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TYPES OF CONSTRUCTION BURNERS USED IN METALLURGICAL FURNACES

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ABSTRACT

The burner is an element of the combustion furnace which provides its fuel and air supply in a well-established proportion and creates the aerodynamic conditions required to produce a flame with the appropriate corresponding to the installation.

KEYWORDS: *burners, fuel, burning, outbreak, nozzle, spraying*

1. INTRODUCTION

From this general burner definition follows the main functions of the burner:

- preparation of combustible material for mixing with air;
- ensuring the direction and speed of the air and fuel jets to be mixed;
- adjusting the air and fuel flow to ensure a certain thermal load at a given air / fuel ratio:
- creating flame stability conditions in the operating range;
- realization of the initiated turbulence necessary to achieve a certain firing wave;
- directing fuel and air so as to achieve a certain flame distribution zone and temperature in the furnace.

The large variety of fuels used and the flame characteristics required in the outbreak make several types of burners available. The classification of these types is based on certain functional and constructive criteries.

2. BURNERS FOR GASEOUS FUELS

Gaseous fuels used in boiler installations are natural gas and only in isolated cases, in chemical or metallurgical, gas, refinery, coke or blast furnace gas.

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Gaseous fuel burners can work by absorbing a portion of the combustion air through ejection, a solution used only for small burner flows.

Ejecting is subject, after the available fuel pressure, to 40-60% of the air required for combustion, the rest of the air being admitted directly into the furnace (due to the depression in the furnace) as secondary air.

An example of such a burner, standardized in our country, is T.D, shown below in figure 1.1.

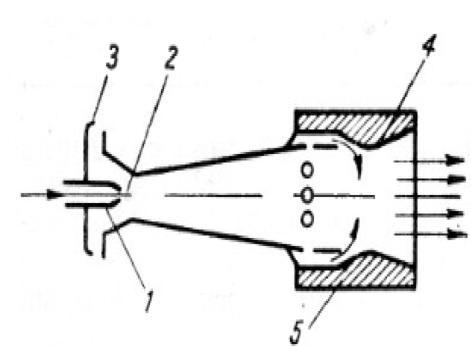

Figure 1.1. Aspiration burner

Working flows are between Nm^3 / s and a working pressure of 2500 N / m^2 or Nm^3 / s at a working pressure of 25000 N / m^2 of gas.

The assembly: 1 - the nozzle, the 2-chamber mixing chamber, the 3-way air regulator, is the ejector side for priming the primary air. In the ceramic head 4 of the burner, part of the fuel mixture is taken up by a few holes and driven through an annular groove 5 where during operation it stabilizes the pilot flame which in turn flames on the central central jet.

This burner is a gas-fired, full-flow, kinetic burner, stabilized with a flaming pilot with natural turbulence.

For larger flows, it is possible to combine, by placing on a circle 3 or 4, the secondary air supply being made through the center of the burner system.

The advantage of self-priming burners is primarily that they do not require an air blower and secondly that the suction air flow is proportional to the gas flow passing through the nozzle to different operating loads.

The main drawbacks of the autosampler burners are the relatively narrow limits of flow regulation and the impossibility of effectively controlling air flow due to the presence of secondary air.

These disadvantages limit the current use of these burners to about 0.05 m^3 / s of fuel and to installations that do not require the automation of the combustion process.

Improvement of the suction conditions at the self-priming burners can be done by using two or three stage ejectors, in which case the injector coefficient increases, but the quality of the homogenization of the mixture decreases, resulting in long, bright and light kinetic-diffusive flame.

Inspired air burners, used for small, medium and large flows, eliminate the disadvantages of self-sparking burners being elastic and adjustable flame.

In relation to the combustion air, the fuel gas can be admitted centrally, median or peripherally. Depending on the intake position, the mixture of air and fuel gas is made more homogeneous or less complete.

In the case of central intake burners, an example is shown in figure 1.2, the degree of mixing is relatively low, especially in the center of the burner, resulting in a flame with a pronounced diffusive character, thus long and bright.

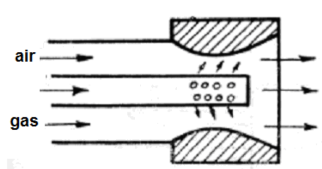

Figure 1.2. Burner with central inlet.

