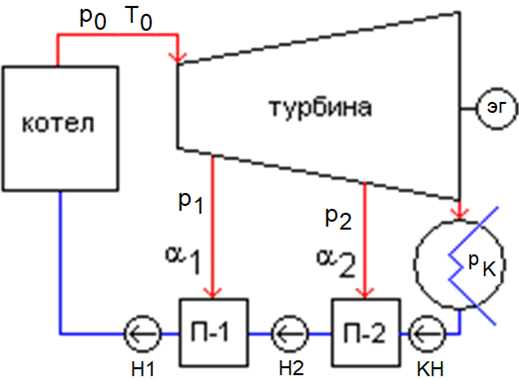


Расчет термического КПД паротурбинной установки с двумя регенеративными подогревателями



Параметры ПТУ

$p_0 := 130 \text{ atm}$ $T_0 := 540 \text{ }^\circ\text{C}$

$p_1 := 70 \text{ atm}$ $p_2 := 30 \text{ atm}$

$p_K := 30 \text{ mmHg}$

$wf := \text{"H2O"}$

$wf := \text{"IF97::H2O"}$

$\eta_T(p_0, T_0, p_1, p_2, p_K) :=$

$T_K := \text{CoolProp_Props}(\text{"T"}, \text{"P"}, p_K, \text{"Q"}, 0.5, wf)$ $h'_{KH} := \text{CoolProp_Props}(\text{"H"}, \text{"T"}, T_K, \text{"Q"}, 0, wf)$ $s_{KH} := \text{CoolProp_Props}(\text{"S"}, \text{"T"}, T_K, \text{"Q"}, 0, wf)$ $T'_{H2} := \text{CoolProp_Props}(\text{"T"}, \text{"P"}, p_2, \text{"Q"}, 0, wf)$ $h'_{H2} := \text{CoolProp_Props}(\text{"H"}, \text{"T"}, T'_{H2}, \text{"Q"}, 0, wf)$ $s_{H2} := \text{CoolProp_Props}(\text{"S"}, \text{"T"}, T'_{H2}, \text{"Q"}, 0, wf)$ $T'_{H1} := \text{CoolProp_Props}(\text{"T"}, \text{"P"}, p_1, \text{"Q"}, 0.5, wf)$ $h'_{H1} := \text{CoolProp_Props}(\text{"H"}, \text{"T"}, T'_{H1}, \text{"Q"}, 0, wf)$ $s_{H1} := \text{CoolProp_Props}(\text{"S"}, \text{"T"}, T'_{H1}, \text{"Q"}, 0, wf)$ $h'_{H1} := \text{CoolProp_Props}(\text{"H"}, \text{"T"}, T'_{H1}, \text{"Q"}, 0, wf)$ $T_{\text{ПБ}} := \text{CoolProp_Props}(\text{"T"}, \text{"P"}, p_0, \text{"S"}, s_{H1}, wf)$ $h'_{H2} := \text{CoolProp_Props}(\text{"H"}, \text{"P"}, p_2, \text{"S"}, s_{H2}, wf)$ $h_0 := \text{CoolProp_Props}(\text{"H"}, \text{"P"}, p_0, \text{"T"}, T_0, wf)$ $s := \text{CoolProp_Props}(\text{"S"}, \text{"P"}, p_0, \text{"T"}, T_0, wf)$ $h_K := \text{CoolProp_Props}(\text{"H"}, \text{"P"}, p_K, \text{"S"}, s, wf)$ $h_1 := \text{CoolProp_Props}(\text{"H"}, \text{"P"}, p_1, \text{"S"}, s, wf)$ $h_2 := \text{CoolProp_Props}(\text{"H"}, \text{"P"}, p_2, \text{"S"}, s, wf)$ $h_{\text{ПБ}} := \text{CoolProp_Props}(\text{"H"}, \text{"P"}, p_0, \text{"S"}, s, wf)$ $T'_{H2} := \text{CoolProp_Props}(\text{"T"}, \text{"P"}, p_2, \text{"S"}, s_{H2}, wf)$ $h'_{KH} := \text{CoolProp_Props}(\text{"H"}, \text{"P"}, p_K, \text{"S"}, s_{KH}, wf)$

