$p_1 := 400000 \quad p_2 := 300000 \quad p_3 := 100000$

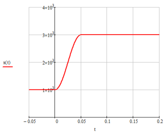
$\xi_1 := \dfrac{1}{2\cdot\rho\cdot(\mu\cdot S)^2}$

$\xi_1 := 1000 \quad \xi_{2.0} := 1000 \quad \xi_3 := 1000 \quad \xi_{\text{д}} := 1000$

$\underset{\sim}{A} := 1000$

$\underset{\sim}{T} := 0.1$

$$x(t) := \begin{cases} A & \text{if } t < 0 \\ \xi_{2.0} + A\cdot\left[\sin\left[\dfrac{2\pi}{T}\left(t - \dfrac{T}{4}\right)\right] + 1\right] & \text{if } 0 \le t \le \dfrac{T}{2} \\ \left(\xi_{2.0} + 2A\right) & \text{if } t > \dfrac{T}{2} \end{cases}$$



$l_1 := 1 \quad l_2 := 1 \quad l_3 := 1 \quad l_{\text{д}} := 0.02$

$S_1 := 0.0025 \quad S_2 := 0.0025 \quad S_3 := 0.0025 \quad S_{\text{д}} := 0.001$

$T_{\text{г}.0} := 293 \quad R_{\text{г}} := 287$

$k := 1.4$

$\rho_{\text{ж}} := 820 \quad V_{\text{ж}.0} := 0.004 \quad m_{\text{ж}.0} := V_{\text{ж}.0}\cdot\rho_{\text{ж}} = 3.28 \quad V_{\text{г}.0} := 0.001$

$\underset{\sim}{C} := 1218$

$j_1 := \dfrac{l_1}{S_1} = 400 \quad j_2 := \dfrac{l_2}{S_2} = 400 \quad j_3 := \dfrac{l_3}{S_3} = 400 \quad j_{\text{д}} := \dfrac{l_{\text{д}}}{S_{\text{д}}} = 20$

Given

$m_1 + m_2 - m_3 = 0$

$p_4 = p_{\text{г}}$

$p_1 - p_4 - \xi_1\cdot m_1^2 = 0$

$p_4 - p_3 - \xi_3\cdot m_3^2 = 0$

$p_2 - p_4 - \xi_{2.0}\cdot m_2^2 = 0$

$$St := \text{Find}(m_1, m_2, m_3, p_4, p_{\text{г}}) \rightarrow \begin{bmatrix} -\frac{(\sqrt{5}-3)\cdot\sqrt{400000\cdot\sqrt{5}+1000000}}{100} & \frac{(\sqrt{5}-3)\cdot\sqrt{400000\cdot\sqrt{5}+1000000}}{100} & \frac{(\sqrt{5}+3)\cdot\sqrt{1000000-400000\cdot\sqrt{5}}}{100} & -\frac{(\sqrt{5}+3)\cdot\sqrt{1000000-400000\cdot\sqrt{5}}}{100} \\ \frac{(\sqrt{5}-2)\cdot\sqrt{400000\cdot\sqrt{5}+1000000}}{100} & -\frac{(\sqrt{5}-2)\cdot\sqrt{400000\cdot\sqrt{5}+1000000}}{100} & -\frac{(\sqrt{5}+2)\cdot\sqrt{1000000-400000\cdot\sqrt{5}}}{100} & \frac{(\sqrt{5}+2)\cdot\sqrt{1000000-400000\cdot\sqrt{5}}}{100} \\ \frac{\sqrt{400000\cdot\sqrt{5}+1000000}}{100} & -\frac{\sqrt{400000\cdot\sqrt{5}+1000000}}{100} & \frac{\sqrt{1000000-400000\cdot\sqrt{5}}}{100} & -\frac{\sqrt{1000000-400000\cdot\sqrt{5}}}{100} \\ 40000\cdot\sqrt{5}+200000 & 40000\cdot\sqrt{5}+200000 & 200000-40000\cdot\sqrt{5} & 200000-40000\cdot\sqrt{5} \\ 40000\cdot\sqrt{5}+200000 & 40000\cdot\sqrt{5}+200000 & 200000-40000\cdot\sqrt{5} & 200000-40000\cdot\sqrt{5} \end{bmatrix}$$

$St^{\langle 0\rangle} = \begin{pmatrix} 10.5146 \\ 3.2492 \\ 13.7638 \\ 289442.7191 \\ 289442.7191 \end{pmatrix} \qquad ST := St^{\langle 0\rangle} = \begin{pmatrix} 10.5146 \\ 3.2492 \\ 13.7638 \\ 289442.7191 \\ 289442.7191 \end{pmatrix}$

$m_{1.0} := ST_0 = 10.5146$

$m_{2.0} := ST_1 = 3.2492$

$m_{3.0} := ST_2 = 13.7638$

$p_{4.0} := ST_3 = 289442.7191$

$p_{\text{г}.0} := ST_4 = 289442.7191$

$m_{\text{д}.0} := 0$

$V_{\text{д}.0} := 0$

$\rho_{\text{г}.0} := \dfrac{p_{\text{г}.0}}{R_{\text{г}}\cdot T_{\text{г}.0}} \text{ explicit, ALL } \rightarrow \dfrac{289442.71909999161}{287\cdot 293} = 3.442$

$m_{\text{г}.0} := \rho_{\text{г}.0}\cdot V_{\text{г}.0} = 0.0034$

$\underset{\sim}{dt} := 0.00001$

$t_{kon} := 1$

$\underset{\sim}{N} := \dfrac{t_{kon}}{dt} = 100000$

БЕЗ УЧЁТА КОЭФФ

БЕЗ ВОЗМУЩЕНИЯ

Без возмущения (с учётом коэффициентов)

