# EURISG

## European Industrial Sizing Group

EURISG Sizing Case Report

**ESC_118**

Stand:06.02.2020

Sizing of safety salve vent line systems according to ISO 4126-10 (Revision 2022)

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# 1 Task description

Safety relief valves are used for critical applications in oil and gas production, refining, and chemical processing. The ISO 4126-10:2022 for safety devices for protection against excessive pressure will present a set of consistent equations for the sizing of safety valves, bursting discs, pipes and fittings for gas/liquid two-phase flow (HNE-CSE model). The solution is based on the so-called Omega equation of state, and allows the calculation of the dischargeable mass flux and the pressure change through a safety valve vent line system.

Consider a steam jacketed agitated vessel protected by a safety valve against impermissible overpressure. The worst-case scenario is assumed to be the abnormal maximum heating of the vessel due to the failure of the steam control valve of the vessel jacket. Consequently, a certain mass flowrate is required to be discharged from the pressurized system as soon as the maximum allowable working pressure is reached. The vessel is connected by an inlet pipe to the safety relief valve, followed by an outlet pipeline to the atmosphere as depicted in Figure 1. The pressure change through the vent line system is to be determined. The system data is compiled in the Tables 1 and 2.

**Table 1**: Process Parameters

| | |
|---|---|
| • Medium: | Acetone |
| • Initial filling level: | 80%vol |
| • Maximum allowable working pressure: | 6 bar g |
| • Filling temperature: | 293.15 K |
| • Ambient temperature: | 293.15 K |
| • Set pressure SV-107: | 6 bar g |
| • Back pressure: | 1.013 bar |
| • Heating jacket medium: | Saturated steam |
| • Steam pressure: | 16 bar g |
| • Steam mass flow rate: | 1530 kg/hr |

**Table 2:** Geometric Parameters

| | |
|---|---|
| • Volume of the pressurized system: | 8 $m^3$ |
| • Cross-sectional area of the vessel: | 2 $m^2$ |
| • Safety valve type: | DN 200 x 300 |
| • Safety valve seat diameter: | 165 mm |
| • Valve discharge coefficient for vapor flow: | 0.70 |
| • Valve discharge coefficient for liquid flow: | 0.45 |
| • Pipe roughness (stainless steel): | 0.0001 m |
| • Inlet pipe inner diameter: | 213.3 mm |
| • Outlet pipe inner diameter: | 317.5 mm |
| • Inlet pipe length: | 1 m |
| • Outlet pipe length before bend: | 3 m |
| • Outlet pipe length after bend: | 2 m |
| • Resistance coefficient at the nozzle entry: | 0.50 |

- Resistance coefficient of the bend: 0.25

**Sizing task**

a) Calculate the minimum required cross-sectional area of the safety valve SV-107, considering the inlet and outlet piping as depicted in Figure 1.
b) Calculate the pressure change through the vent line system and evaluate the built-up back pressure ($p_3$) and inlet pressure loss.
c) Recalculate the sizing tasks a) and b), this time considering a catch pot under a pressure of 3.00 bar abs at the end of the vent line system.

No heat resistance through the heating jacket needs to be considered. Therefore, the heat of condensation of the steam shall be totally transferred to the acetone volume in the pressurized system.

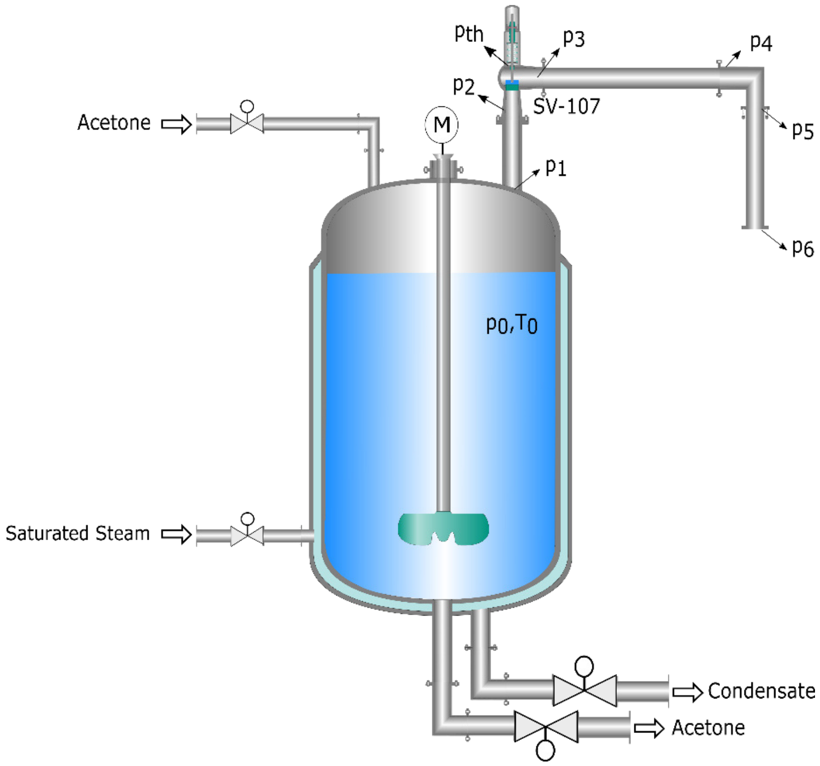


**Figure 1.** Jacketed pressurized vessel comprising the safety relief valve system: the inlet line, the safety valve, and the outlet line comprising a bend. $x_0$, $p_0$, and $T_0$ refer to the total mass flow quality, pressure and temperature at sizing conditions, respectively. $p_1$, $p_2$, $p_3$, $p_4$, $p_5$, and $p_6$ correspond to the static pressure at location 1, 2, 3, 4, 5 and 6, respectively. $p_{th}$ refers to the static pressure at the narrowest cross-section of the safety valve.