Combustion system for premixing distributor and forehearth burners

Glass Service srl Italy has developed a combustion system for premixing distributor and forehearth heating burners. Fulvio Puccioni reports.

Today's glass container industry demands a very high efficiency distributor and forehearth system.

The latest D&FH design is very complex, featuring several different cooling and heating technologies. Because of the better thermal homogeneity requirements of modern production such as NNPB and the desire for less space in the D&FH layout, many combustion systems are now separating the left and right sides into independent combustion zones. This arrangement (figure 1) reduces the maximum power of the combustion system to 50% of the original full zone. Consequently, combustion system precision at low flow becomes much more important than in the past.

CURRENT TECHNOLOGY

The scope of a good combustion system is determined by the settings of the air/gas ratios at a constant value across the system’s full operating range. The technology used in the D&FH combustion system is based mainly on two different technologies, both of which are analysed here.

Venturi-type combustion system (ZGT): In this technology (figure 2), the air/gas ratio is held constant by the gas pressure ratio and air in the tapping pressure position downstream of the zero governor.

- The air flow regulation valve is operated by a servo motor, which controls the flow according to the control systems thermal power demand.
- The venturi tube, including its gas flow regulating valve, manages the gas input to the air stream.
- A copper pressure tapping pipe detects the pressure required from the combustion zone downstream of the venturi tube.
- The zero governor gas device sets the pressure downstream at the same value of the tapping pressure.

In the ZGT system, the air and gas pressure are in constant ratio and consequently also the air and gas flow ratio.

Differential pressure system (GADP): In this technology (figure 3), the air/gas ratio is made constant by the differential pressure in an orifice plate and gas valve.

- The air flow regulation valve is operated by a servo motor, which controls the flow according to the control system’s thermal power demand.
- The air orifice plate produces an air differential pressure that increases according to the air flow.
- Double pressure tapping copper pipe detects the differential pressure according to the air flow required by the combustion process. This differential pressure is transmitted to the ratio valve by two copper pipes.
- An adjusting gas valve downstream of the main ratio gas valve produces a gas differential pressure according to its regulation and its gas pressure drop.
- The ratio valve compares the air differential pressure
and gas differential pressure and sets its ratio to a constant value. In the GADP system, air differential pressure and gas differential pressure are in constant ratio and consequently, so is the flow. Both systems use a correct flow equation for ratio control. However, between the theoretical and the practical application, quality, precision and sizing of the air and gas equipment have an important role to play on the constant value of the air/gas ratio.

**Orifice mixing needle (OMN) system:** With its OMN system (figures 4 and 5), Glass Service Italy has introduced a novel concept that is similar to the venturi type.
- The air flow regulation valve is operated by a servo motor that controls the flow according to the control system’s thermal power demand.
- An orifice flange, including its gas flow regulating needle valve, regulates the gas input to the main air stream.
- A copper pressure tapping pipe detects the pressure required from the combustion zone upstream of the orifice tube.
- The double stage zero governor gas device sets the pressure downstream at the same level as the pressure tapping.
- In the OMN system, the air and gas pressures are in constant ratio and consequently, also the air and gas flow.

Theoretically, it is similar to the venturi ZGT system, although there are some major differences between the two.

**OMN orifice plate:** The orifice plate has a pressure pattern as illustrated in figure 6. The reduced diameter causes a restriction to the air flow that generates a pressure peak upstream of the orifice plate and consequent low pressure downstream. The peak...
pressure is used as pressure tapping, in addition to which the downstream low pressure is used for the gas input to the air stream.

To achieve optimal performance, the orifice diameter is easily adaptable to the correct value for each zone. A program from Glass Service assists the customer with this calculation. Correct calculation of the orifice hole diameter sets the OMN system to the optimal value for each pipe diameter and flow required for each zone (figure 7).

OMN needle valve: The use of an integrated needle valve (figure 8) increases the ratio regulation accuracy. The needle diameter hole is also customised according to the Glass Service calculation program. This fine hole diameter adjustment increases the setting accuracy to the optimal value.

OMN double stage zero governor: The OMN also introduces a different concept for the zero governor (figure 9). The double stage zero governor has a first stage for a gross pressure reduction and a second stage for fine adjustment. The first stage is also connected to the pressure tapping but the preload internal spring is set for a pressure output Pa+spring.

The gross and fine regulations set the pressure value from the second zero governor, with a very fine accuracy also at low flow.

VENTURI ZGT AND OMN ORIFICE PLATE COMPARISON

Field tests for the two different systems (figure 10) have given very interesting results (see table 1). The test was carried out with an eight burners 1/4in diameter zone, with a maximum manifold pressure of 20 mbar and a minimum manifold pressure of 3 mbar.

The test was conducted at 20 testing points, ranging from maximum to minimum flow. Air and gas flows were measured by electronic devices and recorded on a Honeywell Minitrend model video recorder.

The first three columns of table 1 indicate the testing points, air flow and air flow percentage %. Columns four to nine show the pressure tapping, gas flow and combustion ratios for the ZTG venturi and OMN systems. The main column is the combustion ratio for both systems.

For the venturi ZTG technology, the ratio is constant at approximately 100%-60% of air flow. Below this value, the air/gas ratio increases, causing a lack of gas flow. The total ratio variation is 1.2.

For the OMN technology, the ratio is constant throughout the full operating range. The maximum difference is only 0.35.

VENTURI GADP DIFFERENTIAL PRESSURE AND OMN ORIFICE PLATE COMPARISON

The same test on the same zone with eight 1/4in diameter burners was also carried out between the differential pressure GADP and OMN systems (figure 11). Test results are given in table 2.

For the GADP differential pressure technology, the ratio is constant at approximately 100%-60% of air flow. Below this value, the air/gas ratio increases, causing a lack of gas flow. The total ratio variation is 2.25.

For the OMN technology, the ratio is constant on the full operating range. The maximum difference is only 0.35.

CONCLUSION

The recently developed OMN technology for air/gas mixing has a better performance for combustion ratio stability than current technologies available in the market. This results most importantly in stability at both low flow combustion zones and for left and right split forehearth and distributor combustion systems.

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Table 1: Test results.

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Table 2: Test results.