$(V_{\text{д}}\ m_{\text{д}}\ m_1\ m_2\ m_3\ p_4\ p_{\text{г}}\ T_{\text{г}}\ V_{\text{г}}\ V_{\text{ж}}\ t) :=$ for $i \in 0..N$

if $i = 0$

$t_i \leftarrow 0$

${V_{\text{д}}}_i \leftarrow V_{\text{д}.0}$

${m_{\text{д}}}_i \leftarrow m_{\text{д}.0}$

${m_1}_i \leftarrow m_{1.0}$

${m_2}_i \leftarrow m_{2.0}$

${m_3}_i \leftarrow m_{3.0}$

${p_4}_i \leftarrow p_{4.0}$

${V_{\text{ж}}}_i \leftarrow V_{\text{ж}.0} + V_{\text{д}.0}$

${V_{\text{г}}}_i \leftarrow V_{\text{г}.0} - V_{\text{д}.0}$

${T_{\text{г}}}_i \leftarrow T_{\text{г}.0}$

${p_{\text{г}}}_i \leftarrow p_{\text{г}.0}$

otherwise

$t_i \leftarrow t_{i-1} + dt$

${V_{\text{д}}}_i \leftarrow {V_{\text{д}}}_{i-1} + {dV_{\text{д}}}_{i-1}$

${m_{\text{д}}}_i \leftarrow {m_{\text{д}}}_{i-1} + {dm_{\text{д}}}_{i-1}$

${m_1}_i \leftarrow {m_1}_{i-1} + {dm_1}_{i-1}$

${m_2}_i \leftarrow {m_2}_{i-1} + {dm_2}_{i-1}$

${m_3}_i \leftarrow {m_3}_{i-1} + {dm_3}_{i-1}$

${p_4}_i \leftarrow {p_4}_{i-1} + {dp_4}_{i-1}$

${V_{\text{ж}}}_i \leftarrow V_{\text{ж}.0} + {V_{\text{д}}}_i$

${V_{\text{г}}}_i \leftarrow V_{\text{г}.0} - {V_{\text{д}}}_i$

${T_{\text{г}}}_i \leftarrow T_{\text{г}.0}\cdot\left(\dfrac{{p_4}_i}{p_{4.0}}\right)^{\frac{k-1}{k}}$

${p_{\text{г}}}_i \leftarrow \dfrac{m_{\text{г}.0}}{{V_{\text{г}}}_i}\cdot R_{\text{г}}\cdot {T_{\text{г}}}_i$

${dV_{\text{д}.1}}_i \leftarrow dt\cdot\left(\dfrac{{m_{\text{д}}}_i}{\rho_{\text{ж}}}\right)$

$${dm_{\text{д}.1}}_i \leftarrow dt\cdot\left[\frac{{p_4}_i - \frac{m_{\text{г}.0}}{V_{\text{г}.0} - {V_{\text{д}}}_i}\cdot R_{\text{г}}\cdot\left[T_{\text{г}.0}\cdot\left(\frac{{p_4}_i}{p_{4.0}}\right)^{\frac{k-1}{k}}\right] - \xi_{\text{д}}\cdot {m_{\text{д}}}_i\cdot\left|{m_{\text{д}}}_i\right|}{j_{\text{д}}}\right]$$

${dm_{1.1}}_i \leftarrow dt\cdot\left(\dfrac{p_1 - {p_4}_i - \xi_1\cdot {m_1}_i\cdot\left|{m_1}_i\right|}{j_1}\right)$

${dm_{2.1}}_i \leftarrow dt\cdot\left(\dfrac{p_2 - {p_4}_i - \xi_{2.0}\cdot {m_2}_i\cdot\left|{m_2}_i\right|}{j_2}\right)$

${dm_{3.1}}_i \leftarrow dt\cdot\left(\dfrac{{p_4}_i - p_3 - \xi_3\cdot {m_3}_i\cdot\left|{m_3}_i\right|}{j_3}\right)$

${dp_{4.1}}_i \leftarrow dt\cdot\left(\dfrac{{m_1}_i + {m_2}_i - {m_3}_i - {m_{\text{д}}}_i}{\frac{{V_{\text{ж}}}_i}{C^2}}\right)$

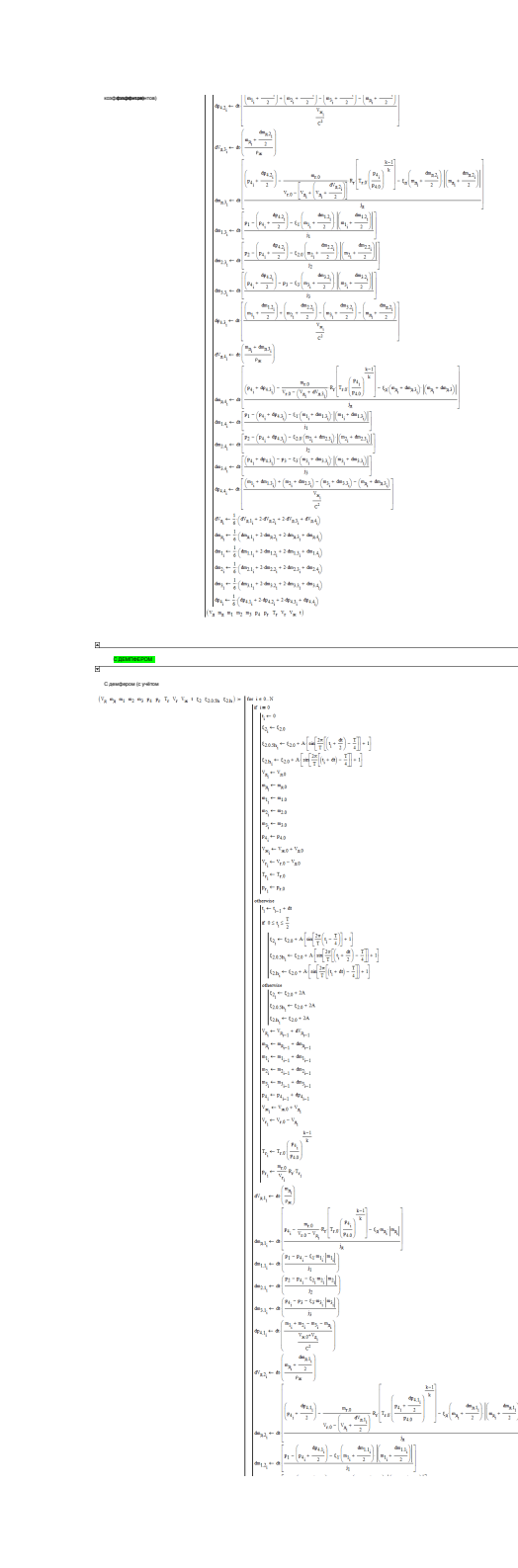
${dV_{\text{д}.2}}_i \leftarrow dt\cdot\left(\dfrac{{m_{\text{д}}}_i + \frac{{dm_{\text{д}.1}}_i}{2}}{\rho_{\text{ж}}}\right)$