In the case of burners with peripheral intake, for example the burner shown in figure 6.3, the mixture is very good because the gas intake is more dispersed in the air flow;

The burner will have a firing with a pronounced kinetic character, so the short and unlit flame.

Medium gas intake leads to flames with average characteristics. A burner of such construction is G.A.R. shown in figure 1.4. Burner flows are from 0.007-0.055 Nm^3/s.

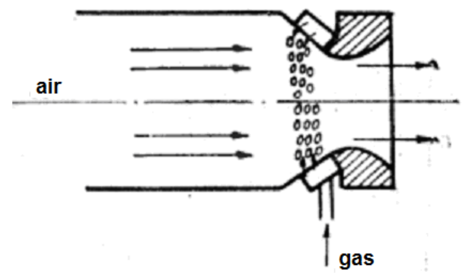

Figure 1.3. Burner with peripheral inlet.

Fuel flows through the annular space between the two air jets.

The outside air flow is higher than the internal air flow, and in addition, by making a swirling motion, it will provide a greater angle of flow of the mixing jet.

In air-fired burners the air pressure is 600-2000 N/m^2, depending on the aerodynamic strength of the stirrup, and the gas is admitted at a pressure of 2000-15000 N/m^2.

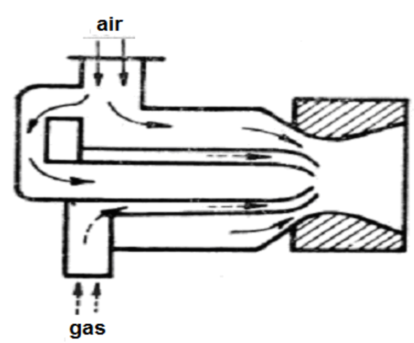

Figure 1.4. Medium intake burner.

The gas outlet velocity in the holes is about 10 times higher than the air to ensure its penetration across the airflow depth.

In the construction of large flow burners, or burners for large tunnel outbreaks, devices are provided that create the conditions of an intensified combustion.

In axial motion, the strong turbulence needed to increase combustion can be achieved by introducing non-aerodynamic hurdles into the jet of mixing, which causes turbulence by suddenly accelerating the current and local turbines created behind the obstacle.

Such obstacles may be grids or nozzles, whose effect on turbulence is always determined experimentally.

A very much used method for combustion intensification is the vortexing of the fuel mixture before the combustion zone.

In general, a helical movement of the combustion air is provided, which, being relatively large, enters the helical movement and the fuel.

Turbulence is obtained either by introducing the air into the burner by means of a spiral shell or by introducing into the air a series of pallets (possibly with adjustable direction) that imparts air to the circulation. Figure 1.5 shows a typical construction solution.

From a functional point of view, such burners, due to the large turbulence created in the helical movement and well-formed mixing, give short kinetic flames and a large flare angle.

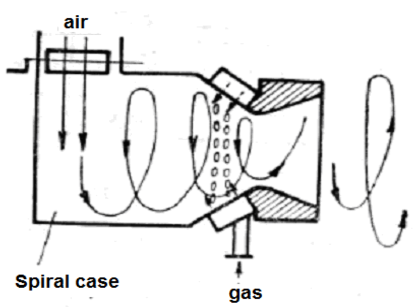

Figure 1.5. Burner with turbulent air flow.

As a constructive feature, it should be noted that swirling air burners can only be achieved with a peripheral gas inlet. In the center of the turbine is created an area with small axial velocities (sometimes null or negative), the high speed being at the periphery. It is therefore normal for the fuel jet to be introduced peripherally, where the specific air flow per section is higher. Figure 1.6 shows the velocity spectrum at the turbulent air injection.

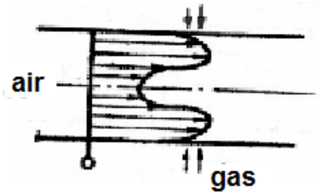

Figure 1.6. Flow chart of the turbine burner.

In the case of too strong swirling, depressurised areas may appear in the center of the burner, with reverse fluid circulation (from the furnace to the burner).

