SYSTEM WITH SPECIAL GEOMETRY USED FOR MAGNETOSTATIC TREATMENT OF FUEL FLUIDS BEFORE BURNER

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Pe plan mondial se face puternic simțită aparitia unor arzătoare perfecționate cu producție redusă de noxe, existănd o preocupare majoră de informare şi corelare a cercetărilor europene in cadrul unor programe internationale la care a aderat şi Romania, prin care se doreşte implementarea acestor sisteme moderne de producere a energiei electrice şi termice cu un grad ridicat de eficiență şi în condiții de maximă protecție a mediului. In concordanta cu aceste cerinte si reglementari de la nivel mondial, colectivul nostru a proiectat si realizat un echipament pentru stimularea magnetostatica a fluidelor combustibile utilizat pentru imbunatatirea performantelor arzatoarelor, usor de montat si intretinut, care nu foloseste o sursa auxiliara de energie.

Worldwide it is strongly felt the appearance of some improved burners with low emissions, and there is a major concern of informing and linking the European research during international programs, at which Romania takes part, through which it is wanted the implementation of these modern systems of producing electrical and thermal energy, with a high efficiency level and in terms of maximum environmental protection. In accordance with these worldwide requirements and regulations, our team has designed and built a device for magnetostatic stimulation of combustible fluids, downstream the burner, used for improving the performance of the traditional burners, which does not use an auxiliary source of energy.

Keywords: Magnetic stimulation, Paramagnetic, Fuel fluids, Flow rate.

1. Introduction

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By applying certain successions and alternations of the gradients of the magnetic fields to the fuel fluid it appears an intensification of the process of change in the stereochemistry of molecules producing brakes which leads at the increase of the characteristic magnetic moment and at a stronger ionization, with beneficial effects on the burning process of combustion and reducing the noxes.

The processes developed can be explained by reducing energy between ions C-C and C-H due to the action of the magnetic field making hydrocarbon groups to polarize and simultaneously to reject, dispersing it into fine particles (Fig. 1).

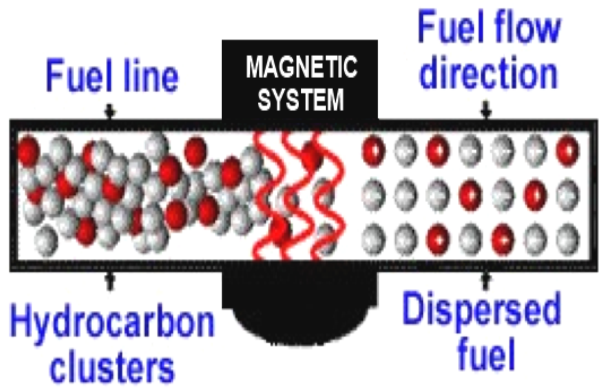

Fig. 1. Schematic

These changes lead to the increase of the affinity of these fuel molecules from other molecules and ions in close proximity, so implicit as opposed to the oxygen in the air, which is highly paramagnetic and which ensures the burning process of the combustion, facilitating the oxidation of the carbon which is placed in the center of the methane molecule and which is difficult to access, obtaining a decrease of the amount of CO.

In the elaboration of the theory to improve combustion dynamics by treatment in magnetic field, a special importance has the oxidation reaction of the hydrogen. The gas hydrogen (at a diatomic molecule) is extremely flammable and inflames itself in air at volumetric concentrations between 4% and 75% and in contact with pure oxygen between 4.65% and 93.9%. The limits between which detonation occurs are between 18.2% and 58.9% in air and between 15% and 90 in oxygen.

The hydrogen atom has one positive charge (proton) and one negative charge (electron), possessing a dipole moment, and it can be either diamagnetic or paramagnetic (weaker or stronger response to the magnetic flux) depending on the relative orientation of its nucleus spins. Hence, the hydrogen molecule has two distinct isomeric forms - para and ortho, characterized by the different opposite nucleus spins. In para H2 molecule, which occupies the even rotation levels (quantum number), the spin state of one atom relative to another is in the opposite direction rendering it diamagnetic. In the ortho molecule, which occupies the odd rotational levels, the spins are parallel with the same orientation for the two atoms, and therefore is paramagnetic and a catalyst for many reactions.

