Discussion:

Dynamic Viscosity using sutherlands formular:

$$sutherland\left(T, T_{ref}, \mu_{ref}, S_\mu\right) := \mu_{ref} \cdot \left(\frac{T}{T_{ref}}\right)^{\frac{3}{2}} \cdot \frac{T_{ref} + S_\mu}{T + S_\mu}$$

Knudsen number:

$$knudsen\left(p, T, L_c, \mu_{ref}, T_{ref}, S_\mu\right) := \frac{sutherland\left(T, T_{ref}, \mu_{ref}, S_\mu\right) \cdot R_s}{p \cdot L_c} \cdot \sqrt{\frac{\pi \cdot M_m \cdot T}{2\ k\ N_A}}$$

Reynolds number:

$$reynolds\left(p, T, L_c, Ma, \gamma, \mu_{ref}, T_{ref}, S_\mu\right) := \frac{Ma}{knudsen\left(p, T, L_c, \mu_{ref}, T_{ref}, S_\mu\right)} \cdot \sqrt{\frac{\gamma \cdot \pi}{2}}$$

Fixed variable definitions:

$T_0 := 300\ K \quad p_0 := 1.5\ bar \quad L_c := 20\ micron$

Hydrogen:

$\mu_{ref} := 8.411 \cdot 10^{-5}\ \frac{N\ s}{m^2} \quad T_{ref} := 273\ K \quad S_\mu := 97\ K \quad \gamma := 1.41 \quad M_m := 2.02\ \frac{gram}{mol} \quad R_s := \frac{R_m}{M_m} = 4116.0753 \cdot \frac{1}{K}\ \frac{J}{kg}$

$p_{crit.ratio} := \left(\frac{2}{\gamma + 1}\right)^{\frac{\gamma}{\gamma - 1}} = 0.5266 \quad T_{crit.ratio} := \frac{2}{\gamma + 1} = 0.8299$

$Re_{H2} := reynolds\left(p_0 \cdot p_{crit.ratio}, T_0 \cdot T_{crit.ratio}, L_c, 1, \gamma, \mu_{ref}, T_{ref}, S_\mu\right) = 23.6553$

$Kn_{H2} := knudsen\left(p_0 \cdot p_{crit.ratio}, T_0 \cdot T_{crit.ratio}, L_c, \mu_{ref}, T_{ref}, S_\mu\right) = 0.0629$

Carbondioxide:

$\mu_{ref} := 1.370 \cdot 10^{-5}\ \frac{N\ s}{m^2} \quad T_{ref} := 273\ K \quad S_\mu := 222\ K \quad \gamma := 1.28 \quad M_m := 44.01\ \frac{gram}{mol} \quad R_s := \frac{R_m}{M_m} = 188.9223 \cdot \frac{1}{K}\ \frac{J}{kg}$

$p_{crit.ratio} := \left(\frac{2}{\gamma + 1}\right)^{\frac{\gamma}{\gamma - 1}} = 0.5494 \quad T_{crit.ratio} := \frac{2}{\gamma + 1} = 0.8772$

$Re_{CO2} := reynolds\left(p_0 \cdot p_{crit.ratio}, T_0 \cdot T_{crit.ratio}, L_c, 1, \gamma, \mu_{ref}, T_{ref}, S_\mu\right) = 632.1449$

$Kn_{CO2} := knudsen\left(p_0 \cdot p_{crit.ratio}, T_0 \cdot T_{crit.ratio}, L_c, \mu_{ref}, T_{ref}, S_\mu\right) = 0.0022$

Argon:

$\mu_{ref} := 2.125 \cdot 10^{-5}\ \frac{N\ s}{m^2} \quad T_{ref} := 273\ K \quad S_\mu := 114\ K \quad \gamma := 1.66 \quad M_m := 39.95\ \frac{gram}{mol} \quad R_s := \frac{R_m}{M_m} = 208.122 \cdot \frac{1}{K}\ \frac{J}{kg}$

$p_{crit.ratio} := \left(\frac{2}{\gamma + 1}\right)^{\frac{\gamma}{\gamma - 1}} = 0.4881 \quad T_{crit.ratio} := \frac{2}{\gamma + 1} = 0.7519$

$Re_{CO2} := reynolds\left(p_0 \cdot p_{crit.ratio}, T_0 \cdot T_{crit.ratio}, L_c, 1, \gamma, \mu_{ref}, T_{ref}, S_\mu\right) = 478.704$

$Kn_{CO2} := knudsen\left(p_0 \cdot p_{crit.ratio}, T_0 \cdot T_{crit.ratio}, L_c, \mu_{ref}, T_{ref}, S_\mu\right) = 0.0034$