

THE COMBUSTION OSCILLOGRAMS OF WATHER-HEAVY FUEL OIL EMULSION DROPLET

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Abstract: The vaporization and combustion characteristics of a marine heavy oil-water emulsion droplet are investigated with graphological method. The combustion graphology of fuel oils is defined as a new technical and scientific field which deals with the graphic transposition of the processes of fuels combustion development in a simulator. Thus, it is easy to establish the ignition-combustion characteristics, including the laws that govern their changes depending on the combustion conditions and fuel specifications.

Keywords: marine oil-water emulsion, vaporization, combustion, graphological method.

INTRODUCTION

The combustion graphology of fuel oils is defined as a new technical and scientific field which deals with the graphic transposition of the processes of fuels combustion development in a simulator [1]. Thus, it is easy to establish the ignition-combustion characteristics, including the laws that govern their changes depending on the combustion conditions and fuel specifications. The graphic representation of the combustion processes development for a droplet of liquid fuel used in the industrial combustion may be made by means of the so-called "combustion oscillogram" (fig. 1).

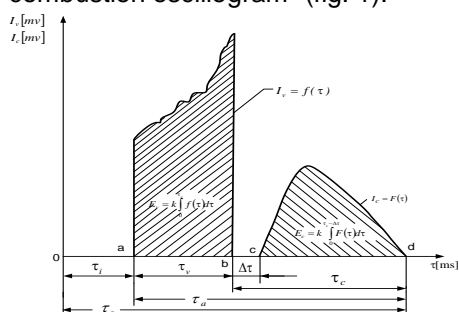


Fig. 1. Graphic representation of the combustion processes development for a heavy oil droplet.

This graph specifies the time variation t of the light-thermal energy radiation intensity I , for a burning droplet, transformed into electric signals by means of an optical-electronically system, equipped with a photoelectrical cell [2] [5]. Thus for a marine heavy fuel oil this ignition and combustion graph establishes, in standard conditions the self-ignition delay τ_i , the volatile matters combustion time τ_v , the cenosphere combustion time τ_c , the maximum radiation intensity obtained at the combustion of the cenosphere I_c^m , the maximum radiation intensity obtained at the combustion of the volatile matter I_v^m , the energy radiated by the burning cenosphere transformed by the photocell into electric energy E_c , etc. The need for increasing the degree of marine fuel combustion with and without researches, through which I can mention that of applying the water emulsion to the atomized fuel combustion. This paper deals with finding new methods and means for improving the combustion processes of

marine liquid fuel. It tries to make evident the effects of water emulsion on the marine liquid fuel during combustion. The assessment of emulsification influence was made by comparing the combustion performance and the results with those obtained in the absence of emulsification under the same test conditions [3]. The laboratory researches developed on the isolated droplet burning had in view to state the measure in which the emulsification would interfere for carrying on the secondary atomization [4]. We also tried to determine the characteristics of induced flames following their configuration and radiation, and to assess the igniting and burning behavior of droplets by laying down comparison criteria of the following times: τ_i - self-igniting delay time; τ_v - burning time of volatile matters old; τ_c - burning time of cenosphere; τ_a - burning time of droplet, E_v -energia radiată de materiile volatile (I_v -intensitatea de radiație a volatilelor), E_c -energia radiată prin arderea cenosferei (I_c -intensitatea de radiație a cenosferei).

THE WATER/HEAVY FUEL EMULSIONS COMBUSTION OSCILOGRAMS

I have made the combustion oscillograms for marine heavy fuel RMF25 with its characteristics mentioned in table 1, at which the water emulsification included four determination tests for water – marine fuel emulsion in proportions of 5%, 10%, 15% and 20%. At the combustion of water – marine fuel emulsion with a water percent of 40%, the combustion becomes unstable.

In figures 2 and 3, there are synthetically presented the experimental results. Each point marked in diagrams represents the arithmetic mean of six determination tests.

FEATURE	RMF 25
Volumetric mass at 15[C], [kg/m ³], max	991,0
Kinematic viscosity at 100°C, [mm ² /s] max	25,0
Ignition point [C], min	60
Flow point in [C] - winter, max	30

-summer, max	30
Coked residue, [%g/g], max	20
Ash, % [g/g], max	0,15
Water, % [v/v], max	1,0
Sulphur, % [g/g], max	5,0
Vanadium, [mg/kg], max	500
Aluminium plus silicon, [mg/kg], max	80
Existing total sediment, % [g/g], max	0,10

Tab. 1. The characteristics of marine heavy fuel RMF25.

Based on the data obtained it results that by emulsifying the RMF25 fuel with water from 0 to 20%, we obtain:

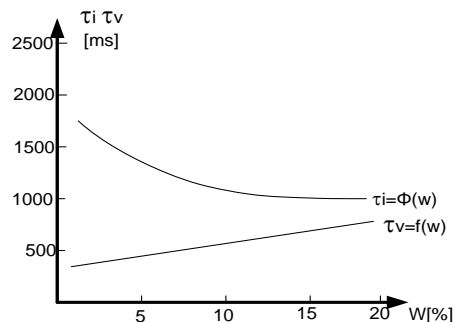


Fig. 2. The influence of water content in water – RMF25 marine heavy fuel emulsion on the quantities τ_i and τ_v .