$${dm_{\text{д}.2}}_i \leftarrow dt\cdot\left[\frac{\left({p_4}_i + \frac{{dp_{4.1}}_i}{2}\right) - \frac{m_{\text{г}.0}}{V_{\text{г}.0} - \left({V_{\text{д}}}_i + \frac{{dV_{\text{д}.1}}_i}{2}\right)}\cdot R_{\text{г}}\cdot\left[T_{\text{г}.0}\cdot\left(\frac{{p_4}_i + \frac{{dp_{4.1}}_i}{2}}{p_{4.0}}\right)^{\frac{k-1}{k}}\right] - \xi_{\text{д}}\cdot\left({m_{\text{д}}}_i + \frac{{dm_{\text{д}.1}}_i}{2}\right)\cdot\left|\left({m_{\text{д}}}_i + \frac{{dm_{\text{д}.1}}_i}{2}\right)\right|}{j_{\text{д}}}\right]$$

$${dm_{1.2}}_i \leftarrow dt\cdot\left[\frac{p_1 - \left({p_4}_i + \frac{{dp_{4.1}}_i}{2}\right) - \xi_1\cdot\left({m_1}_i + \frac{{dm_{1.1}}_i}{2}\right)\cdot\left|\left({m_1}_i + \frac{{dm_{1.1}}_i}{2}\right)\right|}{j_1}\right]$$

$${dm_{2.2}}_i \leftarrow dt\cdot\left[\frac{p_2 - \left({p_4}_i + \frac{{dp_{4.1}}_i}{2}\right) - \xi_{2.0}\cdot\left({m_2}_i + \frac{{dm_{2.1}}_i}{2}\right)\cdot\left|\left({m_2}_i + \frac{{dm_{2.1}}_i}{2}\right)\right|}{j_2}\right]$$

$${dm_{3.2}}_i \leftarrow dt\cdot\left[\frac{\left({p_4}_i + \frac{{dp_{4.1}}_i}{2}\right) - p_3 - \xi_3\cdot\left({m_3}_i + \frac{{dm_{3.1}}_i}{2}\right)\cdot\left|\left({m_3}_i + \frac{{dm_{3.1}}_i}{2}\right)\right|}{j_3}\right]$$



коэффициентов)

$$dp_{4.2_i} \leftarrow dt\cdot\left[\frac{\left(m_{1_i}+\frac{\ldots}{2}\right)+\left(m_{2_i}+\frac{\ldots}{2}\right)-\left(m_{3_i}+\frac{\ldots}{2}\right)-\left(m_{\text{д}_i}+\frac{\ldots}{2}\right)}{\frac{V_{\text{ж}_i}}{C^2}}\right]$$

$$dV_{\text{д}.3_i} \leftarrow dt\cdot\left(\frac{m_{\text{д}_i}+\frac{dm_{\text{д}.2_i}}{2}}{\rho_{\text{ж}}}\right)$$

$$dm_{\text{д}.3_i} \leftarrow dt\cdot\left[\frac{\left(p_{4_i}+\frac{dp_{4.2_i}}{2}\right)-\frac{m_{\text{г}.0}}{V_{\text{г}.0}-\left[V_{\text{д}_i}+\left(V_{\text{д}_i}+\frac{dV_{\text{д}.2_i}}{2}\right)\right]}\cdot R_{\text{г}}\cdot\left[T_{\text{г}.0}\cdot\left(\frac{p_{4_i}}{p_{4.0}}\right)^{\frac{k-1}{k}}\right]-\xi_{\text{д}}\cdot\left(m_{\text{д}_i}+\frac{dm_{\text{д}.2_i}}{2}\right)\cdot\left|\left(m_{\text{д}_i}+\frac{dm_{\text{д}.2_i}}{2}\right)\right|}{j_{\text{д}}}\right]$$

$$dm_{1.3_i} \leftarrow dt\cdot\left[\frac{p_1-\left(p_{4_i}+\frac{dp_{4.2_i}}{2}\right)-\xi_1\cdot\left(m_{1_i}+\frac{dm_{1.2_i}}{2}\right)\cdot\left|\left(m_{1_i}+\frac{dm_{1.2_i}}{2}\right)\right|}{j_1}\right]$$

$$dm_{2.3_i} \leftarrow dt\cdot\left[\frac{p_2-\left(p_{4_i}+\frac{dp_{4.2_i}}{2}\right)-\xi_{2.0}\cdot\left(m_{2_i}+\frac{dm_{2.2_i}}{2}\right)\cdot\left|\left(m_{2_i}+\frac{dm_{2.2_i}}{2}\right)\right|}{j_2}\right]$$

$$dm_{3.3_i} \leftarrow dt\cdot\left[\frac{\left(p_{4_i}+\frac{dp_{4.2_i}}{2}\right)-p_3-\xi_3\cdot\left(m_{3_i}+\frac{dm_{3.2_i}}{2}\right)\cdot\left|\left(m_{3_i}+\frac{dm_{3.2_i}}{2}\right)\right|}{j_3}\right]$$

$$dp_{4.3_i} \leftarrow dt\cdot\left[\frac{\left(m_{1_i}+\frac{dm_{1.2_i}}{2}\right)+\left(m_{2_i}+\frac{dm_{2.2_i}}{2}\right)-\left(m_{3_i}+\frac{dm_{3.2_i}}{2}\right)-\left(m_{\text{д}_i}+\frac{dm_{\text{д}.2_i}}{2}\right)}{\frac{V_{\text{ж}_i}}{C^2}}\right]$$

