STUDY ON THE ORWING REGIME OF THERMAL MOTORS OF AGRICULTURAL TRACTORS

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ABSTRACT

Motor vehicle rating parameters are expressed using features that are graphical representations of sizes that make it possible to compare with other similar engines and establish behavior in service. For motor vehicle dynamics, the engine speed or external characteristic speed characteristic is used, which represents the actual power variation curve and the actual moment depending on the engine speed or angular speed. At present, standards on engine testing methods vary from country to country, with regard to no. engine mounts during the tests, the volume of test work and the working conditions.

As a result, for one and the same engine, it is possible to obtain different speed and load characteristics, depending on the standard or the tests performed.

It has been found that the increase in the speed above the maximum allowable value, the engine power is considerably reduced due to the worsening of the filling of the cylinders with the fuel mixture and the mechanical losses in the motor. For these reasons and in order to avoid the high dynamic loads it is recommended that at maximum speed the displacement max. do not exceed the maximum power speed by 10 ... 20%.

INTRODUCTION

In addition to the characteristic values of actual power and maximum engine power indications, the maximum torque and the specific fuel consumption of the tractor engines are particularly relevant for the variations of these parameters depending on the operating mode and, in particular, the speed and load, variations that are appreciated by the proper engine characteristics (*Ioana Ionel, 2015*).

The curves of the total engine speed characteristic of an engine can be plotted using the following relations:

- for actual power:

$$P_{ex} = P_{emax} .* [a\frac{nx}{np} + b\left(\frac{nx}{np}\right)^2 - \left(\frac{nx}{np}\right)^3] \quad [Kw] \quad (1)$$

- for specific consumption:

$$C_{ex} = c_{ep} .* [c - d\frac{nx}{np} + k\left(\frac{nx}{np}\right)^2] \quad [g.Kw.h] \quad (2)$$

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where:

P emax, Pex represents momentary power;

pin, c ex - fuel consumption at maximum and nominal power;

nx / np ratio between momentum and maximum power;

A, b, c, d, k, coefficients depending on the type of engine

MATERIAL AND METHOD

For the study, a John Deere 4-cylinder engine equipped with agricultural tractors was used. The engine characteristics are shown in (table 1). The method used is presented in the literature (*Bobescu B., 1998; Năstăsoiu St.I., Sărăcin I., 2000; and 1999*).

Table 1

Engine features

Features	CELTIS 446
Number of cylinders	4
Type of injection	Mechanical [rotary pump]
Cylinders capacity [cm^3]	4530
Normal power according to ECE R24 [kw]	66
Speed at maximum power [rot / min]	2100
Specific consumption at maximum power F[g/KW.h]	229
Power mode at [rot / min]	540 la 2111 [rot/ min] engine
	1000 la 2118 [rot/min] engine

The operating mode of the engine is characterized by the effective power P e, which is the main parameter, which in turn depends on the motor torque Me and the crankshaft rotational speed ω or the speed n, expressed by:

$Pn=Mn_1 * \pi n/30$ [kw], (4)

where:

M e is expressed in N·m, n in min-1

During operation, both engine torque and crankshaft speed vary greatly due to the variation of the tractor's resistances and speeds. The minimum stroke is circumscribed by the stable engine operating conditions and the maximum of the gas change process qualities the thermal loading of the main parts, the increase of inertial forces, the increase of mechanical losses, as well as a number of factors defining the durability and reliability of the engine. (*Radu Chiriac, 2011; Liliana-Violeta Constantin, 2006*).

The operating conditions can be represented graphically by a limited area of a power variation curve; or engine torque on a type chart:

Me=f (n) , P e= f'(n). (5)

The engine's operating mode is characterized by the intersection of a power curve developed by the engine and a power curve needed to overcome the tractor's resistance. The operating conditions as a whole are highlighted by power and economy indicators, by thermal, mechanical and other stresses, which characterize the engine's operating regime.

There are three fundamental dimensions that influence the operating mode of an engine defined by:

- crankshaft speed;
- engine load;
- engine thermal regime.

The following categories of indicators are used to evaluate the engine's downturn:

- energy indices;
- economic indices;
- exploitation indexes, including functional ones.

Grouping of operating modes is done in several classes. Thus, the operating regimes in relation to the time variation of the sizes defining them, are divided into (*Sârbu l., 2011*):

- permanent regimes;
- non-permanent schemes.

The permanent regime, also called stationary or stabilized, is characterized by load, speed and thermal and mechanical stresses of constant values within narrow limits of variation due to regulation systems.