At standard temperature and pressure, hydrogen gas contains about 25% of the para form and 75% of the ortho form, also known as the “normal form”. The equilibrium ratio of ortho-hydrogen to para-hydrogen depends on temperature, but because the ortho form is an “excited state” and has a higher energy than the para form, it is unstable and cannot be purified. At very low temperatures, the equilibrium state is composed almost exclusively of the para form.

The orientation of spin moment has a pronounced effect on physical properties (specific heat, pressure, vapours) as well on the behaviour of gas molecule. Parallel spin moments give the orthohidrogen molecule a strong instability, so a pronounced reactivity to oxygen molecule.

Research has shown that para-hydrogen can be converted in orto-hydrogen, through resonance or magnetic stimulation (change the direction of the spins magnetic moment of hydrogen atoms). Through these processes the energy of the atom, and thus the overall reactivity of the fuel increase greatly, increasing combustion efficiency.

2. Magnetic modular system design

A series of results of the experimental research can be found in specialized literature, and they put down the good effects of the magnetic field on the increase of the heating production and on the reduction of the fumes that are released when treated fuels are burned. In these works there are proposed some systems for treating the fuel fluids in a magnetic field [8], systems which use magnets set radial or along the pipeline that creates an uniform magnetic fields or other magnetic devices have the magnets set apart at angles of 120 degrees or 180 degrees in the radial section of the fluid pipeline. These magnetic fields have a series of disadvantages because they don’t treat the entire fuel mass, keep a circular flow of these in the area of the magnetic treatment device and some systems need electrical energy to work.

The designed system which generates the magnetic field used to handle fluid fuels must match all the influential physical factors in order to achieve the envisioned effect by:

- gaining a relative positioning of the magnetic field as favorable as possible in relation to the fluid’s stream line;

- certain alternating successions of the magnetic polarities from the field considered;

- correlating optimum values of the magnetic field's intensity with certain values of the magnetic field gradient and with the stream speed of the fluid in a magnetic field;

- transforming the turbulent stream of the fluid fuel into a laminar stream in the action area of the magnetic field, achieved by changing the shape of the pipe.

Taking into account these observations, our team has designed and built a magnetic system which is distinguished by the fact that the magnets are set so as to produce some magnetic field screens with alternate directions, while the fluid fuel has a laminar stream in the magnetic device area due to the flattened shape of the pipe. As well as this, it must be pointed out that the entire system is to be set upstream in relation to the burner.

To obtain uniform magnetic fields curtains effective to treat natural gas, we have opted for permanent magnets (not to having an additional energy consumption) making an analysis of the main groups of materials used to make permanent magnets (Table 1).

Table 1

Tip magnet	Br (KGs)	BH_C (KOe)	JH_c (KOe)	$(BH)_{max}$	T_c (^0C)	$\alpha_{(B)}$ ($\%/^0C$)	$\alpha_{(jHc)}$ ($\%/^0C$)	T_{max} (^0C)
Nd FeB	12.5	10.5	12.5	>35	310	-0.11	-0.6	<80
Va Codim 383/410	11.9	11	<22	32	310	-0.105	-0.55	<150
AlNiCo4 4/5	12.5	0.6	0.625	5.5	800	-0.02	-0.03	500
AlNiCo 50/6	13	0.655	0.680	6.3	800	-0.02	-0.003	500
Ferita Ba	3.8	2.2	2.8	3	450	-0.2	+0.4	250

To optimize the equipment we tested two types of permanent magnets with the following characteristics given by the manufacturer: NdFeB N48 (dimensions 50x50x25mm; Br=1380-1420mT; Br=13.8-14.2 KGs; Hcb≥923KA/m; Hcb ≥ 11.6Koe; BH_{max}=366-390kj/m^3; BH_{max}=46-49MGOe, T_{max}= 80 C) or NdFeB N50 (dimensions 50x50x25mm; Br=14.0-14.5KGs; Hcb≥10.0 KOe; BH_{max}=382-406KJ/m^3 BH_{max}=48-5MGOe, T_{max}=160).