$$dV_{\text{д}.4_i} \leftarrow dt\cdot\left(\frac{m_{\text{д}_i}+dm_{\text{д}.3_i}}{\rho_{\text{ж}}}\right)$$

$$dm_{\text{д}.4_i} \leftarrow dt\cdot\left[\frac{\left(p_{4_i}+dp_{4.3_i}\right)-\frac{m_{\text{г}.0}}{V_{\text{г}.0}-\left(V_{\text{д}_i}+dV_{\text{д}.3_i}\right)}\cdot R_{\text{г}}\cdot\left[T_{\text{г}.0}\cdot\left(\frac{p_{4_i}}{p_{4.0}}\right)^{\frac{k-1}{k}}\right]-\xi_{\text{д}}\cdot\left(m_{\text{д}_i}+dm_{\text{д}.3_i}\right)\cdot\left|\left(m_{\text{д}_i}+dm_{\text{д}.3}\right)\right|}{j_{\text{д}}}\right]$$

$$dm_{1.4_i} \leftarrow dt\cdot\left[\frac{p_1-\left(p_{4_i}+dp_{4.3_i}\right)-\xi_1\cdot\left(m_{1_i}+dm_{1.3_i}\right)\cdot\left|\left(m_{1_i}+dm_{1.3_i}\right)\right|}{j_1}\right]$$

$$dm_{2.4_i} \leftarrow dt\cdot\left[\frac{p_2-\left(p_{4_i}+dp_{4.3_i}\right)-\xi_{2.0}\cdot\left(m_{2_i}+dm_{2.3_i}\right)\cdot\left|\left(m_{2_i}+dm_{2.3_i}\right)\right|}{j_2}\right]$$

$$dm_{3.4_i} \leftarrow dt\cdot\left[\frac{\left(p_{4_i}+dp_{4.3_i}\right)-p_3-\xi_3\cdot\left(m_{3_i}+dm_{3.3_i}\right)\cdot\left|\left(m_{3_i}+dm_{3.3_i}\right)\right|}{j_3}\right]$$

$$dp_{4.4_i} \leftarrow dt\cdot\left[\frac{\left(m_{1_i}+dm_{1.3_i}\right)+\left(m_{2_i}+dm_{2.3_i}\right)-\left(m_{3_i}+dm_{3.3_i}\right)-\left(m_{\text{д}_i}+dm_{\text{д}.3_i}\right)}{\frac{V_{\text{ж}_i}}{C^2}}\right]$$

$$dV_{\text{д}_i} \leftarrow \frac{1}{6}\cdot\left(dV_{\text{д}.1_i}+2\cdot dV_{\text{д}.2_i}+2\cdot dV_{\text{д}.3_i}+dV_{\text{д}.4_i}\right)$$

$$dm_{\text{д}_i} \leftarrow \frac{1}{6}\cdot\left(dm_{\text{д}.1_i}+2\cdot dm_{\text{д}.2_i}+2\cdot dm_{\text{д}.3_i}+dm_{\text{д}.4_i}\right)$$

$$dm_{1_i} \leftarrow \frac{1}{6}\cdot\left(dm_{1.1_i}+2\cdot dm_{1.2_i}+2\cdot dm_{1.3_i}+dm_{1.4_i}\right)$$

$$dm_{2_i} \leftarrow \frac{1}{6}\cdot\left(dm_{2.1_i}+2\cdot dm_{2.2_i}+2\cdot dm_{2.3_i}+dm_{2.4_i}\right)$$

$$dm_{3_i} \leftarrow \frac{1}{6}\cdot\left(dm_{3.1_i}+2\cdot dm_{3.2_i}+2\cdot dm_{3.3_i}+dm_{3.4_i}\right)$$

$$dp_{4_i} \leftarrow \frac{1}{6}\cdot\left(dp_{4.1_i}+2\cdot dp_{4.2_i}+2\cdot dp_{4.3_i}+dp_{4.4_i}\right)$$

$$\left(V_{\text{д}}\ m_{\text{д}}\ m_1\ m_2\ m_3\ p_4\ p_{\text{г}}\ T_{\text{г}}\ V_{\text{г}}\ V_{\text{ж}}\ t\right)$$

С ДЕМПФЕРОМ

С демфером (с учётом

$$\left(V_{\text{д}}\ m_{\text{д}}\ m_1\ m_2\ m_3\ p_4\ p_{\text{г}}\ T_{\text{г}}\ V_{\text{г}}\ V_{\text{ж}}\ t\ \xi_2\ \xi_{2.0.5h}\ \xi_{2.h}\right) := \text{for } i \in 0..N$$

if $i = 0$

$$t_i \leftarrow 0$$
$$\xi_{2_i} \leftarrow \xi_{2.0}$$
$$\xi_{2.0.5h_i} \leftarrow \xi_{2.0}+A\cdot\left[\sin\left[\frac{2\pi}{T}\left[\left(t_i+\frac{dt}{2}\right)-\frac{T}{4}\right]\right]+1\right]$$
$$\xi_{2.h_i} \leftarrow \xi_{2.0}+A\cdot\left[\sin\left[\frac{2\pi}{T}\left[\left(t_i+dt\right)-\frac{T}{4}\right]\right]+1\right]$$
$$V_{\text{д}_i} \leftarrow V_{\text{д}.0}$$
$$m_{\text{д}_i} \leftarrow m_{\text{д}.0}$$
$$m_{1_i} \leftarrow m_{1.0}$$
$$m_{2_i} \leftarrow m_{2.0}$$
$$m_{3_i} \leftarrow m_{3.0}$$
$$p_{4_i} \leftarrow p_{4.0}$$
$$V_{\text{ж}_i} \leftarrow V_{\text{ж}.0}+V_{\text{д}.0}$$
$$V_{\text{г}_i} \leftarrow V_{\text{г}.0}-V_{\text{д}.0}$$
$$T_{\text{г}_i} \leftarrow T_{\text{г}.0}$$
$$p_{\text{г}_i} \leftarrow p_{\text{г}.0}$$