The non-permanent regime, referred to as transient or unstable, is characterized by the wide variation of the factors mentioned.

It ensures transition from one permanent regime to another, as well as the startup and shutdown operations of the engine.
Depending on the engine running time, it is distinguished:
- continuous operation regimes;
- intermittent operation modes.

The continuous mode of operation is that in which, at any speed, the engine continuously develops the highest effective power, the highest effective motor torque, the highest effective average pressure, provided that the technical and economic indicators Reliability to remain unaffected (*P ec, M ec and furnace*).
The intermittent mode of operation is that in which the effective power, actual engine torque and effective pressure are higher than Pc, M ec, and furnace for short intervals without seriously affecting the durability and dirtiness of the engine.
The maximum power, engine torque and average pressure values that the engine develops under intermittent operating modes are called intermittent blinking power, intermittent motor torque and intermittent mean pressure.
From all the variation processes of the parameters that characterize the engine's operating regime, while reducing the fuel flow per cycle, the low duration of the axle o has the variation in the rotational speed of the crankshaft (*Salvadore Mugurel Burciu, 2015*).
In general, the variation in the operating index of the thermal motors, such as power, engine torque, time and specific fuel consumption, can be studied and represented according to operating mode parameters such as speed, load, etc.
The characteristics that determine the power variation (Pe) and the specific consumption (ge) according to the fuel hourly (Gc), the excess air (λ) or the injection feed angle (θ inj) are the characteristics of engine setting.
The adjustment features can be traced for both total load (maximum injection) and partial loads. The raising of these features is necessary to determine the optimal operating conditions of the engine in relation to the above mentioned factors and the appreciation of the perfection of the engine settings.
For Diesel engines, the amount of fuel injected at a constant speed depends on the injection pump whose flow exceeds, in most cases, the maximum flow required.
Excess fuel injected may worsen the combustion process, causing the economy and efficiency of the engine to decrease.

RESULTS AND DISCUSSIONS

Studying the curve altitude (figure 1) it is observed that the maximum power is reached for degraded mixtures

$$(\lambda P_{max} = 1{,}05 - 1{,}1) \qquad (6)$$

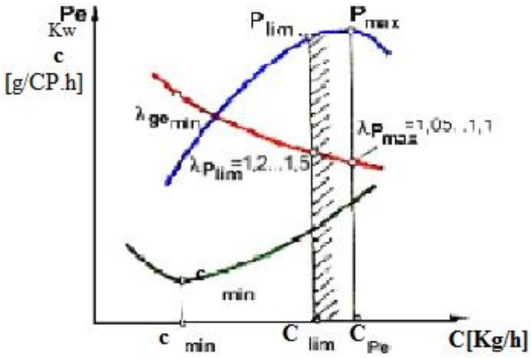

Figure 1- Adjustment feature depending on the composition of the mixture

The variation in fuel hour consumption is achieved by displacing the injection pump load gauge and keeping the speed constant by changing the load.

Increasing fuel hour consumption leads to enrichment of the mix, resulting in increased power. For optimum dosage, specific fuel consumption reaches the limit value. Then the specific fuel consumption increases, due to the worsening of combustion due to lack of air, the engine runs smoke, increases the temperature.

The maximum fuel flow of the pump pumps is adjusted so that the Climate Time Limit Consumption is not exceeded. This mode of operation is called the Maximum Limit Power Mode.

In the power regime, a more economical operation with lower thermal and mechanical stresses and acceptable ecological parameters is ensured.

In practice, the consumption characteristics are determined for different speeds, determining the optimal setting for each speed.

Since cmin is performed at values λ = 2 - 3.5 sometimes, in the case of Diesel engines, air valves are introduced which limit the suction air flows to lower partial loads.

Tractor engines during operation, for the most part, operate at partial loads when the power deliberately drops at a steady speed. The evaluation of the engine in such operating modes is done by economic efficiency, by raising the load characteristics, which determines the dependence of the Cc hour consumption and specifies the fuel charge of the motor at a constant speed (figure 2).

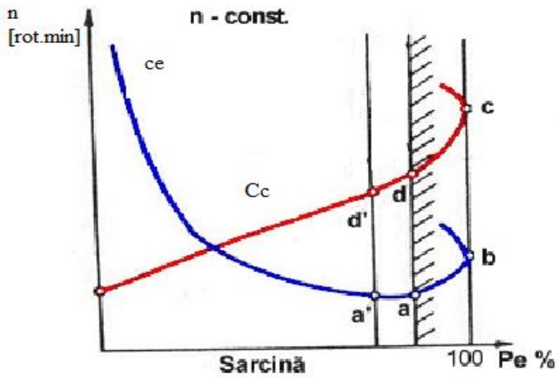

Figure 2 - The MAC load characteristic

The speed characteristic features energy ratios and de-economics of the engine according to the speed. The speed characteristic represents the variation of the effective power P e, the engine torque M e, the time consumption Cc and the specific fuel depending on the engine speed n, at constant load.

