE operating modes. Graphical interpretation of the results showed that with an increase in the duration of the compressed air intake of more than 135 degrees. p.c.v., no change in power and torque is observed. To match the performance of the PM and ICE, it is necessary to use a reducer with smooth adjustment of the compressed air pressure and controlled electro-hydraulic valves to change the angle of onset and duration of the compressed air intake.

## Literature

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