otherwise

$$t_i \leftarrow t_{i-1}+dt$$

if $0 \le t_i \le \frac{T}{2}$

$$\xi_{2_i} \leftarrow \xi_{2.0}+A\cdot\left[\sin\left[\frac{2\pi}{T}\left(t_i-\frac{T}{4}\right)\right]+1\right]$$
$$\xi_{2.0.5h_i} \leftarrow \xi_{2.0}+A\cdot\left[\sin\left[\frac{2\pi}{T}\left[\left(t_i+\frac{dt}{2}\right)-\frac{T}{4}\right]\right]+1\right]$$
$$\xi_{2.h_i} \leftarrow \xi_{2.0}+A\cdot\left[\sin\left[\frac{2\pi}{T}\left[\left(t_i+dt\right)-\frac{T}{4}\right]\right]+1\right]$$

otherwise

$$\xi_{2_i} \leftarrow \xi_{2.0}+2A$$
$$\xi_{2.0.5h_i} \leftarrow \xi_{2.0}+2A$$
$$\xi_{2.h_i} \leftarrow \xi_{2.0}+2A$$

$$V_{\text{д}_i} \leftarrow V_{\text{д}_{i-1}}+dV_{\text{д}_{i-1}}$$
$$m_{\text{д}_i} \leftarrow m_{\text{д}_{i-1}}+dm_{\text{д}_{i-1}}$$
$$m_{1_i} \leftarrow m_{1_{i-1}}+dm_{1_{i-1}}$$
$$m_{2_i} \leftarrow m_{2_{i-1}}+dm_{2_{i-1}}$$
$$m_{3_i} \leftarrow m_{3_{i-1}}+dm_{3_{i-1}}$$
$$p_{4_i} \leftarrow p_{4_{i-1}}+dp_{4_{i-1}}$$
$$V_{\text{ж}_i} \leftarrow V_{\text{ж}.0}+V_{\text{д}_i}$$
$$V_{\text{г}_i} \leftarrow V_{\text{г}.0}-V_{\text{д}_i}$$
$$T_{\text{г}_i} \leftarrow T_{\text{г}.0}\cdot\left(\frac{p_{4_i}}{p_{4.0}}\right)^{\frac{k-1}{k}}$$
$$p_{\text{г}_i} \leftarrow \frac{m_{\text{г}.0}}{V_{\text{г}_i}}\cdot R_{\text{г}}\cdot T_{\text{г}_i}$$

$$dV_{\text{д}.1_i} \leftarrow dt\cdot\left(\frac{m_{\text{д}_i}}{\rho_{\text{ж}}}\right)$$

$$dm_{\text{д}.1_i} \leftarrow dt\cdot\left[\frac{p_{4_i}-\frac{m_{\text{г}.0}}{V_{\text{г}.0}-V_{\text{д}_i}}\cdot R_{\text{г}}\cdot\left[T_{\text{г}.0}\cdot\left(\frac{p_{4_i}}{p_{4.0}}\right)^{\frac{k-1}{k}}\right]-\xi_{\text{д}}\cdot m_{\text{д}_i}\cdot\left|m_{\text{д}_i}\right|}{j_{\text{д}}}\right]$$

$$dm_{1.1_i} \leftarrow dt\cdot\left(\frac{p_1-p_{4_i}-\xi_1\cdot m_{1_i}\cdot\left|m_{1_i}\right|}{j_1}\right)$$

$$dm_{2.1_i} \leftarrow dt\cdot\left(\frac{p_2-p_{4_i}-\xi_{2_i}\cdot m_{2_i}\cdot\left|m_{2_i}\right|}{j_2}\right)$$

$$dm_{3.1_i} \leftarrow dt\cdot\left(\frac{p_{4_i}-p_3-\xi_3\cdot m_{3_i}\cdot\left|m_{3_i}\right|}{j_3}\right)$$

$$dp_{4.1_i} \leftarrow dt\cdot\left(\frac{m_{1_i}+m_{2_i}-m_{3_i}-m_{\text{д}_i}}{\frac{V_{\text{ж}.0}+V_{\text{д}_i}}{C^2}}\right)$$

$$dV_{\text{д}.2_i} \leftarrow dt\cdot\left(\frac{m_{\text{д}_i}+\frac{dm_{\text{д}.1_i}}{2}}{\rho_{\text{ж}}}\right)$$

$$dm_{\text{д}.2_i} \leftarrow dt\cdot\left[\frac{\left(p_{4_i}+\frac{dp_{4.1_i}}{2}\right)-\frac{m_{\text{г}.0}}{V_{\text{г}.0}-\left(V_{\text{д}_i}+\frac{dV_{\text{д}.1_i}}{2}\right)}\cdot R_{\text{г}}\cdot\left[T_{\text{г}.0}\cdot\left(\frac{p_{4_i}+\frac{dp_{4.1_i}}{2}}{p_{4.0}}\right)^{\frac{k-1}{k}}\right]-\xi_{\text{д}}\cdot\left(m_{\text{д}_i}+\frac{dm_{\text{д}.1_i}}{2}\right)\cdot\left|\left(m_{\text{д}_i}+\frac{dm_{\text{д}.1_i}}{2}\right)\right|}{j_{\text{д}}}\right]$$

$$dm_{1.2_i} \leftarrow dt\cdot\left[\frac{p_1-\left(p_{4_i}+\frac{dp_{4.1_i}}{2}\right)-\xi_1\cdot\left(m_{1_i}+\frac{dm_{1.1_i}}{2}\right)\cdot\left|\left(m_{1_i}+\frac{dm_{1.1_i}}{2}\right)\right|}{j_1}\right]$$

$$dm_{2.2_i} \leftarrow dt\cdot\left[\frac{p_2-\left(p_{4_i}+\frac{dp_{4.1_i}}{2}\right)-\xi_{2.0.5h_i}\cdot\left(m_{2_i}+\frac{dm_{2.1_i}}{2}\right)\cdot\left|\left(m_{2_i}+\frac{dm_{2.1_i}}{2}\right)\right|}{j_2}\right]$$

