COMBUSTION AIR
CHAPTER 7

COMBUSTION AIR

The quantity of air required by a forced-draft combustion system can be easily determined if some data are known:

1) The quantity of heat required by the system in kCal/h.
2) The primary air percentage required by the sytem in relation to the stoichiometric ratio.

It is worth remembering that 1.18 Nm^3 of combustion air are necessary to obtain 1,000 kCal of lower heating value to complete combustion. Of course such volume is the result of the primary air plus secondary air (if any).

For example a combustion system delivering 1,000,000 kCal/h with 80% primary aeration will need:

$$(1.000 \times 1{,}18) \times (80 : 100) = 944\ Nm^3/h$$

of combustion air, no matter what fuel gas, the pressure required by the industrial process and the type of combustion equipment used. The remaining quantity of air required for the complete combustion of gas

$$(1.000 \times 1{,}18) - 944 = 236\ Nm^3/h$$

will have to be supplied in some other way.

The pressures required by standard industrial combustion systems range from 100 to 1,400 mm H_20.

In order to obtain some specific thermal rating at the standard air pressures required by the combustion system, the components in the chamber must be taken into consideration. The compensation of the pressure in the combustion chamber is necessary in order to avoid variations in the calorific capacity of the system.

In some particular circumstances and particularly in the generation of controlled atmospheres, air pressures up to 7,000 mm H_20 may turn out to be necessary.

CENTRIFUGAL BLOWERS

Centrifugal blowers are capable of developing air pressures up to 2,100 mm H_20. Obviously the higher the pressure or the blower capacity, the more expensive the blower. Choosing the most adequate blower is important as for the rating the motor needs to satisfy the required features (capacity and pressure). The capacity is more influent than the pressure.

Above the pressure limiting value mentioned above piston compressors or rotary pumps are necessary.

A centrifugal blower creates some draft (negative pressure) where the blades converge towards the rotating and support shaft. The air velocity is slower at the shaft and higher at the impeller or rotor edges where blades diverge. The dynamic pressure (function of speed) is maximum where the air leaves the blade edges and is converted into static pressure in the scroll of the blower.

The blades of the combustion air blower must be kept clean: fouling accumulating on the surface of the blades increases the friction of air and consequently decreases the capacity of the blowers. The phenomenon may also be controlled by means of checks of the electrical load of the engines. In industrial applications and some particular circumstances, we recommend that some proper filtering systems be adopted on the air inlets of the blowers.

In some cases, in order to obtain higher air pressures, blowers in series are used. In this application, the air inlet of the downstream blower is connected to the pressing mouth of the upstream blower, so as to obtain a system where the supplied pressure is equal to the sum of the pressures generated by the single blowers.

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COMPRESSED AIR INJECTORS

When the cost of a centrifugal blower outweights the advantages and when a network of compressed air with excess volume is available, the excess volume may be used to create, on the basis of the venturi, small or medium quantities of combustion air.
In this case, atmospheric mixers similar to the ones used for high-pressure gas can be used. Air compressed to 2.8 ÷ 10,0 bar is issued by orifice A_1 of the venturi (see Fig. 3 Ch. 2). The negative pressure P_2 created by the venturi will entrain more air from the atmosphere. By optimizing the dimensioning the system utilizes 30% compressed air and 70% exhausted air to produce the volume necessary for combustion.
Similar mixing systems are often used to generate small quantities of heat in industrial processes requiring some specific temperature in a very concentrated and small area. The high-pressure outlet of the mixer is usually connected to the inlet of a proportional mixer. In this case there is no need for a butterfly valve to be placed upstream of the proportional mixer, as the total pressure of the mixture may be easily controlled by means of the needle valve of the compressed air injector (Fig. 23).

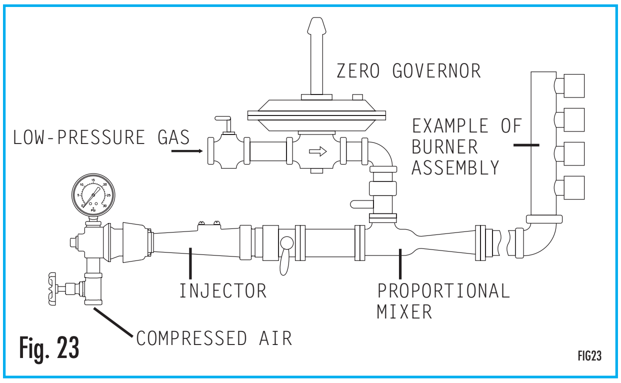

Fig. 23

MIXERS

On the market there are some types of centrifugal or piston compressors capable of compressing gas and combustion air to the manifolds and at the same time mixing the two fluids. Most mixers are equipped with adjustable nozzles on the inlets of the fluids to regulate their volumetric ratio.
Some of these mixers are even equipped with a motorized system designed for extremely precise regulation allowing also for the volumetric control of the mixture via a regulating device affecting both temperature and pressure. It is a modulatory-proportional regulation system and is capable of maintaining the air-gas ratio constant over the whole mixture flowfield .
This type of mixers allow for the use of very-low pressure gas which represents a great advantage. This advantage, though is to be set against some other hazard. In the mixer/compressor set, as well as in the piping downstream of the equipment, there is an explosive mixture. A flashback to the burners or any other source of ignition of the mixture may result in very serious consequences.
For this reason, it is advisable to install a flame trap or some anti-explosion device on the mixture manifold, between the mixer and the burners.