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Eine Frage der Verteilung

# A question of distribution

**Pressure or two-substance nozzles – industrial use of superheated steam cooling**

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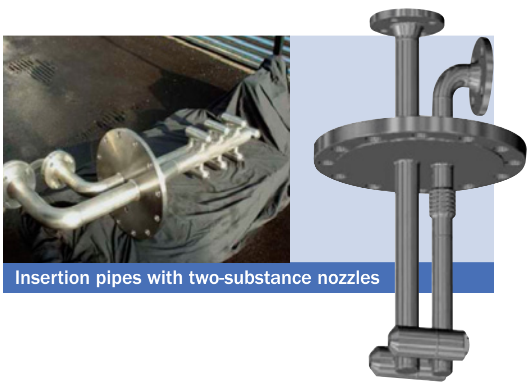
**There are two nozzle systems available for superheated steam cooling: pressure nozzles and two-substance nozzles. Read our specialist article to find out which system is suitable for your application.**

Immediately cooling down freshly produced steam seems to be slightly inconsistent behaviour. However, in many procedures the process engineers want to avoid high steam temperatures or to saturate/cool the superheated steam. In these cases, superheated steam cooling is the procedure of choice, and most chemical plants currently use two systems to achieve this: pressure nozzles (single-substance nozzles) or two-substance nozzles.

**Pressure or two-substance nozzles**
two-substanceIn order to achieve the desired effect, the complete evaporation of the condensate is important in both nozzle systems but this requires very fine atomisation of the medium. The easiest way to cool steam is using pressure nozzles. This process depends on the ability to produce small drops, which in turn demands a high difference in the liquid pressure and holes that are as small as possible. The required high liquid pressure difference is also beneficial for the control mode of these nozzles. On the other hand, in two-substance nozzles the small, mist-like drop size that is required is achieved even with a low difference in liquid pressure, but this requires the use of an atomising medium e.g. steam.

This system has two advantages. Firstly, the amount of cooling water to be brought into the nozzle can be continuously adjusted from zero to the maximum flow rate whilst maintaining the same drop size, and secondly the atomisation is extremely fine. This isespecially true in the lower control range, i.e. with very small amounts of injection water and near the saturated steam limit. In addition, the fine drops also evaporate very quickly and facilitate swift heat transmission. A further advantage is that the use of this kind of system keeps the length of the evaporation section within justifiable limits. There is no corrosion on the piping caused by unevaporated cooling water.

In order to be able to work with a two-substance unit, if possible the atomisation steam should be provided with a pressure ratio of $(P2/P1)_{cr}$. However, the units even work in the sub-critical pressure range up to P2/P1 = approx. 0.8. The two media (cooling water and atomisation steam) are not dependent on the pressure of each other and only mix after they leave the unit, meaning that these systems are not susceptible to blockages.


Insertion pipes with two-substance nozzles

**Cooling with pressure nozzles**
The cooling of the superheated steam with pressure nozzles is mainly dependent on the amount of water that is injected being completely evaporated. This guarantees stable temperatures and the protection of the steam lines from corrosion due to moisture. An important consideration in the design of the cooling system is the length of the evaporation section, which the process engineers must adjust to the respective conditions as it is a variable parameter. This is dependent on several factors, e.g. the amount of water to be introduced, the excess pressure of the injection water, the steam speed, the temperatures etc. As a rule of thumb, there should be at least one straight pipeline which is six to eight metres long from the point of injection. If pipes branch off upwards from the main pipe, an additional nozzle must be installed in the riser.

**Designing branch pipes**

The nozzle should be installed immediately above the branch with an upwards spraying direction. The required cooling temperature will not usually be reached in the riser, especially in the first eight to ten metres, because by nature the condensate/the saturated or cooled steam is largely found in the lower part of the pipe of the straight pipeline until there is complete mixing. The speed of the steam should lie within the normal limits, i.e. in the region of 20 to 40 metres per second. In order to be able to record the temperature as precisely as possible, the measuring point should be roughly 15 to 20 metres behind the injection point/at the end of the straight pipeline and must be positioned so that the entire sensor length is used.

## What does the Pressure Equipment Directive say?

The steam cooling units are grouped into the different modules according to the provisions of the Pressure Equipment Directive 97/23/EC. For example, Düsen-Schlick carries out all necessary production inspections including CE marking in the case of classification according to module A. When there are extremely high requirements e.g. in the case of classification according to module G, a notified body is used for acceptance. Various parameters such as maximum steam pressure, maximum steam temperature and the dimensions of the tubes and flanges are decisive factors for the assessment. As a result of case-dependent design under consideration of the decisive technical and economic influencing variables, the nozzle fittings are individually adapted to the existing/planned features.

Insertion pipes with pressure nozzles

In order to ensure that the pipe wall at the injection point is protected against impinging drops when there are large injection amounts and low steam speeds, a protective pipe can be used to cover the steam line – the gap that is created in this process must be at least six to eight millimetres. In order to protect the pipe wall from stress cracks, a low amount of steam must be channelled through the gap. Even the differential pressure with which the condensate enters the steam line plays an important role. It should preferably be 10 to 60 bar because as the atomisation pressure increases, the drop diameter decreases and therefore the surface of thecondensate to be atomised rises accordingly. This had two advantages: Heat transmission is improved and the length of the evaporation section can be limited. In addition, the injection amount can be regulated in correspondingly wide limits by increasing or decreasing the condensate pressure.

**Installation of insertion pipes**

The supply of the insertion pipes takes place with a blind flange for the sockets and a weld neck flange for the condensate line. During the installation of the insertion pipe it must be ensured that the spraying direction of the nozzle points in the longitudinal direction of the piping (normal spraying direction = direction of steam flow). A locking plate is used as protection to ensure that the installed nozzles do not loosen/fall out. It must be checked that the condensate line is clean before the insertion pipe is installed as any impurities that are carried along such as welding beads etc. may impair the function of the nozzles.

**Conclusion**

No matter what atomisation technology is used in industrial applications of superheated steam cooling units (be it single or two-substance nozzles), individual consideration and design is indispensable for integration into the whole concept. Düsen-Schlick helps to define the important parameters and to provide a tailor-made superheated steam cooling unit for use.