$$dm_{3.2_i} \leftarrow dt\cdot\left[\frac{\left(p_{4_i}+\frac{dp_{4.1_i}}{2}\right)-p_3-\xi_3\cdot\left(m_{3_i}+\frac{dm_{3.1_i}}{2}\right)\cdot\left|\left(m_{3_i}+\frac{dm_{3.1_i}}{2}\right)\right|}{j_3}\right]$$

$$dp_{4.2_i} \leftarrow dt\cdot\left[\frac{\left(m_{1_i}+\frac{dm_{1.1_i}}{2}\right)+\left(m_{2_i}+\frac{dm_{2.1_i}}{2}\right)-\left(m_{3_i}+\frac{dm_{3.1_i}}{2}\right)-\left(m_{\text{д}_i}+\frac{dm_{\text{д}.1_i}}{2}\right)}{\frac{V_{\text{ж}.0}+\left(V_{\text{д}_i}+\frac{dV_{\text{д}.1_i}}{2}\right)}{C^2}}\right]$$

$$dV_{\text{д}.3_i} \leftarrow dt\cdot\left(\frac{m_{\text{д}_i}+\frac{dm_{\text{д}.2_i}}{2}}{\rho_{\text{ж}}}\right)$$

$$dm_{\text{д}.3_i} \leftarrow dt\cdot\left[\frac{\left(p_{4_i}+\frac{dp_{4.2_i}}{2}\right)-\frac{m_{\text{г}.0}}{V_{\text{г}.0}-\left(V_{\text{д}_i}+\frac{dV_{\text{д}.2_i}}{2}\right)}\cdot R_{\text{г}}\cdot\left[T_{\text{г}.0}\cdot\left(\frac{p_{4_i}+\frac{dp_{4.2_i}}{2}}{p_{4.0}}\right)^{\frac{k-1}{k}}\right]-\xi_{\text{д}}\cdot\left(m_{\text{д}_i}+\frac{dm_{\text{д}.2_i}}{2}\right)\cdot\left|\left(m_{\text{д}_i}+\frac{dm_{\text{д}.2_i}}{2}\right)\right|}{j_{\text{д}}}\right]$$

$$dm_{1.3_i} \leftarrow dt\cdot\left[\frac{p_1-\left(p_{4_i}+\frac{dp_{4.2_i}}{2}\right)-\xi_1\cdot\left(m_{1_i}+\frac{dm_{1.2_i}}{2}\right)\cdot\left|\left(m_{1_i}+\frac{dm_{1.2_i}}{2}\right)\right|}{j_1}\right]$$

$$dm_{2.3_i} \leftarrow dt\cdot\left[\frac{p_2-\left(p_{4_i}+\frac{dp_{4.2_i}}{2}\right)-\xi_{2.0.5h_i}\cdot\left(m_{2_i}+\frac{dm_{2.2_i}}{2}\right)\cdot\left|\left(m_{2_i}+\frac{dm_{2.2_i}}{2}\right)\right|}{j_2}\right]$$

$$dm_{3.3_i} \leftarrow dt\cdot\left[\frac{\left(p_{4_i}+\frac{dp_{4.2_i}}{2}\right)-p_3-\xi_3\cdot\left(m_{3_i}+\frac{dm_{3.2_i}}{2}\right)\cdot\left|\left(m_{3_i}+\frac{dm_{3.2_i}}{2}\right)\right|}{j_3}\right]$$

$$dp_{4.3_i} \leftarrow dt\cdot\left[\frac{\left(m_{1_i}+\frac{dm_{1.2_i}}{2}\right)+\left(m_{2_i}+\frac{dm_{2.2_i}}{2}\right)-\left(m_{3_i}+\frac{dm_{3.2_i}}{2}\right)-\left(m_{\text{д}_i}+\frac{dm_{\text{д}.2_i}}{2}\right)}{\frac{V_{\text{ж}.0}+\left(V_{\text{д}_i}+\frac{dV_{\text{д}.2_i}}{2}\right)}{C^2}}\right]$$

$$dV_{\text{д}.4_i} \leftarrow dt\cdot\left(\frac{m_{\text{д}_i}+dm_{\text{д}.3_i}}{\rho_{\text{ж}}}\right)$$

$$dm_{\text{д}.4_i} \leftarrow dt\cdot\left[\frac{\left(p_{4_i}+dp_{4.3_i}\right)-\frac{m_{\text{г}.0}}{V_{\text{г}.0}-\left(V_{\text{д}_i}+dV_{\text{д}.3_i}\right)}\cdot R_{\text{г}}\cdot\left[T_{\text{г}.0}\cdot\left(\frac{p_{4_i}+dp_{4.3_i}}{p_{4.0}}\right)^{\frac{k-1}{k}}\right]-\xi_{\text{д}}\cdot\left(m_{\text{д}_i}+dm_{\text{д}.3_i}\right)\cdot\left|m_{\text{д}_i}+dm_{\text{д}.3_i}\right|}{j_{\text{д}}}\right]$$

$$dm_{1.4_i} \leftarrow dt\cdot\left[\frac{p_1-\left(p_{4_i}+dp_{4.3_i}\right)-\xi_1\cdot\left(m_{1_i}+dm_{1.3_i}\right)\cdot\left|\left(m_{1_i}+dm_{1.3_i}\right)\right|}{j_1}\right]$$

$$dm_{2.4_i} \leftarrow dt\cdot\left[\frac{p_2-\left(p_{4_i}+dp_{4.3_i}\right)-\xi_{2.h_i}\cdot\left(m_{2_i}+dm_{2.3_i}\right)\cdot\left|\left(m_{2_i}+dm_{2.3_i}\right)\right|}{j_2}\right]$$

$$dm_{3.4_i} \leftarrow dt\cdot\left[\frac{\left(p_{4_i}+dp_{4.3_i}\right)-p_3-\xi_3\cdot\left(m_{3_i}+dm_{3.3_i}\right)\cdot\left|\left(m_{3_i}+dm_{3.3_i}\right)\right|}{j_3}\right]$$

