



HANDBOOK
SAFETY DEVICES

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 **Castel**[®]
Italian technology

CHAPTER 10 ■

FUSIBLE PLUGS IN SERIES 3080 AND 3082



GENERAL DESCRIPTION

According to the definition given in Para. 3.6.4 of EN 378-1:2016, a fusible plug is a device containing material that melts at a predetermined temperature, thereby relieving the pressure.

Castel has decided to classify the fusible plugs in series 3080/.C and 3082/.C in the Risk Category I. This determines their use, as protection devices, on specific pressure equipment, in the same Risk Category I, in compliance with Annex II, Point 2, of Directive 2014/68/EU. Consequently, fusible plugs in series 3080/.C and 3082/.C **cannot be used**, as sole protection devices, on pressure equipment in Risk Categories greater than I.

CONSTRUCTION

The body of the fusible plug is an NPT threaded plug drilled with a through hole, with the taper opposite that of the thread. This hole is filled with a specific amount of fusible alloy, with known melting point.

Materials used:

- EN 12164 – CW 614N lead-free hot tinned brass for the plug
- Cadmium-free eutectic alloy with several components for the fusible material

SCOPE

Use: fusible plugs are basically used to protect the components in a refrigerating system or heat pump against possible overpressure, based on the operating

conditions for which they have been designed, caused by an excessive external heat source, such as fire. (Para. 6.2.6.6 of EN 378-2:2016)

Fluids: fusible plugs in series 3080 and 3082 can be used with Group 2 refrigerant fluids in either the gaseous or vapour state:

- HCFC (R22)
- HFC (R134a , R404A , R407C , R410A , R507)
- HFO and HFO/HFC mixtures (R1234ze , R448A , R449A , R450A , and R452A)

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

MARKING

In compliance with the provisions of Article 19 of Directive 2014/68/EU and of Para. 7.3.3 of EN 378-2:2016, the following data are reported on the hex nut of fusible plug:

- CE marking
- Castel logo
- Maximum allowable pressure, PS
- Melting point

INSTALLATION

If a fusible plug is mounted on a pressure vessel, it must be installed in a position in which the refrigerant in the superheated gaseous state does not compromise proper operation. Fusible plugs must never be covered by thermal insulation.

Discharge from fusible plugs shall take place so that persons and property are not endangered by the released refrigerant. (Para. 6.2.6.6 of EN 378-2:2016).

EN 378-2:2016 establishes that a fusible plug cannot be used as pressure relief device on vessels containing refrigerants in Groups A2, B1, B2, A3 or B3. The same standard establishes that a fusible plug cannot be used as the sole pressure relief device between a refrigerant containing vessel and the atmosphere in systems with a refrigerant charge greater than 2.5 kg of Group A1 refrigerants (for ex. R22, R134a, R404A, R407C, R410A, R507).

FUSIBLE PLUG SELECTION

Directive 2014/68/EU requires that pressure equipment, in which it is reasonably possible to forecast that the admissible limits will be exceeded, shall be fit with suitable protection devices, for instance safety devices such as fusible plugs. 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.

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

- 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 fusible plugs.

SIZING OF FUSIBLE PLUGS (REF. EN 13136:2013)

As fusible plugs discharge to the atmosphere, they always work in critical flow (for the definition of critical flow, see Chapter 5).

Fusible plugs must be sized as follows:

$$A_c = 3,469 \times \frac{Q_{md}}{C \times K_{dr}} \times \sqrt{\frac{v_o}{P_o}} \quad [\text{mm}^2]$$

where:

- A_c = minimum net cross-section area of the fusible plug orifice [mm^2]
- Q_{md} = minimum required discharge flow rate of fusible plug [kg/h]
- K_{dr} = derated coefficient of discharge of fusible plug, equal to $0.9 \times K_d$
- p_o = pressure upstream of the fusible plug, inside the equipment to be protected [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 plug inlet during discharge, defined by the user or by the designer [m^3/kg]

- C = expansion coefficient as a function of the k coefficient (as measured at 25°C , see Para. 7.2.3 of EN 13136:2013) in the isentropic equation calculated with the following formula:

$$C = 3,948 \times \sqrt{k \times \frac{2}{k+1} \left(\frac{k+1}{k-1} \right)^{\frac{k+1}{k-1}}}$$

To find the values of k and C for the more common refrigerants, see Chapter 5

The evaluation of the minimum required discharge capacity of a fusible plug is closely linked to the main cause that can cause its opening, which is an external heat source. The minimum required discharge capacity is determined by the following formula:

$$Q_{md} = \frac{3600 \times \varphi \times A_{surf}}{h_{vap}} \quad [\text{kg/h}]$$

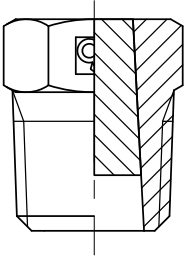
where:

- φ = density of heat flow rate, assumed to be $10 \text{ [kW/m}^2\text{]}$
- A_{surf} = external surface area of the vessel [m^2]
- h_{vap} = latent heat of vaporization of liquid at p_o [kJ/kg]

EN 13136:2013 also establishes the following maximum limits for the value of K_{dr} , based on the type of connection between the fusible plug and the equipment to be protected:

- flush or flared fitting to the housing of the vessel: $K_{dr} = 0.70$
- internally protruding fitting to the housing of the vessel: $K_{dr} = 0.55$

TABLE 27: General characteristics, dimensions and weights of fusible plugs 3080 and 3082

	Catalogue Number	NPT Connections	Flow Diameter [mm]	Flow Section [mm^2]	Kd	Melting Point [$^\circ\text{C}$]	Maximum working temperature [$^\circ\text{C}$]	PS [bar] (1)	Hexagonal Key	Wrench Torque min/max [Nm]	Weight [g]	Risk Category according to PED Recast
	3080/1C	1/8"	4,9	18,8	0,91	79	68	42	12	7 / 10	11	I
	3080/2C	1/4"	5,7	25,5					17	10 / 15	23	
	3080/3C	3/8"	8,5	56,7					14 / 20	39		
	3080/4C	1/2"	9,3	67,9					22	21 / 30	76	
	3082/1C	1/8"	4,9	18,8		138	127	30	12	7 / 10	11	
	3082/2C	1/4"	5,7	25,5					17	10 / 15	23	
	3082/3C	3/8"	8,5	56,7					14 / 20	39		
	3082/4C	1/2"	9,3	67,9					22	21 / 30	76	

(1): at maximum working temperature

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Castel Srl - Via Provinciale 2-4 - 20060 Pessano con Bornago - MI