NEXT-100 DIMENSIONS D. Shuman Jan 10, 2013

Mass of Xenon in Vessel at Maximum Operating Pressure (absolute): rev A Jan 11, 2013- add EP_ICS)

$M_{Xe\_100} := 100kg$

Maximum Operating pressure (absolute):

$P_{MOPa\_100} := 15bar$

Minimum Operating pressure (minus sign indicates external pressure)

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

$T_{amb} := 293K$ $R := 8.314J \cdot mol^{-1} \cdot K^{-1}$ $M_{a\_Xe} := 136gm \cdot mol^{-1}$

Critical Pressure, temperature of Xenon:

$P_{c\_Xe} := 58.40bar$ $T_{c\_Xe} := 15.6K + 273K$ $T_{c\_Xe} = 288.6\,K$

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

$P_{r\_100} := \frac{P_{MOPa\_100}}{P_{c\_Xe}}$ $P_{r\_100} = 0.257$ $P_{r\_8bar} := \frac{8bar}{P_{c\_Xe}}$ $P_{r\_8bar} = 0.137$

reduced temperature

$T_r := \frac{T_{amb}}{T_{c\_Xe}}$ $T_r = 1.015$

Compressibility Factor: from chart for pure gasses shown below

$Z_{Xe\_15bar} := .93$ $Z_{Xe\_8bar} := .96$

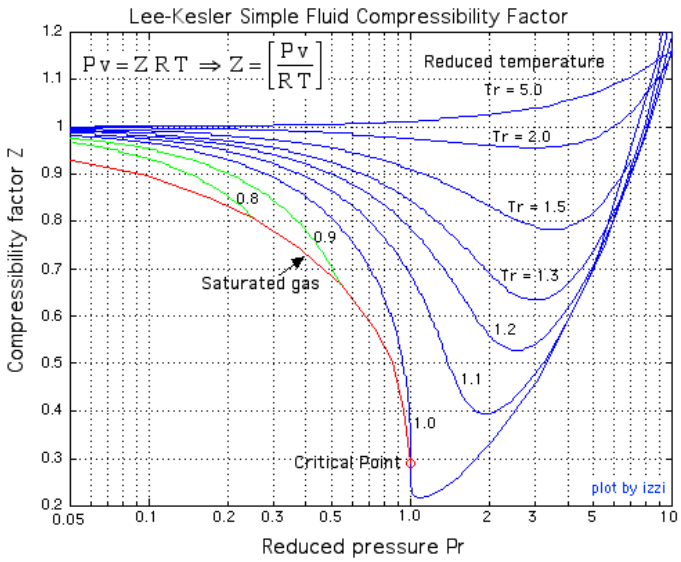

Fig. 6 Compressibility Factor, pure gasses

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/

Number of moles:

$n_{Xe\_100} := \frac{M_{Xe\_100}}{M_{a\_Xe}}$ $n_{Xe\_100} = 735.294\,mol$

Vessel and system volumes, from CAD measurements

$V_v := 3.07m^3$ (includes nozzle extensions)

$V_{ICS} := .665m^3$ (12 cm copper bars only)

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

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

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

$V_{ep\_ICS} := .145m^3$ (copper shield disk behind EP) <---rev. A added this component

Total Volume:

$V_t := V_v - (V_{ep} + V_{ICS} + V_{fc} + V_{tp} + V_{ep\_ICS})$ $V_t = 1.864\,m^3$

$V_{t\_no\_ICS} := V_t + V_{ICS} + V_{ep\_ICS}$ $V_{t\_no\_ICS} = 2.674\,m^3$

Pressures for 100 kg Xe total:

$$P_{100kg\_tot} := \frac{n_{Xe\_100} \cdot Z_{Xe\_8bar} \cdot R \cdot T_{amb}}{V_t} \qquad P_{100kg\_tot} = 9.102\,bar$$

$$P_{100kg\_tot\_no\_ICS} := \frac{n_{Xe\_100} \cdot Z_{Xe\_8bar} \cdot R \cdot T_{amb}}{V_{t\_no\_ICS}} \qquad P_{100kg\_tot\_no\_ICS} = 6.345\,bar$$

Pressures for 150 kg Xe total:

$$P_{150kg\_tot} := \frac{1.5n_{Xe\_100} \cdot Z_{Xe\_15bar} \cdot R \cdot T_{amb}}{V_t} \qquad P_{150kg\_tot} = 13.226\,bar$$

$$P_{150kg\_no\_ICS} := \frac{1.5n_{Xe\_100} \cdot Z_{Xe\_15bar} \cdot R \cdot T_{amb}}{V_{t\_no\_ICS}} \qquad P_{150kg\_no\_ICS} = 9.22\,bar$$