Because the system is positioned very close to the burner, in the choice of permanent magnets one important characteristic was the variation of magnetic flux with temperature. For a variation of temperature in the range 10-80 °C was find an acceptable variation very small magnetic induction of 40 mT (Fig. 2). After the tests carried, but also from the economic judgments we chose the use NdFeB type magnets which have a optimal behavior in the working for the system projected.

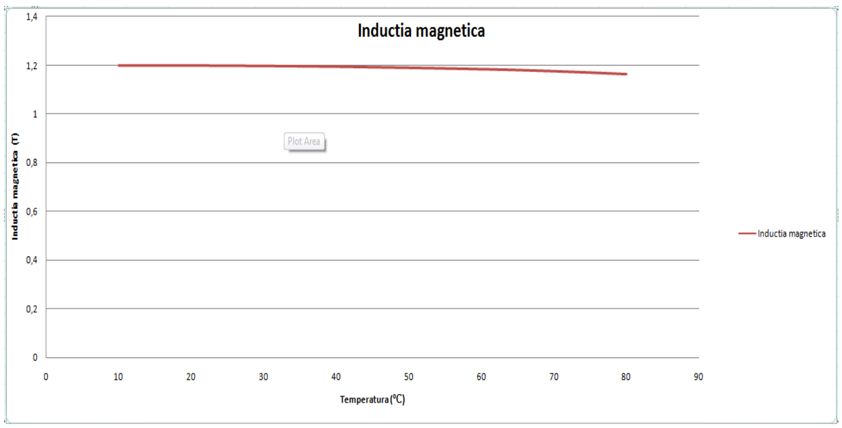

Fig. 2. Graphic dependence

For the polar parts needed to shape the magnetic field feeds, we did not chose materials with pemendur (Bsat=23.5 KGs) which is very expensive (30$/Kg), we selected cheaper materials, the drop in the magnetic saturation was compensated by an intelligent technical solution in the conception of the magnetic circuits.

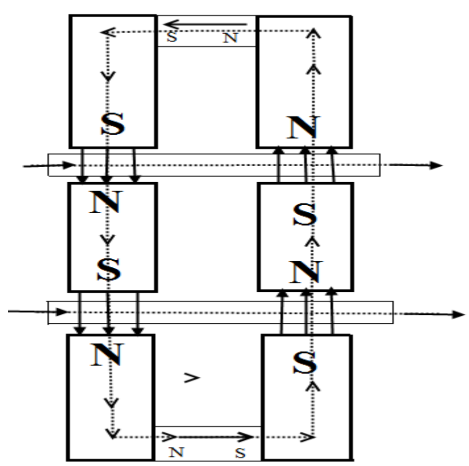

Fig. 3. Magnets.

For the designed magnetic circuit is calculated the magnetic flux in air gap along the middle field line (Fig. 3) and it can be write the relationship [1]:

$$\int_{\Gamma} \overline{H} \cdot \overline{\mathrm{d}s} = \int_{C_{Fe}} \overline{H} \cdot \overline{\mathrm{d}s} + \int_{C_{\delta}} \overline{H} \cdot \overline{\mathrm{d}s} = H_{Fe} \cdot l_{Fe} + 2H_{\delta} \cdot \delta = 0 \qquad (1)$$

where C_{Fe} is the curve corresponding to field line from the feromagnetic core, and C_{δ} is the curve corresponding to field line from the air gap.

