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COMBUSTION GRAPHOLOGY USED TO IMPROVE EMULSIONS OF WATER-IN-HEAVY FUEL OIL

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Abstract: *This work is trying to establish new criterions for improving the emulsions of water-in-heavy fuel oil by using the combustion graphology for testing the burning of droplets of th above mentioned emulsions.*
Keywords*: emulsions of water-in-heavy fuel oil, combustion, graphology.*

1. INTRODUCTION

Oxides of nitrogen (NO_x) emissions from ship engines are significant on a global level. NO_x emissions participate in the formation of photochemical smog and acid rain. Marine sourced emissions have significant impact on air quality on land. The challenge is to control NO_x emissions without increasing fuel consumption and smoke. Most engine manufacturers can meet the current IMO limits by engine tuning measures. Exists much interest on the potential of utilizing oil/water emulsion in liquid-fueled combustors for pollutant reduction and enhanced fuel economy.

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.

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).

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-electronical system, equipped with a photoelectrical cell.

Thus, for a heavy fuel oil. this ignition and combustion graph establishes, in standard conditions: the self-ignition delay τi, the volatile matters combustion time τ_v, the cenosphere combustion time τ_c^m, 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 Ec, etc.

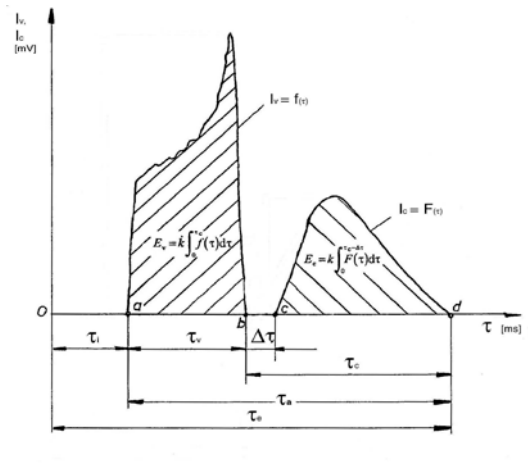

Fig. 1. The combustion oscillogram for a heavy fuel oil (RMD 15).

The standard conditions of the combustion test are mainly specified by:

- the geometry of the combustion chamber;
- the temperature and pressure inside the combustion chamber; the temperature of the emulsion water-in-heavy fuel oil;
- the system of supporting and inserting the droplet inside the combustion chamber;
- the air flow conditions around the droplet, mainly characterized by the value of the Reynolds number;
- the mean initial diameter of the combusted droplet.

By using an automatic processing of the results of the combustion tests on a droplet and a following storage of the data on an adequate computer, it is possible to give a quantitative shape to the evolution of the combustion processes in diverse conditions

The application of the combustion graphology -for improving the emulsions of water-in-heavy fuel oil which are produced by an industrial installation is a necessity, since in this manner the characteristics to determine the optimum may rapidly and accurately be obtained by using a computer.

The combustion of the water(3-6%)-in-heavy fuel oil emulsions which secures a complete secondary atomization, besides obtaining a dramatic drop in the pollution of the environment, also determines an increase of the thermal efficiency of boilers and a decrease of their maintenance costs.

The advantages to be obtained by using the early mentioned emulsions in the combustion processes depend on the quality of the emulsion, the water becoming a drag when only a non-homogeneous water-heavy fuel oil mixture is used.

2. THE EXPERIMENTS

The experiments established that when burning droplets of water-in-heavy fuel oil emulsions, two distinct situations may appear, comparing to the combustion of non-emulsified heavy fuel oils:

- the situation in which the values of τ_c, Ec. and I_c^m drop sensitively due to a more rapid combustion of the chemosphere, the effects of secondary atomization being partially confirmed.

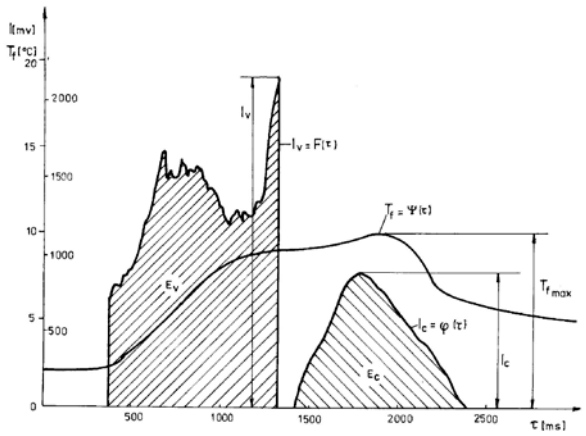

Fig. 2. The combustion of the water(4 %)-in-heavy fuel oil emulsions (RMD 15).

- the optimal situation in which a complete secondary atomizations produced, the wholedroplet exploding, following thecombustion of the volatile matter,

thus τ_c, Ec. and I_c^m I are zero.

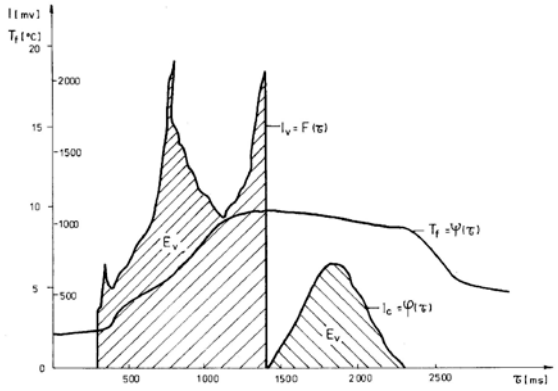

Fig. 3. The combustion of the water(8 %)-in-heavy fuel oil emulsions (RMD 15).

Fig 4. The effects of secondary atomization to the combustion of the water(12 %)-in-heavy fuel oil emulsions (RMD 15).\

To reach the first or the second situation depends on:

- the conditions in which the situation was obtained (the emulsifying installation type and its functioning rate), and the quality of the emulsion, respectively;
- the potential of a particular heavy fuel oil to be emulsified;
- the thermal conditions inside the furnace where the combustionof the droplets takes place, determining the heating rate, theignition and finally the combustion.

In both cases the maximum radiation intensity I_{vm} increases sensitively due to the increase in the flame emission coefficient. The abrupt increase of the temperature Tt is characteristic to the combustion of high quality emulsions.

3. CONCLUSIONS

The graphological characteristics τ_c ,Ec, and I_c^m and the appearance of the curve $T_f = \phi_{(t)}$ which are obtained from the combustion oscillogram constitute a criteria for establishing the quality emulsions water-in-heavy fuel oil.

The results obtained in industrial applications confirm the validity of these conclusions and the proposed testing method.

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