Such situations should be avoided either by shuffling the vortex, or by accelerating in the exit nozzle the entire jet so that in the center the speeds will be advancing.

The return (return) of the flame to the burner results in its destruction.

In rare cases, it is necessary to obtain long (radiant) flares in the outbreak. Such flames can be achieved by diffuse combustion of fuel, a process in which cracking at high temperature in the absence of air of the fuel will result in the appearance of the free carbon which is radiant in the flame.

Diffusive flame burners with circular or rectangular ducts ensure that air and gas penetrate into the furnace in parallel jets of the same velocity and low turbulence to avoid rapid mixing. Examples of such burners are given in Figure 1.7 below.

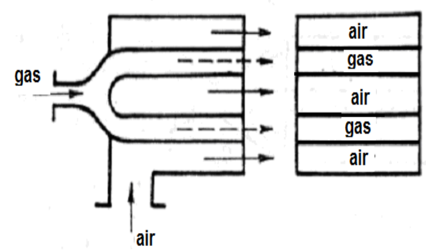

Figure 1.7. Burner flame diffuser.

3. BURNERS FOR LIQUID FUEL

In order to achieve the combustion of the liquid fuel in a short time, the furnace run time, the liquid fuel must be sprayed in fine droplets, thereby increasing the contact surface with the combustion air and shifting the thickness of the air layer.

Printing the energy required to separate fuel in small droplets is done either by compressing the fuel by means of a pump (spray drift) or by a secondary agent: combustion air or steam (agent spraying).

The special fuel used in small boilers is sufficiently fluid for spraying, but the oil has to be preheated to 360-420 K for the necessary fluidity.

Mechanical spraying burners have the main spraying nozzle as the main spraying nozzle.

The fueled fuel gets high, then, due to friction with the air in the environment it is expanding, the jet drops in fine drops.

For better spraying, the acceleration received in the nozzle is generally accompanied by printing a helical jet movement, in which case the velocities increase, and due to the strong flare out of the orifice, spraying is finer. Figure 1.8 shows a swirl nozzle.

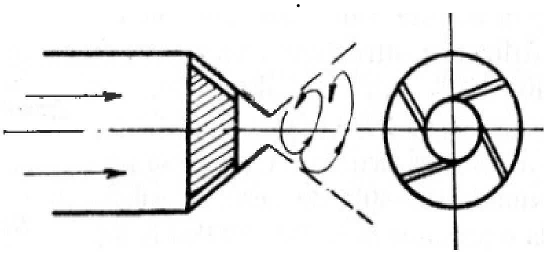

Figure 1.8. Swirl injection aid.

The main disadvantage of simple spraying nozzles is that the particle diameter d is directly influenced by the injection pressure p and the flow rate B at which the injector works:

$$d \approx \frac{1}{p} \; so \;\; d \approx \frac{1}{B^2} \qquad (1)$$

It results, for example, that the particle diameter will increase 16 times in operation at the load of 25% of the nominal flow, and thus the burn will become worse.

For this reason, the minimum injection pressure is limited to about 10 bar.

The mentioned disadvantage can be largely avoided by adopting a swirl nozzle construction with fuel recirculation as shown in the figure below, figure 1.9

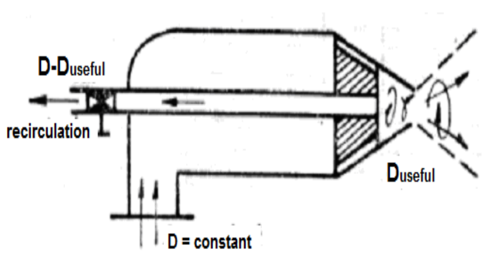

Figure 1.9. Swirl and recirculation injection aid.

In these systems the intake fuel flow is constant, the load variation being obtained by adjusting the flow rate.

It follows that the tangential velocity is constant at the nozzle exit at any flow rate and only varies axial velocity. As the tangential velocity is large enough to ensure a fine spraying, even at low flow rates and low axial velocities, the burner will work in good conditions.

Burners that use combustion air as a spraying agent have different forms of construction;

Generally, however, fuel, admitted as a thin film or small diameter vein, is sprayed by the air that passes through the velocity through this area.

