HANDBOOK
SAFETY DEVICES

Castel®
Italian technology

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CHAPTER 9
BURSTING DISC DEVICES IN SERIES 3070

GENERAL DESCRIPTION

Safety device 3070 is a pressure relief device that cannot be closed again, in which a bursting disc is sensitive to a positive differential pressure between the upstream and downstream sections. It is designed to burst at a specified pressure.
Bursting discs in series 3070 are identified by means of:

- a model number formed of an alphanumerical code that includes:
  - the family identity (for ex. 3070/44C)
  - the type of connection (C = NPT)
  - the burst pressure, expressed in bar, multiplied by 10 (for ex. 140)
- a serial number for the lot production.

CONSTRUCTION

Bursting disc holder: this is the body of the device; it is manufactured in two halves, screwed together, that hold the burst disc in position. The two body halves are obtained through bar machining. The lower half of the body houses the inlet connection, while the upper half houses the outlet connection and two 1/8" NPT female service ports.
Material used: EN 12164-CW614N brass

Bursting discs: the discs are designed and tested, according to the requirements of EN ISO 4126-2:2003, to burst at a pre-defined pressure. This pressure is called specified burst pressure, and is related to an associated temperature and a burst tolerance. The disc is manufactured from a calibrated gauge of nickel sheet, contained by a copper ring case.

SCOPE

Use: protection against possible overpressure of the apparatuses listed below, with regard to the operating conditions for which they have been designed:

- Refrigeration system or heat pump components, for instance: condensers, liquid receivers, evaporators, liquid accumulators, positive displacement compressor discharge, heat exchangers, oil separators, or piping. (reference standard: EN 378-2:2016)

Fluids: the bursting disc devices in series 3070 can be used with:

a. Refrigerant fluids in liquid or gaseous state belonging to Group 2:
   - HCFC (R22)
   - HFC (R134a , R404A , R407C , R410A , R507)
   - HFO and HFO/HFC mixtures (R1234ze , R448A , R449A , R450A , and R452A)
   - R744

with reference to Article 13, Para. 1(b) of Directive 2014/68/EU (EC Regulation No. 1272/2008).

b. Air and nitrogen (reference Directive: 2009/105/EC)

The bursting disc devices in series 3070, which can only be used in combination with safety valves in series 3061 or 3065, can be used with:

c. Refrigerant fluids in liquid or gaseous state belonging to Group 1:
   - HFC (R32)
   - HFO (R1234yf)
   - HC (R290 , R600 , R600a)

with reference to Article 13, Para. 1(a) of Directive 2014/68/EU (EC Regulation No. 1272/2008).

For specific applications with refrigerant fluids not listed above, please contact Castel Technical Department.

MARKING

In compliance with the provisions of Article 19 of Directive 2014/68/EC, the following information is reported on the bursting disc holder:

- Manufacturer's mark
- CE marking
- Identification number of the notified body involved in the production control phase
- device model
- Flow section
- Indication of flow direction
- Bursting pressure
- Performance tolerances
- Temperature associated with bursting pressure
- Production date
- Lot number

DOCUMENTATION

The bursting disc devices in series 3070 are supplied with the following documents, provided in the packaging:

- operating instructions for the user, containing all information useful for safety in terms of assembly, commissioning, use, and maintenance.
- Compliance Statement for the equipment according to Directive 2014/68/EU, required in Article 17 and issued in compliance with Annex IV of the same directive.

BURSTING DISC DEVICES SELECTION

Directive 2014/68/EU requires that pressure equipment, in which permissible limits are reasonably likely to be exceeded, shall be fitted with suitable protection devices, for instance safety devices such as bursting disc devices. Such devices shall prevent pressure from permanently exceeding the maximum allowable pressure (PS) of the equipment they protect. In any case, a short pressure peak limited to 10% of maximum allowable pressure is permitted.

The bursting disc safety device 3070 may be used either as sole pressure relief device or in conjunction with a Castel safety valve (types 3030, 3060, 3061, or 3065). The disc and valve combination prevents refrigerant leakage through the safety valve and the total loss of refrigerant after bursting. The disc and valve combination can be also equipped with a suitable pressure switch to detect if the valve has discharged.

The bursting pressure of a bursting disc is affected by the operating temperature of fluid contained in the equipment to be protected. The specified bursting pressure (Pb), stamped on the body of the bursting disc, is the nominal bursting pressure at the associated temperature of 22 °C. At higher operating temperatures, the nominal bursting pressure is reduced while at lower operating temperatures, the nominal bursting pressure is increased. Refer to table 6 for temperature adjustment factors for Pb.

