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Two-phase flow through safety valves – what needs to be done?

During quick relief of a pressurized container using a release line located on the vapor space side, a rupture disk or a safety valve, a surge of the bubbling liquid may lead to a two-phase flow of vapor and accompanying liquid. Gas dissolved in the liquid may also be released by the discharge of pressure and cause a full surge – as when opening a champagne glass, when carbon dioxide bubbles suddenly form and push the liquid out of the bottle.

Two-phase flow that may be caused by a surge leads to the following challenges:

1. The accompanying liquid can be released into the surroundings, which in the case of flammable or toxic substances can be particularly critical. To avoid the release of liquids into the environment, liquid separators, e.g. cyclone separators, should be used for all flammable or toxic substances.
2. Pressure loss in the pressure relief line system is increased by the liquid. In some cases, the liquid may also accumulate and the developing plug flow can cause pressure surges. Pressure loss in the pressure relief line during a two-phase flow must be considered in the sizing.
3. The liquid blocks a part of the relieving opening, which reduces the mass flow of gas through which the majority of energy is carried out of the vessel in the form of evaporation heat. To compensate for the equal increase in pressure in the vessel, a greater relief cross-section is required than is the case with a pure gas flow. The sizing of safety valves for two-phase flows has been governed since October 2010 by the international standard ISO 4126 part 10, which in particular takes into account the conditions in the chemical industry.

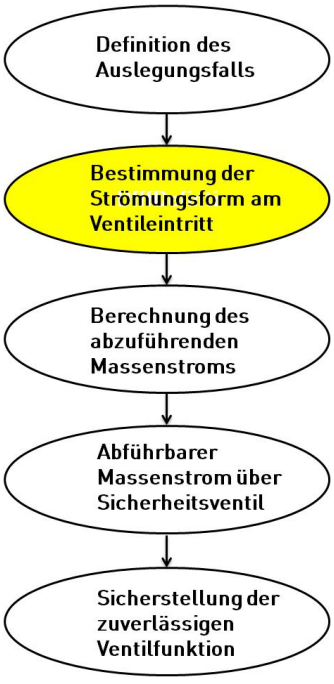

Fig. 1: safety

The entire procedure for sizing is also described for the first time in ISO 4126-10. The individual steps are shown in Figure 1. An essential step is the determination of whether a two-phase flow is even possible under the given conditions, or if in fact a pure gas flow can be expected. This decisions depends largely on the substance system's tendency to foam and its viscosity, from the speed of steam production and, above all, the filling level of the container. With systems that foam and have higher viscosity (> 100 mPa·s), a two-phase flow must be expected even at low filling levels. With other substance systems, Figure 2 indicates a maximum filling level beyond which a two-phase flow can be expected. It is then easier to decide whether the filling level of the container is so high that a two-phase flow might occur during relief.

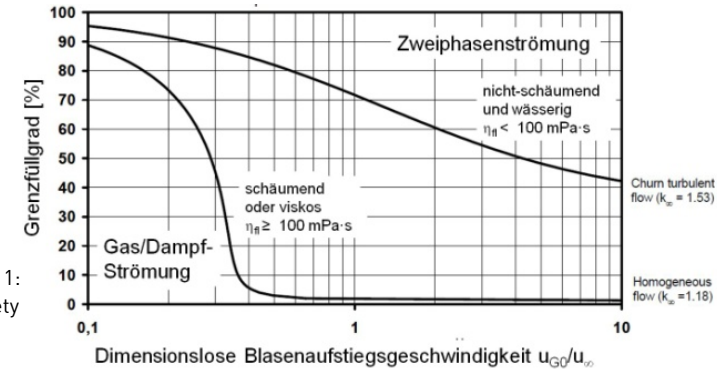

Fig. 2: Limit curves for determining the flow form as defined in ISO 4126-10

If we can assist you with a similar issue, please contact us. Our experts will be happy to help you.

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