The amount of air used for spraying is 40-100% of the combustion air at a pressure of 6000-10000 N / m ^{2}, at medium pressure spraying.

As an example, figure 1.10 shows a low pressure spraying burner, in which the fuel film is created by a rotating cup.

The burner construction is of a block type, comprising inside its drive motor, spray air blower, fuel filters, adjusting valve and rotary cup.

Such burners are manufactured for flows of 0.007-0.055 kg / s of fuel.

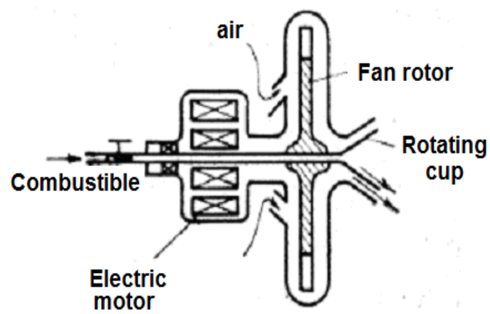

Figure 1.10. Rotary cup burner.

The integral blowing of the combustion air leads to the possibility of automatic adjustment to these burners.

Burners that use high pressure air, 0.7-2 bar (sometimes 6 Bar) are used only in companies with a compressed air network for technological purposes, so installing a burner's own compressor is not economical.

The airflow required for spraying is 3-10% of the combustion air, 0.30-1.3 kg / air per kg of spraying fuel.

With a high sprayer pressure, high velocities can be obtained at the exit nozzle where the fuel is also fed.

The spraying is fine and the jet angle of the jet may be small in the case of simple nozzles, or high when a swirling propeller is inserted on the air path.

Figure 1.10 shows a high-pressure air sprinkler; At the same type of burner, steam (similar pressure) can be used as a spraying agent.

The construction of the burner does not change, but there are a number of disadvantages related to the use of steam:

- the consumption of 0.3-0.5 kg / steam per kg of fuel represents 3-4% of the boiler output;

- increase the H_2O content in the combustion gases and raise the dew point temperature;

- the steam consumed is not recovered as condensate, so the treated water consumption of the boiler increases.

The above mentioned drawbacks make the spray steam burners not to be used in small boilers but as backup burners in case of damage to other burners, their simple construction and their functional independence being the main advantages for such uses.

Thanks to the large boilers, the possibility to make very fine steam sprays and to reduce the excess air at values of 1.02-1.05, they make such burners to be used in the case of burning sulfur sulphides.

Multiple methods of obtaining liquid fuel spraying require a comparative analysis of these.

The main comparison criteria are:

- spraying characteristics (by mean and maximum droplet diameter)

- the cost of the installation

- the power required to compress fuel or air.

Spray uniformization is characteristic of each type of injector, experimentally determined as the ratio between the maximum droplet diameter and the mean diameter.

A relatively good uniformity is obtained in the case of air spray where the ratio dmax / dmed is about 3;

Larger unevenness results in mechanical spraying, which makes the burners for such burners long.

An overall economic benchmark is the cost of spraying.

Low-pressure air spraying is the most economical in the field of small flow rates for 1 or 2MW boilers, and mechanical spraying is economical in the field of high flow rates.

Medium and high pressure spraying should only be used when it is necessary to obtain a short flame by a finer spraying of the fuel.

Finally, the power required to spray is also dependent on the system adopted. The mean values are:

- for low pressure air spray: 26.5 kW/kg/s;
- average pressure: 212 kW/kg/s;
- high pressure: 212 kW/kg/s
- for mechanical spraying: 18.5 kW/kg/s

4. BURNERS FOR PULVERIZED CARBONS

The complexity of the charcoal power plant makes this solution only for medium and large boilers. It follows that these burners will be for big fuel flows.

Transporting pulverized coal by pneumatic means, the burners have the advantage of receiving a mixture of primary air (about 20-50% of total air) with coal, the role of the burner remaining only to carry out the further mixing of the primary air jet with air secondary.

The presence in the burner channels of a mixture of air-coal, which is very easily flammable due to volatile content, makes the flame retardant explosion hazard much higher than that of burners for other fuels.