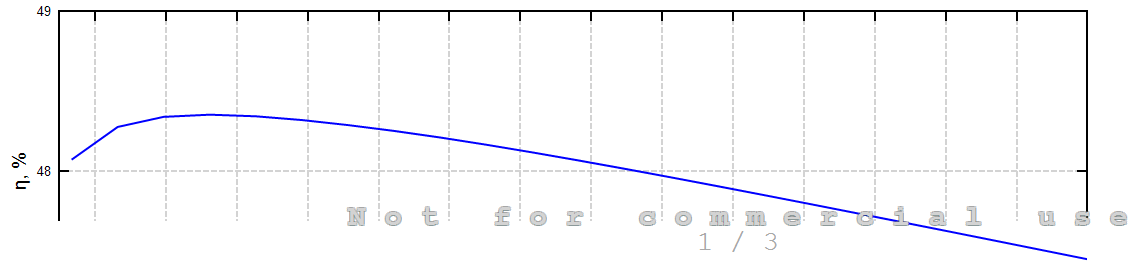
$\alpha_1 := \frac{h'_{H2} - h'_{H1}}{h'_{H2} - h_1}$ $\alpha_2 := \frac{h'_{KH} \cdot (-1 + \alpha_1) + h'_{H2} \cdot (1 - \alpha_1)}{h_2 - h'_{KH}}$

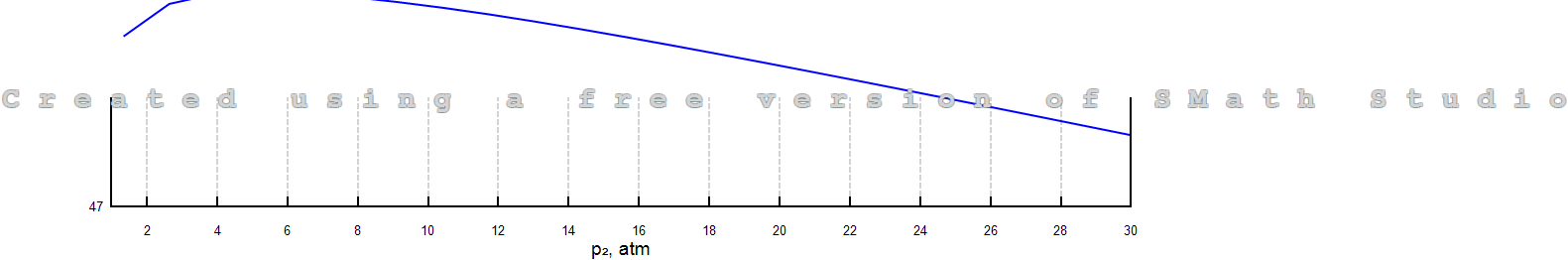
$$\frac{(h_0 - h_1) + (1 - \alpha_1) \cdot (h_1 - h_2) + (1 - \alpha_1 - \alpha_2) \cdot (h_2 - h_K) - (1 - \alpha_1 - \alpha_2) \cdot (h'_{KH} - h'_{KH}) - (1 - \alpha_1) \cdot (h'_{H2} - h'_{KH})}{h_0 - h_{\text{ПБ}}}$$

