SIZING FOR TWO-PHASE LIQUID/VAPOR RELIEF

Along with a typical instrument data sheet for each tag number the following process data is required for two-phase sizing per API 520.

<u>REFERENCE TO:</u> API STANDARD 520 9TH EDITION, JULY 2014,
SIZING, SELECTION, AND INSTALLATION OF PRESSURE-RELIEVING DEVICES
PART I SIZING AND SELECTION

The following excerpts are taken from the API 520 9th Edition and can be used to identify which two-phase liquid/vapor relief scenario (according to API 520 9TH Edition) fits your application. Proceed to the corresponding method and fill in the needed process information.

TWO PHASE RELIEF SCENARIOS

1. Two-phase system (liquid vapor mixtures, including saturated liquid) enters the PRV and flashes. No noncondensable[a] gas present. Also includes fluids both above and below the thermodynamic equilibrium point in condensing two-phase flow.

   Example: Saturated liquid/vapor propane system enters PRV and the liquid propane flashes. **Method:** C.2.1 or C2.2.

2. Two-phase system (highly sub-cooled[b] liquid and either non-condensable gas, condensable vapor or both) enters PRV and does not flash.

   Example: Highly sub-cooled propane and nitrogen enters PRV and the propane does not flash. **Method:** C.2.1 or C.2.2

3. Two-phase system (the vapor at the inlet contains some non-condensable gas and the liquid is either saturated or sub-cooled) enters PRV and flashes. Non-condensable gas enters PRV.

   Example: Saturated liquid/vapor propane system and nitrogen enters PRV and the liquid propane flashes
   Method: C.2.1 or C.2.2

4. Sub-cooled (including saturated liquid) enters PRV and flashes. Non-condensable vapor or non-condensable gas present.

   Example: Sub-cooled propane enters PRV and flashes
   Method: C.2.1 or C.2.3

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[a]: A noncondensable gas is a gas that is not easily condensed under normal process conditions. Common noncondensable gases include air, oxygen, nitrogen, hydrogen, carbon dioxide, carbon monoxide, and hydrogen sulfide.

[b]: The term highly subcooled is used to reinforce that the liquid does not flash passing through the PRV.

METHOD C.2.1: Sizing by Direct Integration of the Isentropic Nozzle Flow

❑ W = Mass flow rate (kg/hr) of the two-phase system

❑ G = Mass flux (kg/s·m^2)

❑ x_o = Vapor mass fraction (quality) at the PRV inlet

METHOD C.2.2: Sizing for Two-Phase Flashing or Non-Flashing flow through a PRV using the Omega Method

- ❑ W = Mass flow rate (kg/hr) of the two-phase system

- ❑ ω = Omega Parameter (if known)

- ❑ v_o = Specific volume of the two-phase system at the PRV inlet (m^3/kg)

- ❑ v_9 = Specific volume evaluated at 90% of the PRV inlet pressure P_o (m^3/kg); when determining v_9, the flash calculation should be carried out isentropically, but an isenthalpic (adiabatic) flash is sufficient for low quality mixtures far from the thermodynamic critical point.

- ❑ x_o = Vapor mass fraction (quality) at the PRV inlet

METHOD C.2.3: Sizing for Sub-cooled Liquid at the PRV inlet using the Omega Method

- ❑ Q = Volumetric flow rate (LPM) of the two-phase system

- ❑ ω_s = Saturated omega parameter (if known)

- ❑ ρ_{lo} = Liquid density at the PRV inlet (kg/m^3)

- ❑ ρ_9 = Density evaluated at 90% of the saturation (vapor) pressure P_s, corresponding to the PRV inlet temperature T_o, (kg/m^3). For a multi component system, use the bubble point pressure corresponding to T_o for P_s. When determining ρ_9, the flash calculation should be carried out isentropically, but an insenthalpic (adiabatic) flash is sufficient for low quality mixtures far from the thermodynamic critical point.

- ❑ P_s = Saturation (vapor) pressure corresponding to T_0 (psia). For multi component system use the bubble point pressure corresponding to T_0. Units to be the same as set pressure.

- ❑ Saturated fluid (YES/NO)