Applying the law of the magnetic flux on a closed surface Σ crossing ferromagnetic core on the one hand, and the air gap on the other hand, we can write the relationship:

$$\Phi_{\mathrm{Fe}} = \Phi_{\delta}$$

or

$$B_{Fe} A_{Fe} = B_{\delta} A_{\delta} = \mu_o H_{\delta} A_{\delta} \qquad (2)$$

From the system of equations corresponding relations (1) and (2) results the relation between magnetic flux density and magnetic field intensity in the ferromagnetic core.

$$H_{\mathrm{Fe}} \cdot l_{\mathrm{Fe}} + 2 \cdot H_{\delta} \cdot \delta = 0 \qquad (3)$$

$$B_{\delta} A_{\delta} = \mu_o H_{\delta} A_{\delta} \qquad (4)$$

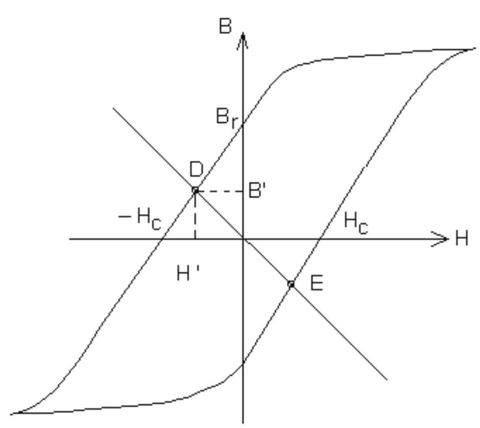

Fig. 4. Hysterezis curve

$$B_{\mathrm{Fe}} = \frac{\mu_0 \cdot A_\delta}{A_{\mathrm{Fe}}} \cdot \left(-\frac{H_{\mathrm{Fe}} \cdot l_{\mathrm{Fe}}}{2 \cdot \delta} \right) \quad (5)$$

$$B_{\mathrm{Fe}} = -\mu_0 \cdot \frac{A_\delta}{A_{Fe}} \cdot \frac{l_{\mathrm{Fe}}}{2\delta} \cdot H_{\mathrm{Fe}} \quad (6)$$

Given known values of the air gap's volume and of the air gap induction necessary to achieve the desired effect, the volume of the permanent magnetic matter is to be minimum provided that the B'•H' product is maximum (Fig. 4). The maximum product B'•H' constitutes the quality coefficient of the magnet, ant the D working point of the magnet is to be as close as possible to the point P that stands for the quality coefficient of the magnet [2; 3].

After computer simulation we have chosen a smart solution for disposing the problems concerning the nature of flow which largely depended on properties which characterized the treated fuel fluid by modifying the section from circular in an aplatisate elliptical shape (Fig. 5) realized by hot plastic deformation (the material was melted through a thermal treatment of annealing, tempering and partial recrystallization at a temperature of 350 degrees/10-15minutes) [4].

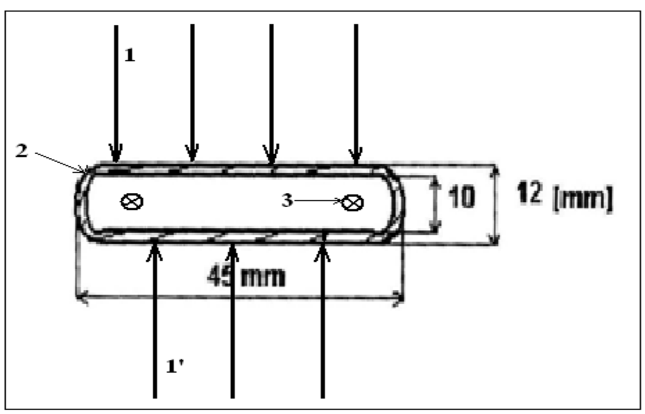

Fig. 5. 1,1' - alternative magnetic field lines; 2 - pipeline; 3 - direction of flow of fuel fluid.

This type of pipeline ensures a homogeneous and optimal magnetic treatment of the fluid, which at a molecular level provides a more facile break in the intermolecular cross-links as well as in their respective polar chains.

In the range of the magnetostatic field the projected pipeline has a special form, ramified who divides the volume of gas of the air gap (Fig. 6), so there is a uniform stimulation of fluid combustible.