As to the selection and sizing of the suitable protection device, users shall refer to the specific product and sector standards listed below:

- Standard EN ISO 4126-2: 2003: “Safety devices for protection against excessive pressure – Part 2: Bursting disc safety devices” specifies the design, manufacturing, inspection, testing, certification, marking and packaging requirements for bursting disc safety devices.

- EN ISO 4126-3:2006 Safety devices for protection against excessive pressure – Part 3: Safety valves and bursting disc safety devices in combination” specifies the general requirements for design, application and marking for a product assembled from the in-series combination of a safety valve and bursting disc safety device.

- EN ISO 4126-6: 2003: “Safety devices for protection against excessive pressure – Part 6: Application, selection and installation of bursting disc safety devices” gives guidance on the application, selection and installation of bursting disc safety devices used to protect against overpressure.

- EN 378-2:2016: “Refrigerating systems and heat pumps – safety and environmental requirements – Part 2: Design, construction, testing, marking and documentation” provides a general outline of the protection devices to be used in refrigerating systems and their characteristics (Para. 6.2.5) and the criteria for the selection of the device suitable for the type and size of the system component to be protected (Para. 6.2.6).

- EN 13136:2013: “Refrigerating systems and heat pumps – Pressure relief devices and their associated piping – Methods for calculation” highlights the possible causes of overpressure in a system and provides users with the tools for sizing pressure relief devices, among which safety valves.

SIZING OF BURSTING DISC DEVICES DESIGNED TO DISCHARGE GAS OR VAPOUR AT CRITICAL FLOW (REF. EN ISO 4126-6:2003)

A bursting disc safety device which discharges to atmosphere works at critical flow. For the definition of critical flow, please see Chapter 5.

Bursting disc devices designed to discharge gas or vapour at critical flow must be sized according to the following formula:

$$A_c = 3{,}469 \times \frac{Q_{md}}{C \times \alpha} \times \sqrt{\frac{v_o}{p_o}} \quad [mm^2]$$

where:

- A_c = minimum cross-section area of the bursting disc [mm^2]
- Q_{md} = minimum required discharge flow rate of the bursting disc [kg/h]
- α = bursting disc coefficient of discharge
- p_o = bursting pressure [bar abs]
- v_o = specific volume of gas or vapour at discharge conditions p_o and T_o, where T_o is the fluid temperature at bursting disc inlet, defined by the user or by the designer [m^3/kg]
- C = expansion rate as a function of the k coefficient in the isentropic equation T_o calculate C and to find the values of k and C for the more common refrigerants, see Chapter 5.

- EN ISO 4126-6:2003 establishes different values for the coefficient of discharge, “α”, depending on the nozzle entry configuration where the bursting disc is mounted. The following cases are demonstrated in the aforesaid Standard, Par. C.2.2.1:
- In case of an internally protruding branch/nozzle: $\alpha = 0.68$
- In case of a flush branch/nozzle whose inlets are not of hydrodynamic configuration: $\alpha = 0.73$
- In case of a flush branch/nozzle with rounded or chamfered inlets: $\alpha = 0.80$

The evaluation of the minimum required discharge capacity of the bursting disc device is closely linked to the type of system where the equipment it protects is installed, with the causes that may cause it to burst, i.e.:

- external heat sources
- internal heat sources
- increased pressure caused by a positive displacement compressor

For the calculation of minimum required discharge capacity in these three cases see Chapter 5 “Selection Criteria for Safety Valves” in this technical handbook.

SIZING OF COMBINED SAFETY DEVICES DESIGNED TO DISCHARGE GAS OR VAPOUR AT CRITICAL FLOW (REF. EN ISO 4126-3:2006)

A **combination** is an installation which includes a bursting disc safety device installed at most five pipe diameters before the inlet of a safety valve. The combination of a specific safety valve with a bursting disc device is characterized by a combination discharge capacity coefficient “F_d”. According to EN ISO 4126-3: 2006, this coefficient is the ratio of the average of the discharge coefficients (“K_d”) of the combination, measured in test bench flow rate tests, to the certified discharge coefficient (“K_d)” of the safety valve alone. The same standard also permits, as an alternative to the tests to determine “K_d” of the group, the use of a predefined discharge coefficient (“F_d”), equal to 0.9, a slightly lower value than that which could be obtained from testing. Therefore, to size the combination of a safety valve (3030. 3060, 3061 or 3065) with a bursting disc safety device (3070), please follow the procedure provided in Chapter 5, but multiply the certified coefficient of discharge (“K_d”) by 0.9.

