

EURISG

European Industrial Sizing Group

EURISG Sizing Case Report

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Sizing of a rupture disc to protect a vessel
against impermissible overpressure due to exces-
sive pressure accumulation in a boiler

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Revisions

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2 Task description

In the chemical industry steam boilers are installed to ensure efficient delivery of process steam for plant processes. In normal operation, liquid boiling water is discharged through a bottom valve CV01 into the blow down vessel. The blow down vessel delivers steam to a deaerator. This blow down vessel is to be protected against unadmissible overpressure.

The scenario to be safeguarded is the pressure accumulation in the boiler up to the maximum allowable working pressure, while the boiler is working at full capacity. Malfunctioning of the control valve CV01 may then lead to an unadmissible pressure in the blow down vessel.

The blow down vessel is protected by means of a safety valve SV 02 for minor scenarios and a rupture disc RD 02 in parallel for the worst case. The rupture disc shall not rupture for minor scenarios.

Sizing task

- a) Determine the mass flow rate to be discharged.
- b) Size an additional rupture disk. Keep the safety valve for other other minor scenarios.
- c) Define the set and bursting pressures for safety valve and rupture disc respectively.

In the following tables, data for the sizing calculation is given:

Table 1: Process and geometric parameters - Boiler

- Medium:	Water
- Operating pressure:	10 bar
- MAWP:	20 bar g at 220°C
- Ambient pressure:	1.013 bar
- Ambient temperature:	20 °C
- Boiler volume:	50 m ³
- H/D:	1.5

Table 2: Process and geometric parameters – control valve CV01

- Flow factor (100%) (K_{vs})	25
- Pressure recovery factor, F_L	0.95
- Differential pressure ratio, x_T	0.75

Table 3: Geometric Parameters – Piping system

Pipes are numbered along the flow path. The start of the numeration is at the end of the boiler.

- Pipe length 0-1:	1100 mm
- Pipe length 1-2:	1200 mm

- Pipe length 2-3: 800 mm
- Pipe length 3-4: 800 mm
- Pipe length 4-5: 800 mm
- Pipe length 5-6: 1200 mm
- Pipe length 6-7: 900 mm
- Pipe length 7-8: 100 mm
- Nominal pipe diameter 0-8: 3"

- Pipe length 9-10: 800 mm
- Pipe length 10-11: 50 mm
- Nominal pipe diameter 9-11: 8 "

- Pipe length 12-13: 50 mm
- Pipe length 14-15: 1000 mm
- Pipe length 10-16: 800 mm
- Pipe length 17-18: 100 m
- Nominal pipe diameter 10-16: 8 "

- Pipe length 16-17: 100 mm
- Nominal pipe diameter 16-17: 3 "

Table 4: Process and geometric parameters – Blow Down vessel

- Operating pressure 2,5 bar
- Maximum allowable working pressure: 7 bar g at 170 °C
- Vessel volume: 3 m³
- Safety valve SV02 size: 3"x4"
- Safety valve SV02 orifice type: K

Table 5: Geometric parameters – Rupture Disc

- Burst tolerance of the rupture disc: +/-5%
- Operating ratio of the rupture disc: 90%
- Minimum net flow area (MNFA) for different rupture discs:

Diameter of the rupture discs	MNFA [mm ²]	MNFA [cm ²]	MNFA [in ²]
3"	4700	47	303.23
4"	8000	80	516.13
5"	12000	120	774.19
6"	18000	180	1161.29

Common assumptions / boundary conditions for the calculation are:

- Pipe lengths are given in millimeter
- Safety valves are API-type.

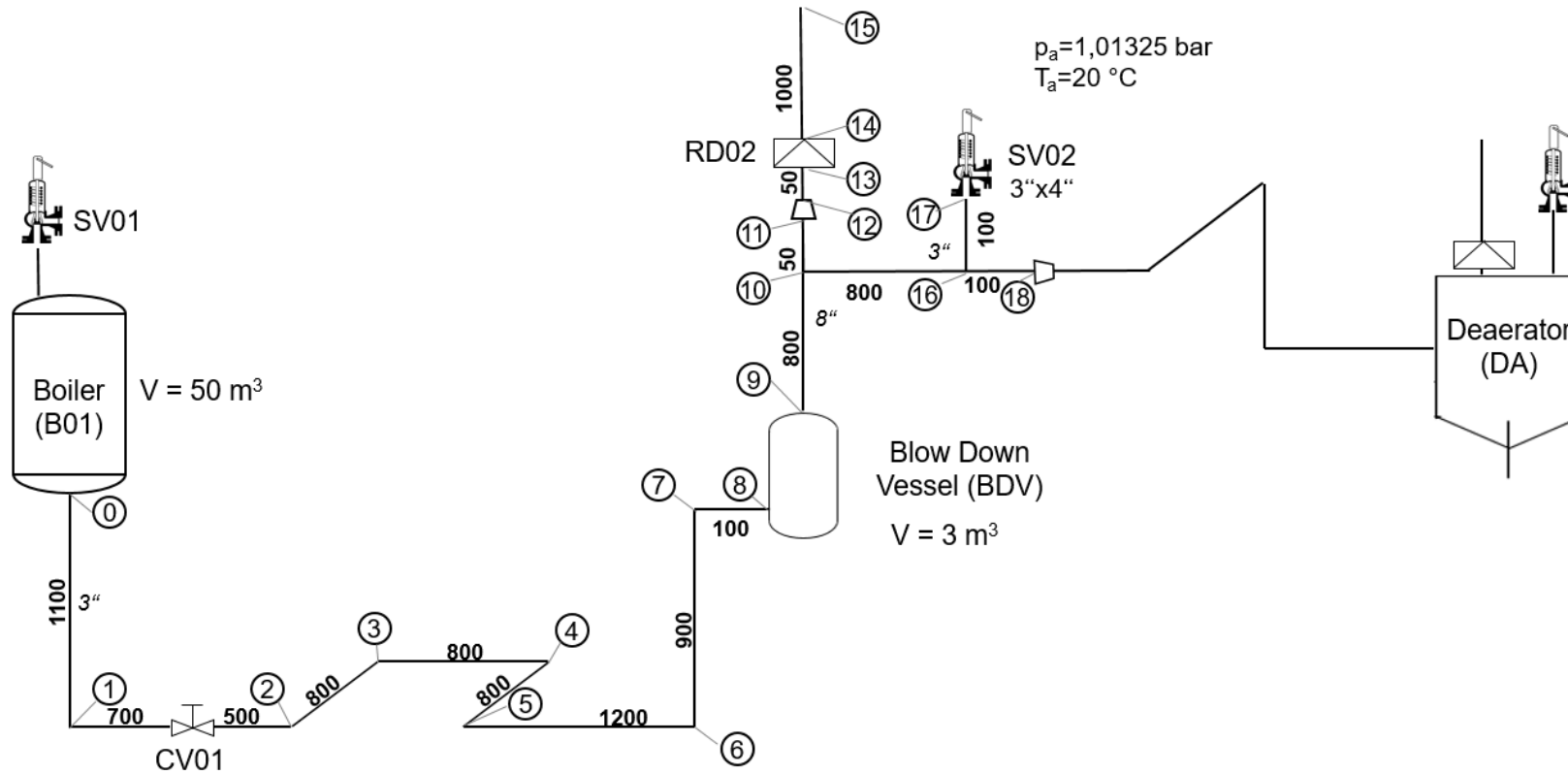


Figure 1: Flow sheet of the sizing scenario