

NEXT-100 DIMENSIONS

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Mass of Xenon in Vessel at Maximum Operating Pressure (absolute):

$$M_{Xe_100} := 100\text{kg}$$

Maximum Operating pressure (absolute):

$$P_{MOPa_100} := 15\text{bar}$$

Minimum Operating pressure (minus sign indicates external pressure)

$$P_{min} := -1.5\text{bar}$$

this is driven by the need to pull vacuum with a possible hydrostatic head of 0.4bar if water tank is used for shielding

Operating Temperature, physical constants:

$$T_{amb} := 293\text{K}$$

$$R := 8.314\text{J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$$

$$M_{a_Xe} := 136\text{gm}\cdot\text{mol}^{-1}$$

Critical Pressure, temperature of Xenon:

$$P_{c_Xe} := 58.40\text{bar} \quad T_{c_Xe} := 15.6\text{K} + 273\text{K} \quad T_{c_Xe} = 288.6\text{K}$$

reduced pressure (MOP):

reduced pressure (100kg total Xe, 8 bar estimated pressure)

$$P_{r_100} := \frac{P_{MOPa_100}}{P_{c_Xe}} \quad P_{r_100} = 0.257 \quad P_{r_8\text{bar}} := \frac{8\text{bar}}{P_{c_Xe}} \quad P_{r_8\text{bar}} = 0.137$$

reduced temperature

$$T_r := \frac{T_{amb}}{T_{c_Xe}} \quad T_r = 1.015$$

Compressibility Factor: from chart for pure gasses shown below

$$Z_{Xe_15\text{bar}} := .93$$

$$Z_{Xe_8\text{bar}} := .96$$

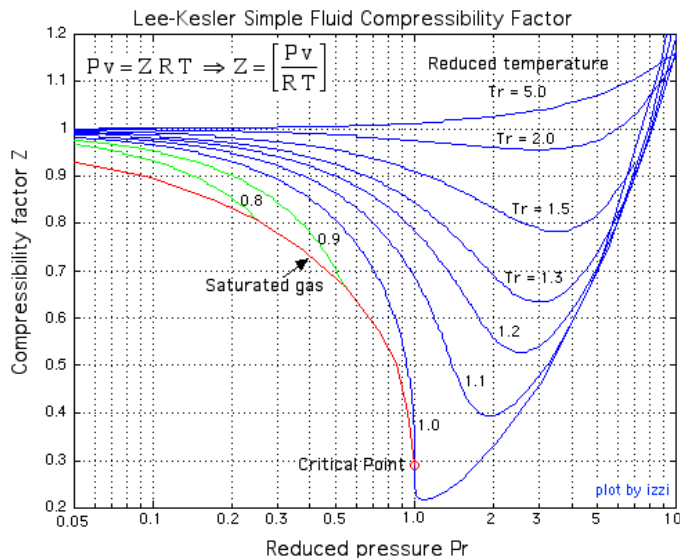


Fig. 6 Compressibility Factor, pure gasses

Number of moles:

$$n_{Xe_100} := \frac{M_{Xe_100}}{M_{a_Xe}} \quad n_{Xe_100} = 735.294\text{ mol}$$

Vessel and system volumes, from CAD measurements

$$V_v := 3.07\text{m}^3 \quad (\text{includes nozzle extensions})$$

ref: A Generalized Thermodynamic Correlation based on Three-Parameter Corresponding States, B.I.Lee & M.G.Kesler, AIChE Journal, Volume 21, Issue 3, 1975, pp. 510-527' (secondary ref. from: <http://www.ent.ohiou.edu/~thermo/>)

$$V_{ics} := .665\text{m}^3 \quad (12 \text{ cm copper bars})$$

$$V_{fc} := .167\text{m}^3 \quad (\text{TAMU design})$$

$$V_{tp} := .112\text{m}^3 \quad (\text{assume a 12 cm disk shield})$$

$$V_{ep} := .117\text{m}^3 \quad (\text{with thick carrier plate and central manifold})$$

Total Volume:

$$V_t := V_v - (V_{ep} + V_{ics} + V_{fc} + V_{tp}) \quad V_t = 2.009\text{m}^3$$

$$V_{t_no_ICS} := V_t + V_{ics} \quad V_{t_no_ICS} = 2.674\text{m}^3$$

Pressures for 100 kg Xe total:

$$P_{100\text{kg_tot}} := \frac{n_{Xe_100} \cdot Z_{Xe_8\text{bar}} \cdot R \cdot T_{amb}}{V_t} \quad P_{100\text{kg_tot}} = 8.445 \text{ bar}$$

$$P_{100\text{kg_tot_no_ICS}} := \frac{n_{Xe_100} \cdot Z_{Xe_8\text{bar}} \cdot R \cdot T_{amb}}{V_{t_no_ICS}} \quad P_{100\text{kg_tot_no_ICS}} = 6.345 \text{ bar}$$