The speed characteristic (figure 3) is the speed variation curves of the known parameters and corrected parameters (actual power and lobe torque - dotted curves).

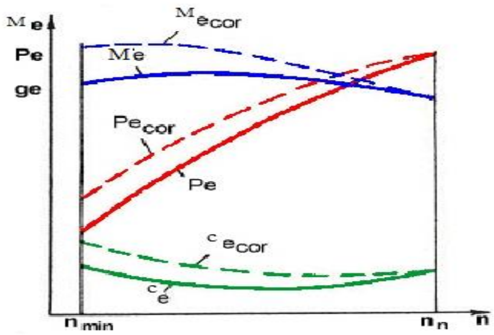

Figure 3 - Correcting the speed characteristic

It is noted that the torque reduction which equals the decrease of the torque is obtained due to the rising speed. The maximum idling speed depends on the destination of the engine and varies within the limits

n_{mq}= (1,06 ... 1,1)n_n.   (7)

The characteristic curves extend over the entire speed range, regardless of speed, and are approximately parallel. This is explained by the fact that the filling degree of the cylinder remains virtually invariable depending on the constant bending load.

Estimating the dynamic performance of an internal combustion engine can be done by analyzing the torque and power characteristics. These characteristics represent the variation of torque and power depending on engine speed. If we are only interested in dynamic performances and less in consumption, we have the characteristics of torque and power at full load (figure 4).

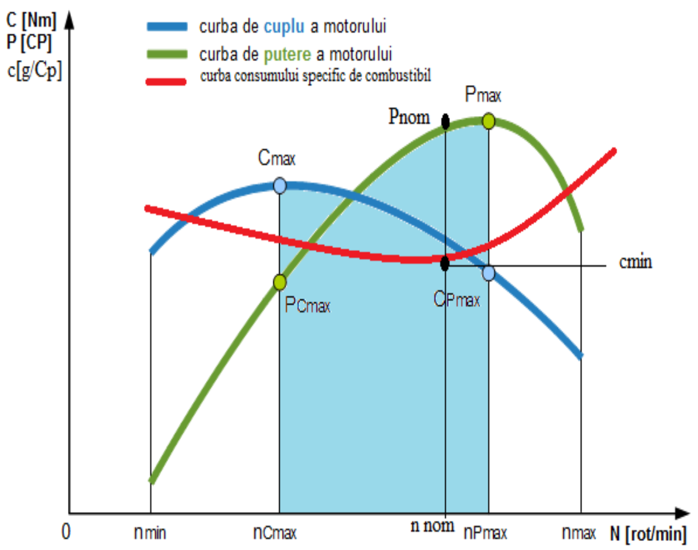

Figure 4 - The torque and power characteristic of a thermal engine

The interdependence of several engine functional parameters, generally including the variations of a functional parameter, (engine torque) depending on a mode parameter (speed) over which the isometric curves of interdependent sizes (specific fuel consumption) overlap represented by the complex features.

Since the minimum specific fuel consumption is achieved at a single speed and torque regime, the complex feature gives a representative point of economic significance.

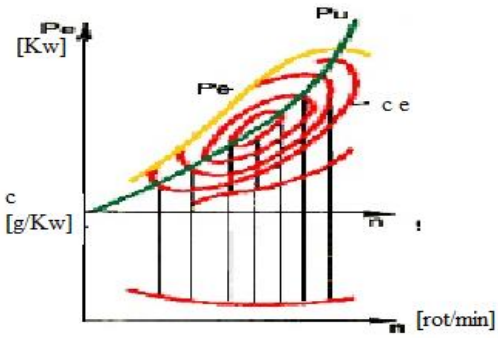

Figure 5 - Complex torque characteristics and specific consumption depending on the speed

The closest approximation of the economic pole of this complex characteristic of the power curve or their superposition (figure 5) and the arrangement of the respective pole at the average speed, most frequently used in operation, increase the engine's economy.

CONCLUSIONS

There are three fundamental dimensions that influence the operating mode of an engine defined by: crankshaft speed; engine load; engine thermal regime.

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