INSTALLATION OF BURSTING DISC DEVICES AND COMBINATIONS

Bursting disc safety device 3070 must never be subjected to a negative pressure differential upstream and downstream of the disc (for example: discharge to the atmosphere and pressure inside the equipment to be protected lower than that of the atmospheric pressure) to avoid damaging or breaking the disk. For this reason, safety device 3070 must always be used along with a cut-off device (such as valve 3064/44) which can exclude device 3070 any time there is a vacuum in the equipment to be protected.

When the bursting disc discharges it is necessary to replace the entire unit, as safety devices 3070 are sealed components and the bursting disc cannot be replaced.

The maximum operating pressure of the equipment to be protected must not be greater than 75 % of the burst pressure of device 3070 to avoid damages to the disc or leakage. If the operating pressure exceeds 85 % of the burst pressure, safety device 3070 must be replaced immediately.

As far as the installation of bursting disc safety devices and combined devices is concerned, remember these basic points:

- Safety devices must be installed in an area of the system where vapours or gases are present and there is no fluid turbulence.
- Vessels joined by piping, of a diameter deemed by the manufacturer and the user to be adequate, without any stop valves between them, may be considered as a single vessel for the installation of a safety device.
- The fitting between the combined device and the equipment to be protected must be as short as possible. Furthermore, the cross-section of the piping must not be smaller than the valve inlet. In any case, EN 13136:2013 states that the pressure drop between the protected vessel and the combined device, at discharge capacity, shall not exceed 3% of the pressure setting value, including any accessories in the line.
- The location selected for installation of the safety device must consider that its operation involves the discharge of the refrigerant fluid under pressure, sometimes at high temperature. Where there is the risk of causing injuries to people nearby, exhaust piping must be provided, sized so as to not compromise the operation of the device. When installing combined devices, EN 13136:2013 requires that this piping must not generate, at discharge capacity, a back-pressure exceeding 10% of the valve setting pressure. In the event of multiple valves installed in parallel, it is highly recommended that each valve be fit with a dedicated exhaust line rather than a single manifold for all of the valves. The risk of the latter solution is to create an overpressure in the manifold determined when a valve discharges. This overpressure can modify the operating characteristics of all the other valves installed in parallel.

To calculate the pressure loss in either the upstream line (between vessel and safety device) or the downstream line (between safety device and atmosphere) refer to Chapter 5 “Selection Criteria for Safety Valves” in this technical handbook.

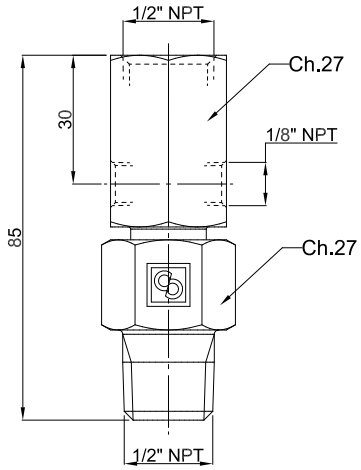

TABLE 26: General characteristics of rupture discs 3070			
Catalogue Number		3070/44	
Connections	Inlet male	1/2" NPT	
	Outlet female	1/2" NPT	
	Service	2 x 1/8" NPT	
Inlet connection wrench torque (min/max) [Nm]		21/30	
Flow Diameter [mm]		12	
Flow Section [mm^2]		113	
TS [°C]		- 50 / + 150	
TA [°C]		- 40 / + 50	
Bursting Pressure Pb [bar]		14,0	
		15,0	
		16,0	
		19,0	
		21,0	
		24,0	
		24,8	
		25,0	
		27,0	
		27,5	
		28,0	
		44	
Pb tolerance	from 14 up to 19 bar	+/- 15 %	
	from 21 up to 44 bar	+/- 10%	
Coincident temperature Ta [°C]		22	
Correction factor of Pb for Ta ≠ 22 °C		-50 °C	1,13
		-35 °C	1,12
		-25 °C	1,10
		-10 °C	1,03
		-0 °C	1,03
		22°C	1,00
		40°C	0,99
		60 °C	0,97
		80 °C	0,95
		100 °C	0,94
		150 °C	0,93
Max operating pressure		75 % Pb	
Risk Category according to PED Recast		IV	

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