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Estimation of Working Combined Power Plant Cycle Parameters and Indicators Applied to Function Modes Featuring Frequencies Corresponding to External Speed Characteristic

B. Sharoglazov*, O. Mashkov

South Ural State University, 76, Lenin Avenue, Chelyabinsk 454080, The Russian Federation

Abstract

The article is based on the thermodynamic equations of mechanics and ICE theory using step functions Heaviside, a system of equations describing the nature of changing parameters and indicators CPP cycle (piston ICE with turbo-supercharging), with respect to the working conditions of its at full load conditions (in particular, modes for no regulatory branches ESC). The choice of initial conditions for the calculation of parameters and indicators of the cycle at different speeds is based on the use of the statistical relationships that characterize the relationship of parameters corresponding to the CPP on specific frequencies ESC. It is shown that the proposed method of calculation allows performing a numerical estimate of the parameters and performance energy plant in terms of its use at full load as early as at the stage of pre-calculations. The examples of the ESC-performing CPP parameters assessment are presented.

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Keywords: Internal combustion engine; reciprocating engine; the outer velocity characteristic; a supercharger mode of operation; a compressor; a turbine working fluid; the working cycle status parameters.

1. Introduce

The creation of every power plant, including the establishment of power plant based massively widespread piston internal combustion engine, always precedes the calculated evaluation parameters and indicators of its work in the conditions of the planned use of this power plant [1-4]. That kind of problems can be solved already at the stage pre-project research and development with the use of appropriate methods and analytical models that allow a certain

* Corresponding author. Tel.: +7-902-897-4557;
E-mail address: G389@mail.ru

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degree of confidence reflect the real conditions of use of these machines. This fully applies to the CPP generated based on reciprocating internal combustion engines. [**Note:** Let us pay attention of the reader, that the term CCP authors of the article circulated at the PP , including of a piston diesel engine and supercharger, of the united in one unit through gas connections. And, depending on the context, ICE, PP and CPP used by the authors as synonyms].

Nomenclature

BDP	bottom dead point
CPP	combined power plant
deg. RC	degree rotation of the crankshaft
ESC	external speed characteristics
ICE	internal combustion engine
PP	power plant
TDP	top dead point

2. Development of the simulation unit external speed characteristics CPP

In the combined power plant, made on the basis of a piston ICE and a gas turbine supercharger, processes proceeding in the above the piston ICE and in the working cavity of the turbine and compressor, interdependent. This fact when designing (or more precisely: already at the design stage of preparation of the corresponding jobs) should take into account. And, if we speak about the steady CPP modes of operation with a full load on the branches without regulatory ESC (namely, this subject is devoted to offer our readers an article), then applied to each of the speeds following equalities are valid: $N_t = N_c$ and $G_t = G_e$ (if we neglect the working medium leakage through leakages). Differently words, for all rotation frequency of a sufficiently high degree of accuracy (and as often allowed) power turbine and compressor are nearly equal, and gas mass flow through the turbine is the mass flow rate through working medium engine. The above implies, see. [5-9]

$$\pi_c^{\frac{k_a-1}{k_a}} = 1+\beta\cdot\tau\cdot\left[1-\left(\frac{1}{\pi_t}\right)^{\frac{k_g-1}{k_g}}\right] \qquad (1)$$

in which $\pi_t = p_{e.m}/p_t$ – the degree of pressure reduction in the turbine; k_a – air adiabatic index; k_g – gas adiabatic index; β – parameter determined thermal properties working medium flowing through the turbine and the compressor. In particular:

$$\beta = \frac{k_g}{k_g-1}\cdot\frac{k_a-1}{k_a}\cdot\frac{R_g}{R_a}$$

τ – parameter characterizing the load on the engine:

$$\tau = \eta_s\cdot\left(1+\frac{1}{\alpha_m\cdot L_0^{\backslash}\cdot\varphi}\right)\cdot\frac{T_t}{T_0} \qquad (2)$$

$L_0^{\backslash}$ - theoretically required amount of air for the combustion of one kg fuel; φ – a purge factor; η_s – efficiency supercharger.

From recorded (1), (2), (3) that the parameters contained in them influence on character of the processes in the cylinder portion of the piston CPP. And at the same time ourselves (their numerical values) are a consequence of