$$dp_{4.4_i} \leftarrow dt\cdot\left[\frac{\left(m_{1_i}+dm_{1.3_i}\right)+\left(m_{2_i}+dm_{2.3_i}\right)-\left(m_{3_i}+dm_{3.3_i}\right)-\left(m_{\text{д}_i}+dm_{\text{д}.3_i}\right)}{\frac{V_{\text{ж}.0}+\left(V_{\text{д}_i}+dV_{\text{д}.3_i}\right)}{C^2}}\right]$$

$$dV_{\text{д}_i} \leftarrow \frac{1}{6}\cdot\left(dV_{\text{д}.1_i}+2\cdot dV_{\text{д}.2_i}+2\cdot dV_{\text{д}.3_i}+dV_{\text{д}.4_i}\right)$$

$$dm_{\text{д}_i} \leftarrow \frac{1}{6}\cdot\left(dm_{\text{д}.1_i}+2\cdot dm_{\text{д}.2_i}+2\cdot dm_{\text{д}.3_i}+dm_{\text{д}.4_i}\right)$$

$$dm_{1_i} \leftarrow \frac{1}{6}\cdot\left(dm_{1.1_i}+2\cdot dm_{1.2_i}+2\cdot dm_{1.3_i}+dm_{1.4_i}\right)$$

$$dm_{2_i} \leftarrow \frac{1}{6}\cdot\left(dm_{2.1_i}+2\cdot dm_{2.2_i}+2\cdot dm_{2.3_i}+dm_{2.4_i}\right)$$

$$dm_{3_i} \leftarrow \frac{1}{6}\cdot\left(dm_{3.1_i}+2\cdot dm_{3.2_i}+2\cdot dm_{3.3_i}+dm_{3.4_i}\right)$$

$$dp_{4_i} \leftarrow \frac{1}{6}\cdot\left(dp_{4.1_i}+2\cdot dp_{4.2_i}+2\cdot dp_{4.3_i}+dp_{4.4_i}\right)$$

$$\left(V_{\text{д}}\ m_{\text{д}}\ m_1\ m_2\ m_3\ p_4\ p_{\text{г}}\ T_{\text{г}}\ V_{\text{г}}\ V_{\text{ж}}\ t\ \xi_2\ \xi_{2.0.5h}\ \xi_{2.h}\right)$$

БЕЗ ДЕМПФЕРА

Без демфера (с учётом

$j_1 := 10000$ $j_2 := 10000$ $j_3 := 100000$

$$\left(m_1\ m_2\ m_3\ p_4\ V_{\text{ж}}\ t\ \xi_2\ \xi_{2.0.5h}\ \xi_{2.h}\right) :=$$

for $i \in 0..N$

if $i = 0$

$$t_i \leftarrow 0$$

$$\xi_{2_i} \leftarrow \xi_{2.0}$$

$$\xi_{2.0.5h_i} \leftarrow \xi_{2.0}+A\cdot\left[\sin\left[\frac{2\pi}{T}\left[\left(t_i+\frac{dt}{2}\right)-\frac{T}{4}\right]\right]+1\right]$$

$$\xi_{2.h_i} \leftarrow \xi_{2.0}+A\cdot\left[\sin\left[\frac{2\pi}{T}\left[\left(t_i+dt\right)-\frac{T}{4}\right]\right]+1\right]$$

$$m_{1_i} \leftarrow m_{1.0}$$

$$m_{2_i} \leftarrow m_{2.0}$$

$$m_{3_i} \leftarrow m_{3.0}$$

$$p_{4_i} \leftarrow p_{4.0}$$

$$V_{\text{ж}_i} \leftarrow V_{\text{ж}.0}$$

otherwise

$$t_i \leftarrow t_{i-1}+dt$$

if $0 \le t_i \le \frac{T}{2}$

$$\xi_{2_i} \leftarrow \xi_{2.0}+A\cdot\left[\sin\left[\frac{2\pi}{T}\left(t_i-\frac{T}{4}\right)\right]+1\right]$$

$$\xi_{2.0.5h_i} \leftarrow \xi_{2.0}+A\cdot\left[\sin\left[\frac{2\pi}{T}\left[\left(t_i+\frac{dt}{2}\right)-\frac{T}{4}\right]\right]+1\right]$$

$$\xi_{2.h_i} \leftarrow \xi_{2.0}+A\cdot\left[\sin\left[\frac{2\pi}{T}\left[\left(t_i+dt\right)-\frac{T}{4}\right]\right]+1\right]$$

otherwise

$$\xi_{2_i} \leftarrow \xi_{2.0}+2A$$

$$\xi_{2.0.5h_i} \leftarrow \xi_{2.0}+2A$$

$$\xi_{2.h_i} \leftarrow \xi_{2.0}+2A$$

$$m_{1_i} \leftarrow m_{1_{i-1}}+dm_{1_{i-1}}$$

$$m_{2_i} \leftarrow m_{2_{i-1}}+dm_{2_{i-1}}$$

$$m_{3_i} \leftarrow m_{3_{i-1}}+dm_{3_{i-1}}$$

$$p_{4_i} \leftarrow p_{4_{i-1}}+dp_{4_{i-1}}$$

$$V_{\text{ж}_i} \leftarrow V_{\text{ж}.0}$$

$$dm_{1.1_i} \leftarrow dt\cdot\left(\frac{p_1-p_{4_i}-\xi_1\cdot m_{1_i}\cdot\left|m_{1_i}\right|}{j_1}\right)$$

$$dm_{2.1_i} \leftarrow dt\cdot\left(\frac{p_2-p_{4_i}-\xi_{2_i}\cdot m_{2_i}\cdot\left|m_{2_i}\right|}{j_2}\right)$$

$$dm_{3.1_i} \leftarrow dt\cdot\left(\frac{p_{4_i}-p_3-\xi_3\cdot m_{3_i}\cdot\left|m_{3_i}\right|}{j_3}\right)$$

$$dp_{4.1_i} \leftarrow dt\cdot\left(\frac{m_{1_i}+m_{2_i}-m_{3_i}}{\frac{V_{\text{ж}_i}}{C^2}}\right)$$

