C.01.01.Z1 – Biblioteca Simplificada de Gás Ideal

Aplicação em FTHA – Finite Time Heat Addition Otto Engine Model

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https://github.com/CNThermSci/ApplThermSci

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Equação de Estado (EoS): Comportamento $P - T - v$

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$$v = \frac{RT}{P} \qquad \bar{v} = \frac{\bar{R}T}{P} \quad \therefore$$

Equação de Estado (EoS): Comportamento $P - T - v$

$$
\begin{aligned}
Pv &= RT & P\bar{v} &= \bar{R}T & &\rightharpoondown \\
P &= \frac{RT}{v} & P &= \frac{\bar{R}T}{\bar{v}} & &\rightharpoondown \\
T &= \frac{Pv}{R} & T &= \frac{P\bar{v}}{\bar{R}} & &\rightharpoondown \\
v &= \frac{RT}{P} & \bar{v} &= \frac{\bar{R}T}{P} & &\therefore
\end{aligned}
$$

Cada equação com forma nas bases mássica, e molar, com $R = \bar{R}/M$ — armazenar $\bar{R}$ e M!

Modelo de $\bar{c}_p(T)$ Polinomial:

$$\bar{c}_p(T) = \sum_{i=1}^{4} a_i T^{i-1}, \qquad T_{min} \leqslant T \leqslant T_{max} \qquad \rightarrow$$

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Armazenar a_i, T_{min} e T_{max} e saber as conversões (i) $a_i \to b_i$ e (ii) $\bar{c}_{p,v}(T) \to c_{p,v}(T)$.

Modelo de $\bar{c}_p(T)$ Polinomial: $\bar{u}(T)$

$$\bar{u}(T) = \int_{T_{ref}}^{T} \bar{c}_v(T)\, dT = \int_{T_{ref}}^{T} \sum_{i=1}^{4} b_i T^{i-1}\, dT, \qquad T_{min} \leqslant T \leqslant T_{max} \qquad \rightharpoondown$$

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- Saber as conversões $\bar{u}(T) \rightarrow u(T)$.

Modelo de $\bar{c}_p(T)$ Polinomial: $\bar{h}(T) = \bar{u}(T) + \bar{R}T$

$$\bar{h}(T) = \int_{T_{ref}}^{T} \bar{c}_p(T)\, dT + \bar{R}T_{ref} = \int_{T_{ref}}^{T} \sum_{i=1}^{4} a_i T^{i-1}\, dT + \bar{R}T_{ref}, \quad T_{min} \leqslant T \leqslant T_{max} \qquad \rightharpoondown$$

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Modelo de $\bar{c}_p(T)$ Polinomial: $P_r(T)$ e $v_r(T)$

$$\left(\frac{P_2}{P_1}\right)_s = \frac{P_{r2}}{P_{r1}} \qquad \left(\frac{v_2}{v_1}\right)_s = \frac{v_{r2}}{v_{r1}} \qquad \rightarrow$$

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$$P_r(T) \equiv e^{\bar{s}^\circ(T)/\bar{R}} \qquad P_r(T) = e^{s^\circ(T)/R}$$

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- Sem requisitos adicionais de armazenamento!

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- Sem requisitos adicionais de armazenamento!
- Sem conversões de base!

Padrões nos Cálculos:

$$\bar{c}_p(T) = a_1 + a_2 T + a_3 T^2 + a_4 T^3, \qquad T_{min} \leqslant T \leqslant T_{max}$$

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$$\bar{h}(T) = \left(a_1 T + \frac{a_2 T^2}{2} + \frac{a_3 T^3}{3} + \frac{a_4 T^4}{4} \right)\Bigg|_{T_{ref}}^{T} + \bar{R} T_{ref}, \qquad T_{min} \leqslant T \leqslant T_{max}$$

Padrões nos Cálculos:

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\begin{aligned}
\bar{c}_p(T) &= a_1 + a_2T + a_3T^2 + a_4T^3, && T_{min} \leqslant T \leqslant T_{max} && \rightharpoondown \\
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\bar{s}^\circ(T) &= \left(a_1 \ln(T) + a_2T + \frac{a_3T^2}{2} + \frac{a_4T^3}{3} \right)_{T_{ref}}^{T} + \bar{s}^\circ_{ref}, && T_{min} \leqslant T \leqslant T_{max} && \therefore
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$$

Padrões nos Cálculos:

$$\bar{c}_p(T) = a_1 + a_2T + a_3T^2 + a_4T^3, \qquad T_{min} \leqslant T \leqslant T_{max} \qquad \neg$$

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- Verificação de limites;
- Coef./func. próprios; e

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- Verificação de limites;
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- Produtos matriciais.

```julia
# Universal gas constant
R̄() = 8.314472 # ± 0.000015 # kJ/kmol·K

# Standard Tref
Tref() = 298.15 # K

# IG (Ideal Gas) structure: values for each gas instance
struct IG
    MW                  # Molecular "Weight", kg/kmol
    CP::Ntuple{4}       # Exactly 4 c̄p(T) coefficients
    Tmin                # T_min, K
    Tmax                # T_max, K
    sref                # s̄°ref, kJ/kmol·K
end
```

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