Nozzle Systems Used in Combustion Processes

Atomisation in the Combustion Chamber

In the combustion of exhaust gases and residual liquids, the nozzles are mainly used in two fields: namely for the injection of residual liquids into the combustion zone or for the combustion chamber, and for injection of reduction media for selective catalytic reduction (SNCR) in a reaction chamber, in order to convert nitrous oxide into non-hazardous nitrogen.

In both cases, in order to achieve a good reaction result, it is necessary to achieve the mutual mixing of the liquid as possible over the available chamber cross-section, together with the finest possible dispersion of the liquids. The incrementation of liquids which provide energy is carried out in the highly turbulent swirl burner, the combustor. Due to the type of air supply and the form of the outlet unit, an axial motion is created, which is superimposed on the swirl flow. The result is a thorough mixing of the hazardous substances with the process air/burner air and the auxiliary air.

The entry flow created in such a manner that it:

- brings about an extremely rapid mixing of the reactants in the highly turbulent regions, and therefore enables a complete conversion of the hazardous substance and the fuel in the smallest possible space;
- the combustion process is stabilised with regard to flow, and therefore ensures reliable combustion behaviour even under extreme conditions.

The free dispersion of the residual fluids in the fluid field also ensures the rapid and residue-free conversion of the hazardous substances. The energy content of the liquids compensates for the fuel consumption. If the energy content is high enough, the use of an auxiliary fuel can be dispensed with.

Boundary Conditions for Complete Combustion with the Nozzle System

- The volumetric average droplet diameter should be between 20–40 µm
- Homogeneous distribution of fluid over the entire cross-section
- Liquid control range up to 1:10
- Temperature resistant
- Convex resistant
- Not prone to clogging, in order to ensure uninterrupted operation
- Maximum contact area between the spray and the combustion air
- Even distribution of velocity with sufficient outlet velocity for optimum utilisation of the combustion chamber geometry.

Three- and Four-Substance Nozzles

For combustion processes in which heating oil, waste water and liquid residues are burned simultaneously, three- and four-substance nozzle systems can be used. The Düsen-Schlick multi-substance units provide a continuous and fine atomisation of several liquids at the same time, using one nozzle, and only one atomising medium (air, gas or steam). At the same time, thorough mixing of the media takes place at the nozzle exit. There is also the possibility of changing one channel with air, gas or steam, in order to create a greater exchange area between the atomising liquid and the medium. The fractions between the different liquids inside the nozzle are mixed out, as due to the external mixing of the media, they only meet at the exit of the nozzle.

Multi-substance nozzle generates a full-cone spray pattern.

And It Burns!

Two-substance nozzle with external mixing

- The fundamental concept of the development was the modification of the geometry of the internal mixing zone, in particular to avoid frictions prone to clogging, and to achieve a more thorough mixing of the atomising air and the liquid. This makes it possible to reduce the amount of air which the nozzle requires to produce a constant droplet size, and therefore to minimise the penetration power of the spray. As well as this, the configuration of the holes was designed in such a way as to greatly increase the spray angle. The stream of liquid impinging onto the tip of a cone in the mixing chamber. The resulting film is then fragmented into individual drops by the atomising air. The flanks of this cone taper into the nozzle holes. The nozzle holes are therefore bored in a defined manner, and the surface impinged upon is larger. The entire removable front part of the nozzle is referred to as the air cap.

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