1 Gas Calculations and MIPS

The atmospherics simulation in Stationeers currently features seven gasses that behave according to most ideal gas laws.

Name	Formula (g)	Specific heat (c_g)
Hydrogen	H_2	20.4
Nitrogen	N_2	20.6
Oxygen	O_2	21.1
Pollutant	X	24.8
Carbon dioxide	CO_2	28.2
Water	H_2O	72
Nitrous oxide	N_2O	23

Where specific heat is given in joules per mole Kelvin (and note that a joule is equivalent to a liter kilo-pascal). We will index these gases via their formula, and let G be the set of indices:

$$G = \{ \mathrm{H_2}, \mathrm{N_2}, \mathrm{O_2}, \mathrm{X}, \mathrm{CO_2}, \mathrm{H_2O}, \mathrm{N_2O} \}.$$

1.1 Moles and pressures in compositions

Fix A a gas mixture, and let $g \in G$ be the index of one of the seven gases. We define n_A to be the total number of moles of any and all gases in A, and $n_A(g)$ to be the number of moles of gas g specifically in A.

Note that P_{AB} is the sum of the pressures (partial pressures) P_A and P_B.

1.2 Final temperature of mixing two gas compositions

Let A and B be gas compositions, and let P_A, T_A and $n_A(g)$ be the kilo-pascal pressure, Kelvin temperature, and moles of gas $g \in G$ for composition A; similarly for B. To calculate T_{AB} the final temperature of combining the mixtures in a one-to-one ratio with a gas mixer:

$$T_{AB} = \frac{T_A S_A + T_B S_B}{S_A + S_B} \tag{1}$$

Where, for M_1 either A or B and $M_2 = A$ if M_1 is B, or $M_2 = B$ if M_1 is A

$$S_{M_1} = p_{M_1} s_{M_1} \tag{2}$$

And where

$$p_{M_1} = \frac{P_{M_2}}{P_{AB}} \tag{3}$$

$$s_{M_1} = \sum_{g \in G} s_{M_1}(g) \tag{4}$$

$$s_{M_1}(g) = \frac{n_{M_1}(g)}{n_{M_1}} \cdot c_g. \tag{5}$$

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alias sensorA d0
alias sensorB d1

alias PB r0
alias PA r1
alias PAB r2 # P_{AB} = P_A+P_B
alias ptr r3
alias TM
alias SM r8 # S_{M_1}
alias pM r9 # p_{M_1}
alias nM r10 # n_{M_1}
alias sM r11 # s_{M_1}
alias sMg r12 # s_{M_1}(g)
alias cg r13 # c_g
alias x r14
alias y r15
alias numerator
alias denominator

main:
calculateTAB # equation (1)
l PA sensorA Pressure # P_A
l PB sensorB Pressure # P_B
add PAB PA PB

move ptr 0
jal MIncrement # S_A, P_B, T_A
jal MIncrement
div TAB numerator denominator # equation (1)
j main

MIncrement: # equation (2)
push ra
alias sensor dr3 # d(ptr)
# equation(3)
alias pM rr3  # pM           = P_{M_2}
div pM pM PAB # pM = p_{M_1} = P_{M_2}/P_{AB}
l nM sensor Quantity # nM = n_{M_1}
# equation (4)
move sM 0
# equation (5) for each gas
l nMg sensor RatioVolatiles # Hydrogen
move cg 20.4
jal sMgIncrement
l nMg sensor RatioNitrogen
move cg 20.6
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jal sMgIncrement
l nMg sensor RatioOxygen
move cg 21.1
jal sMgIncrement
l nMg sensor RatioPollutant
move cg 24.8
jal sMgIncrement
l nMg sensor RatioCarbonDioxide
move cg 28.2
jal sMgIncrement
l nMg sensor RatioWater
move cg 72
jal sMgIncrement
l nMg sensor RatioNitrousOxide
move cg 23
jal sMgIncrement
mul SM pM sM # S_{M_1} = p_{M_1}*s_{M_1}
l TM sensor Temperature
mul TM TM SM
add numerator numerator TM
add denominator SM
add ptr 1 ptr # advance composition index
pop ra
j ra

sMgIncrement:
mul nMg nMg nM # n_M(g) = gas ratio * n_M
mul nMg nMg cg
add sM sM nMg # s_{M_1} += n_{M_1}(g)/n_{M_1}*c_g
j ra
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