INTENSIFICATION OF HEAT EXCHANGE AT BURNING IN AN ELECTRIC FIELD

SAJIN TUDOR[1*]

[1] *"Vasile Alecsandri" University of Bacău, Calea Mărăşeşti 156, Bacău, 600115, Romania*

Abstract: The enhancement and the possibilities for control of heat transfer at combustion in electric field are considered. The influence of electrical potential on heating rate is measured.

Key words: combustion, flame, burner, heating of parts and semi-products, electric field, heat exchange, electrical charge, polarity, applied potential.

1. INTRODUCTION

The electric aspect of the combustion process was observed still in 1600, when V. Gilbert, doctor to Queen Elizabeth I, has demonstrated the discharge of the electroscope by flame, this phenomenon retaining the attention of J. Thompson. The modern vision of the flame interaction with the electric field have been developed in recent years, in connection with the interesting of practical applications, such as: direct conversion of energy of mooving combustion products into electrical energy; control of the combustion process in an external electric field; sedimentation of soot from flame; interaction of radio waves with the flames of cosmic missile; use of the ionizing sensors in the study of the detonation and at the identification of the flame [1-3].
Among the first researchers who have estimated the practical importance of the effects arising from the application of the electric field on the flame was Brand [1]. In a system of two parallel electrodes was noted that the negative electrode warming is more than positive. Later was published a number of papers, in which has been studied the fine structure of flame in the presence of the electric field (the concentration and the mobility of the charged particles) as well as the general problems characteristic of the phenomena of variation of the flame shape, of the stabilization of the combustion, of the ignition and of the convection of heat from the flame.
However, the detailed mechanism of these processes has not yet been established, although many phenomena that have been studied only qualitatively were applied in practice.

2. HEATING RATE OF A METALLIC PLATE AT BURNING IN AN ELECTRIC FIELD

At applying of an external electric field on the flame, under the action of ionic wind, the flame adheres on the first to the surface of the heat adsorption. In a result the warming speed of the surface increases.
Some of the schemes of the electric field application on the flame and its effect on the combustion process are shown in [1]. The simplest method of the applying of electric field must be considered those, at achieving of which the charge with a high voltage and with the required polarity is applied to the burner (injector) directly or on the flame base with a further electrode and the surface of heat exchange is connected to ground. To test for verifying of pilot plant, as well as in a series of experiments carried out by Stepanov [1], were measured heating speed of two metal plates 60x150x3 mm size each, in which were encapsulated the alumel-cromel thermocouples. The plates were placed above the burner and vertically oriented parallel to the direction of flame

* Corresponding author e-mail: sajin_tudor@yahoo.com

propagation. One of the plates was connected with the earth, another was isolated. On the burner was applied the pozitiv potential.

The characteristic graphics of heating rate of plates arranged according to their height above the burner are shown in Figure 1.

3. DISCUSSIONS AND CONCLUSIONS

The analysis results and their confrontation with Stepanov's data were confirmed the conclusions in [1], which are summarized as follows:

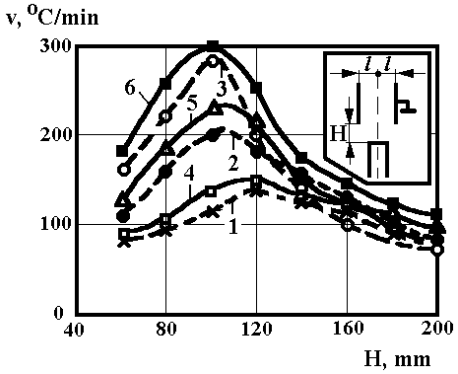

Fig. 1. Variation of the heating rate of the plate (v) in dependence of height (H) of placing them above the burner and of size of the applied potential (U): 1,2,3 (flashing curves) - experimental results [1] (U, kV: 1-0; 2-21; 3-33; gas flow 0.72 m^3/h); 4,5,6 (continuous curves) - results of this studies (U, kV: 4-0; 2-23; 3-32; gas flow 0.76 m^3/h)

- By increasing the intensity of the electric field the maximum heating speed is moving to the the outlet nozzle of the burner;
- The heating rate of the plate at applying of a longitudinal electric field increases only in the area where the fuel molecules are present that have not yet reacted in the chemical reaction; the effectiveness of the applying the electric field, estimated by the ratio of maximum heating rates in the presence and in the absence of the field, was on average 200% in all regimes;
- Increasing the heating speed occurs in conditions of reducing the field strength (in the case of the constant value of the potential is changing the distance);
- The most interesting result is the intersection of the graph of variation v (H) in an electric field with the graph v (H) in the absence of the field; in the zone of the combustion products, in which the fuel molecules are absent, the convection of heat from the flame in the longitudinal electric field is lower than in the absence of the field;
- By increasing the flow of fuel gas the heating rate increases as in the case of increasing the field strength.

Heating rates of metallic plates have the values greater than the results [1], what can be explained by the greater gas flow and sometimes by the greater potential applied to the burner. In view of this fact and qualitatively identical nature of the curves v (H, U), we can say that the experimental installation maintained the verification test and that it can be used for the experimental study of heat exchange at burning in an electric field.
This study has practical importance in various fields, for example, in metallurgy for heating of parts and semi-products.

REFERENCES

[1] Stepanov, E. M., Diachkov, B. G. Ionization in the flame and in an electric field, Moscow, 1968, 311 p. [In Russian].
[2] Lawton I., Weinberg F.I. (1969), Electrical aspects of combustion, Clarendon Press, Oxford, 294 p.
[3] Diachkov, B. G., Polonskii, I. Ia., Salimov, M. A., Fedorov, N. A. Intensification of flame proceses by electric discharge, Moscow, 1976, 200 p. [In Russian].