$p := \left[p_0, p_0 - \frac{p_0 - p_K}{100} \cdot p_K \right]$

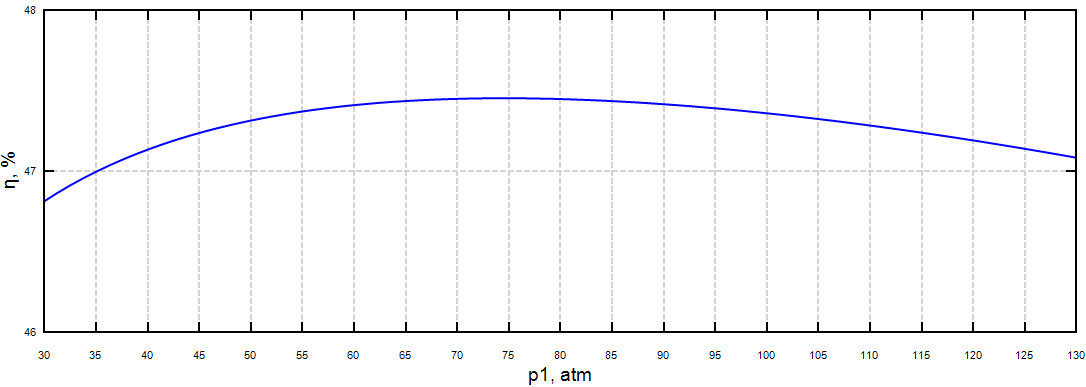
$\eta_T(p_0, T_0, 70 \text{ atm}, 6 \text{ atm}, p_K) = 0.4835$

$\begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} := \text{roots} \left(\begin{bmatrix} \alpha_1 \\ \alpha_2 \cdot h_2 + \end{bmatrix} \right)$

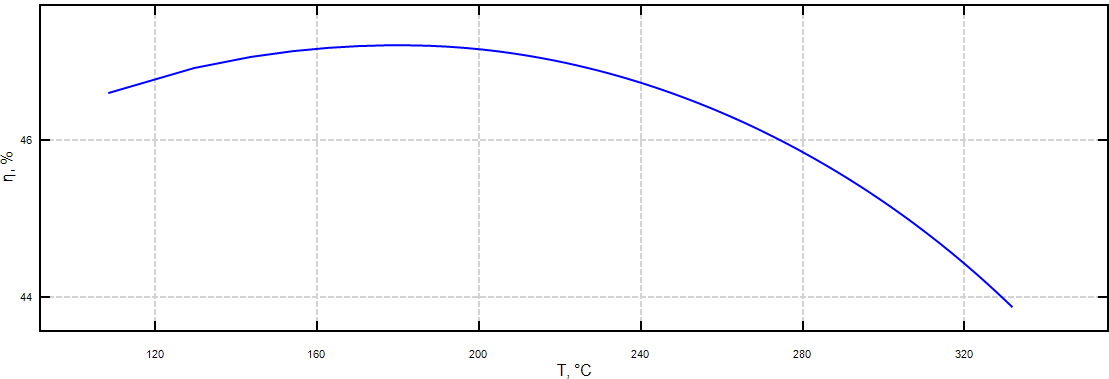




$$\text{augment}\left(\frac{p}{\text{atm}}, \frac{\overrightarrow{\eta_T(p_0, T_0, p_1, p, p_K)}}{\%}\right)$$



$$\text{augment}\left(\frac{p}{\text{atm}}, \frac{\overrightarrow{\eta_T(p_0, T_0, p, p_2, p_K)}}{\%}\right)$$