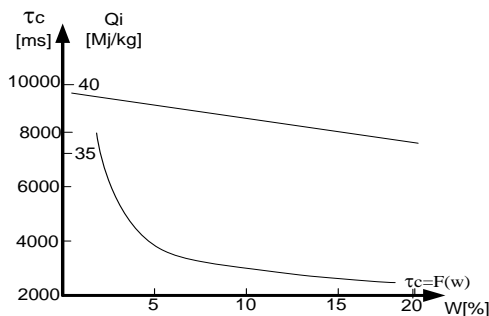


Fig. 3. The influence of water content in water RMF25 marine heavy fuel emulsion on the quantities Q_i and τ_c .

- the increase of self – ignition delay τ_i from 525[ms] to 1170[ms];
- the decrease of lower heating power Q_i ;
- the maximum temperature variation T_f during the ignition processes;
- from the rate of curves $\tau_v = f(w)$ and $\tau_c = F(w)$ it results that in the emulsifying range 0 – 10[%] water the fastest decrease of times τ_v and τ_c appears; so it is recommended an average emulsifying value of 5 – 8[%];

- as the substitution of a fuel part for water reduces the combustion temperature once the vaporization of emulsified water needs an additional energy consumption, it is recommended that we should have an average value.

The decrease velocities of times τ_v and τ_c , respectively, that is the ratios $d\tau_v / dw$ and $d\tau_c / dw$ depend on the characteristic of emulsifying system used, namely, the smaller diameter of water drops in the resulted emulsion and more homogeneous distributed, the more sudden the decrease of times; as a result, for the same effect of reducing the nitrogen oxide generation, it will be necessary a smaller percentage of water for emulsification. For a systematical differentiation of fuels, from the three points of interest, namely, of ignition, of combustion and of luminous drop energy, the following specific indices and global quality indices of combustion have been defined:

- the expression of combustion quality S_a (its value is reduced according to the damage of fuel quality)

$$S_a = \frac{\tau_c}{\tau_v} \quad (1)$$

To state the weight of ignition process to the combustion processes of volatile matters and cenosphere, the ignition ratio ψ has been defined, increasing with the rise of τ_i value:

$$\Psi = \frac{\tau_i}{\tau_i + \tau_v + \tau_c} \quad (2)$$

The weight of the energy radiated by burning the volatile matters E_v to the total energy $E_v + E_c$ has been stated by the radiation index (ratio) B , of which the value decreases with the damage of fuel quality:

$$B = \frac{E_v}{E_v + E_c} \quad (3)$$

The global combustion quality index $G = f(A,0)$ decreases by damaging the composition of heavy liquid fuels:

$$G = C \frac{\tau_v}{\tau_i + \tau_c} \quad (4)$$

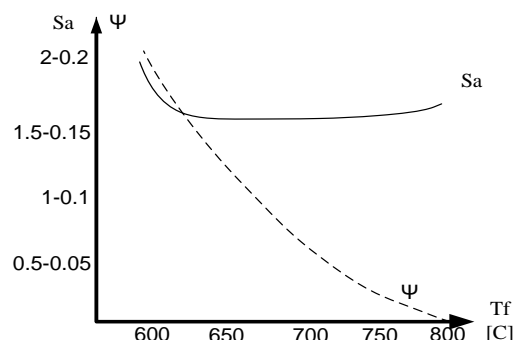


Fig.4. The variation according to the temperature of combustion simplex S_a and ignition ratio ψ .

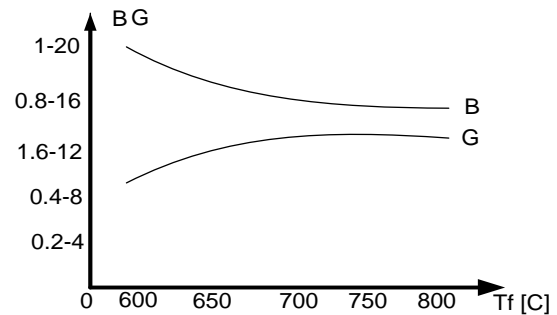


Fig. 5. Variation of B and G indices depending on the temperature T_f .

CONCLUSIONS

The test results presented lead to the following conclusions: the increase of S_a value together with the increase of cenosphere content of fuel; the decrease of ignition index ψ by increasing the temperature T_f ; the ignition index (ratio), ψ , increases with the rise of T_i value; the decrease of radiation index, B, by damaging the content in cenosphere of fuel. The introduction of water into the combustion chamber reduces the combustion temperature due to the absorption of energy for vaporization. Humidification can reduce the NO_x emissions.

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