Avoiding the danger of explosion is generally done by fitting an obstacle in the exit opening of the primary mixture to create locally an increased flow velocity greater than the propagation velocity of a flame front and to avoid by the direct radiation of the furnace, the primary mixture whose excessive heating could lead to self-ignition.

A burner used for medium fuel flows is shown in figure 1.11 with the ring-shaped outlet of the mixture.

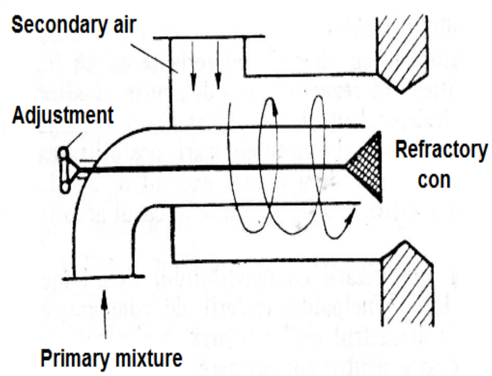

Figure 1.11. Circular burner for pulverized coal.

The introduction of the primary air-fuel mixture is done through the central pipe at the end of which the conical piece of ceramic material is found to protect the flame retardant and the spreading of the mixture as a tapered cone with an opening angle α.

The secondary air is introduced peripherally through a spiral casing that provides a swirling motion of the air, thus improving the quality of the primary and secondary jet mixing in the furnace.

At higher fuel flows, the air-dust mixture ends of the carbon-powder mixture are rectangular slots, this construction shifting the burner gauge.

The inlet speed of the fuel mixture is 20-40 m / s and the secondary air is introduced separately through other openings in the furnace.

5. MIXED BURNERS

Achieving a balance of stability between fuel consumption makes it necessary, in peak periods of gas consumption, to switch to the use of liquid fuel in larger industrial and energy installations. Hence, there is a need for gas or liquid fuel burners to simply switch from one fuel to another.

Another case when it is necessary to install mixed burners is that of boilers running with dusty carbines, boilers which at start or at low loads, because of the instability of the combustion of solid fuel, must be fed with liquid or gaseous fuel. Liquid and gaseous fuel burners use a central injector for combustion of the frost, and a peripheral gas intake for the combustion of gaseous fuel. In Figure 1.12 there is a mixed burner. Combined burners for coal and gas dust retain the central part of the dust burners and the peripheral part is completed with a gas fuel distributor as in figure 1.13.

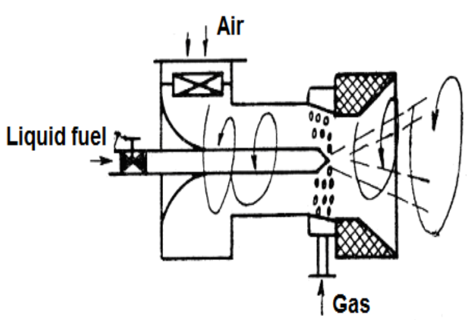

Figure 1.12. Mixed burner, gas-oil burner.

Because in the case of running with gaseous fuel the distribution head of the primary mixture of air-dust of coal does not burn due to the high temperature, without cooling the mixture, the head is withdrawn by a telescopic system from the focal area of the furnace, thus As shown in the figure.

The same procedure for protecting the injection head of the injection head is sometimes used in mixed gas burner burners to avoid coking of the spray head when the burners operate with gaseous fuel.

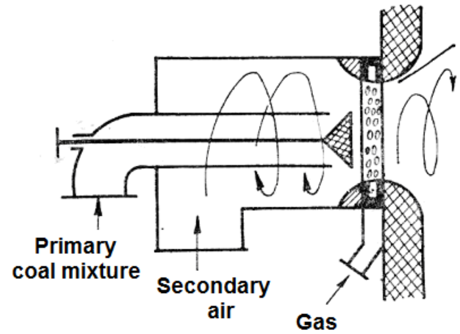

Figure 1.13. Combustion burner, gas-fired charcoal.

6. CONCLUSIONS

Achieving a balance between the consumption of different fuels makes it necessary, during peak periods of gas consumption, to switch to the use of liquid fuel in larger industrial and energy installations.

Hence the need for gas or liquid fuel burners with simple switching from one fuel to another.

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