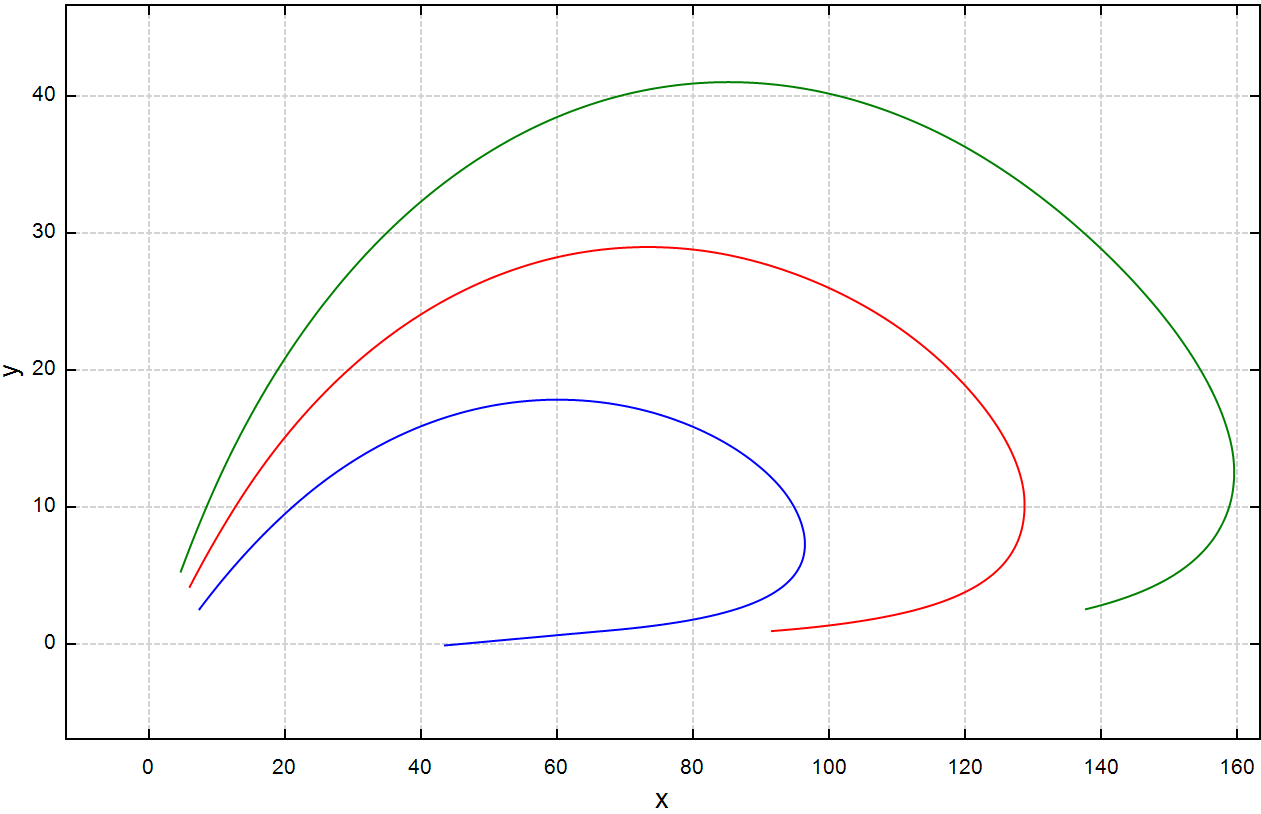
$$\text{augment}\left(\frac{\overrightarrow{\text{CoolProp_Props}(\text{"T"}, \text{"P"}, p, \text{"Q"}, 0, \text{wf})}}{\text{K}} - 273.15, \frac{\overrightarrow{\eta_T(p_0, T_0, p, p, p_K)}}{\%}\right)$$

Dragilev method, n=2

$\Delta P := 10^{-3}$
(atm)

$$PP(\eta, al) := \left| \begin{array}{l} \eta_0(p) := \eta - \eta_T(p_0, T_0, p_1 \text{ atm}, p_2 \text{ atm}, p_K) \\ p_0 := \text{al_nleqsolve}\left(\left[\begin{smallmatrix} 5 \\ 5 \end{smallmatrix}\right], \eta_0\right) \\ DM(t, pp) := \left| \begin{array}{l} p := \left[\max\left(\left[\begin{smallmatrix} PP_1 & 1 \end{smallmatrix}\right]\right) \max\left(\left[\begin{smallmatrix} PP_2 & 1 \end{smallmatrix}\right]\right)\right] \\ \eta_0 := \eta_0(p) \\ \Delta := \left[\begin{array}{l} \eta_0 - \eta_0\left(\left[\begin{smallmatrix} p_1 & p_2 + \Delta P \end{smallmatrix}\right]\right) \\ \eta_0\left(\left[\begin{smallmatrix} p_1 + \Delta P & p_2 \end{smallmatrix}\right]\right) - \eta_0 \end{array}\right] \\ \frac{\Delta}{\text{norme}(\Delta)} \end{array} \right. \\ RK := \text{dn_ExplicitRK45}(p_0, 0, al, 500, DM) \\ \text{augment}(\text{col}(RK, 2), \text{col}(RK, 3)) \end{array} \right.$$

$al = \pm \text{arc_length}$



$$\begin{cases} PP(0.48, -150) \\ PP(0.475, -175) \\ PP(0.47, -200) \end{cases}$$