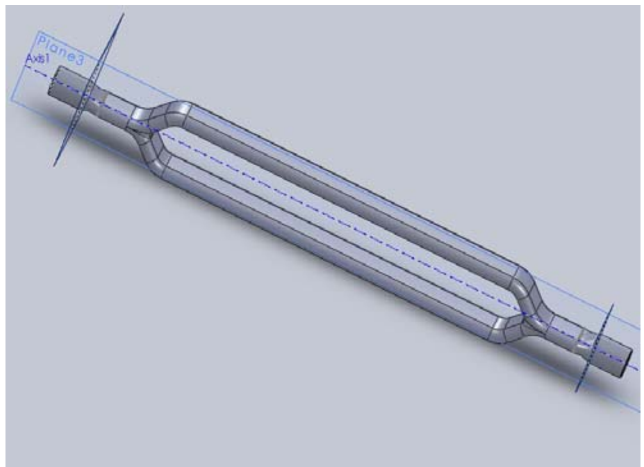

Fig. 6. 3D View.

In order for the stream lines inside a fluid, lines which define the flow of the fluid, to be parallel and to be in an angle of approximately 90 degrees with the magnetic field lines generated by the permanent magnets, advanced research in the field of fluid dynamics have been conducted [5].

After simulation, for a maximum flow rate allowed by the experimental installation, a low flow speed was obtained, of approximately 0.25m/s in the area of magnetic field action (Fig. 7).

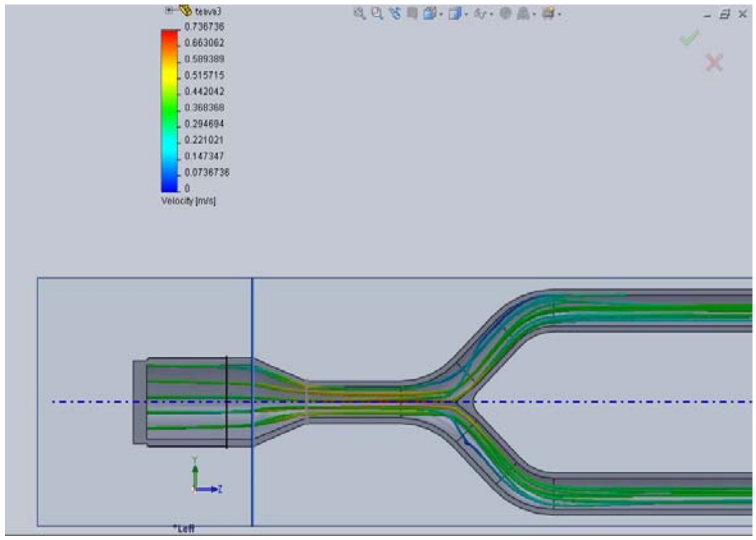

Fig. 7. Stress Analysis

The flow is completely laminar so it can be satisfied the condition of perpendicularity between magnetic field lines and flow lines.

3. Conclusions

Taking into consideration the shapes and dimensions of magnets, a modulate constructive conception was used, while the assembly was composed of a number of elementary magnetic circuits which are detachable and easy to set on the pipe through which the fluid fuel streams.

In conclusion we can say that the original constructive solution taken for the magnetic system for treating liquid and gaseous fuels in alternating curtains of magnetic fields, is the response to all the requirements to touch our purpose which is increasing heating yield and reducing the noxes eliminated

These magnetic systems with the changes they require can be used for small capacity burners as well as in power plants, in which the advantages of the system are considerable increased from both the economic point of view as well as environmental protection.

In a future paper we will show the research undertaken and the results of measurements performed at the Department of Boilers that provided us a combustion chamber. The main objective of the tests is to measure the pollutants concentration (CO, NOx) produced in the burning process using a gas analyzer in case the system for magnetic treatment of the fuel is placed in the system and when the burning is made in normal conditions in order to compare the results. Of great importance is also the control of distance at which the magnetic system is placed from the burner in the elaboration of future theories.

R E F E R E N C E S

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