$$dm_{1.2_i} \leftarrow dt\cdot\left[\frac{p_1-\left(p_{4_i}+\frac{dp_{4.1_i}}{2}\right)-\xi_1\cdot\left(m_{1_i}+\frac{dm_{1.1_i}}{2}\right)\cdot\left|\left(m_{1_i}+\frac{dm_{1.1_i}}{2}\right)\right|}{j_1}\right]$$

$$dm_{2.2_i} \leftarrow dt\cdot\left[\frac{p_2-\left(p_{4_i}+\frac{dp_{4.1_i}}{2}\right)-\xi_{2.0.5h_i}\cdot\left(m_{2_i}+\frac{dm_{2.1_i}}{2}\right)\cdot\left|\left(m_{2_i}+\frac{dm_{2.1_i}}{2}\right)\right|}{j_2}\right]$$

$$dm_{3.2_i} \leftarrow dt\cdot\left[\frac{\left(p_{4_i}+\frac{dp_{4.1_i}}{2}\right)-p_3-\xi_3\cdot\left(m_{3_i}+\frac{dm_{3.1_i}}{2}\right)\cdot\left|\left(m_{3_i}+\frac{dm_{3.1_i}}{2}\right)\right|}{j_3}\right]$$

$$dp_{4.2_i} \leftarrow dt\cdot\left[\frac{\left(m_{1_i}+\frac{dm_{1.1_i}}{2}\right)+\left(m_{2_i}+\frac{dm_{2.1_i}}{2}\right)-\left(m_{3_i}+\frac{dm_{3.1_i}}{2}\right)}{\frac{V_{\text{ж}_i}}{C^2}}\right]$$

$$dm_{1.3_i} \leftarrow dt\cdot\left[\frac{p_1-\left(p_{4_i}+\frac{dp_{4.2_i}}{2}\right)-\xi_1\cdot\left(m_{1_i}+\frac{dm_{1.2_i}}{2}\right)\cdot\left|\left(m_{1_i}+\frac{dm_{1.2_i}}{2}\right)\right|}{j_1}\right]$$

$$dm_{2.3_i} \leftarrow dt\cdot\left[\frac{p_2-\left(p_{4_i}+\frac{dp_{4.2_i}}{2}\right)-\xi_{2.0.5h_i}\cdot\left(m_{2_i}+\frac{dm_{2.2_i}}{2}\right)\cdot\left|\left(m_{2_i}+\frac{dm_{2.2_i}}{2}\right)\right|}{j_2}\right]$$

$$dm_{3.3_i} \leftarrow dt\cdot\left[\frac{\left(p_{4_i}+\frac{dp_{4.2_i}}{2}\right)-p_3-\xi_3\cdot\left(m_{3_i}+\frac{dm_{3.2_i}}{2}\right)\cdot\left|\left(m_{3_i}+\frac{dm_{3.2_i}}{2}\right)\right|}{j_3}\right]$$

$$dp_{4.3_i} \leftarrow dt\cdot\left[\frac{\left(m_{1_i}+\frac{dm_{1.2_i}}{2}\right)+\left(m_{2_i}+\frac{dm_{2.2_i}}{2}\right)-\left(m_{3_i}+\frac{dm_{3.2_i}}{2}\right)}{\frac{V_{\text{ж}_i}}{C^2}}\right]$$

$$dm_{1.4_i} \leftarrow dt\cdot\left[\frac{p_1-\left(p_{4_i}+dp_{4.3_i}\right)-\xi_1\cdot\left(m_{1_i}+dm_{1.3_i}\right)\cdot\left|\left(m_{1_i}+dm_{1.3_i}\right)\right|}{j_1}\right]$$

$$dm_{2.4_i} \leftarrow dt\cdot\left[\frac{p_2-\left(p_{4_i}+dp_{4.3_i}\right)-\xi_{2.h_i}\cdot\left(m_{2_i}+dm_{2.3_i}\right)\cdot\left|\left(m_{2_i}+dm_{2.3_i}\right)\right|}{j_2}\right]$$

$$dm_{3.4_i} \leftarrow dt\cdot\left[\frac{\left(p_{4_i}+dp_{4.3_i}\right)-p_3-\xi_3\cdot\left(m_{3_i}+dm_{3.3_i}\right)\cdot\left|\left(m_{3_i}+dm_{3.3_i}\right)\right|}{j_3}\right]$$

$$dp_{4.4_i} \leftarrow dt\cdot\left[\frac{\left(m_{1_i}+dm_{1.3_i}\right)+\left(m_{2_i}+dm_{2.3_i}\right)-\left(m_{3_i}+dm_{3.3_i}\right)}{\frac{V_{ж_i}}{C^2}}\right]$$

$$dm_{1_i} \leftarrow \frac{1}{6}\cdot\left(dm_{1.1_i}+2\cdot dm_{1.2_i}+2\cdot dm_{1.3_i}+dm_{1.4_i}\right)$$

$$dm_{2_i} \leftarrow \frac{1}{6}\cdot\left(dm_{2.1_i}+2\cdot dm_{2.2_i}+2\cdot dm_{2.3_i}+dm_{2.4_i}\right)$$

$$dm_{3_i} \leftarrow \frac{1}{6}\cdot\left(dm_{3.1_i}+2\cdot dm_{3.2_i}+2\cdot dm_{3.3_i}+dm_{3.4_i}\right)$$

$$dp_{4_i} \leftarrow \frac{1}{6}\cdot\left(dp_{4.1_i}+2\cdot dp_{4.2_i}+2\cdot dp_{4.3_i}+dp_{4.4_i}\right)$$

$$\left(m_1\ \ m_2\ \ m_3\ \ p_4\ \ V_ж\ \ t\ \ \xi_2\ \ \xi_{2.0.5h}\ \ \xi_{2.h}\right)$$

$p_4 =$

	0
0	289442.7191
1	289442.7191
2	289442.7191
3	289442.7191
4	289442.7191
5	289442.7191
6	289442.7191
7	289442.7191
8	289442.719
9	289442.719
10	289442.7189
11	289442.7189
12	289442.7188
13	289442.7186
14	289442.7185
	...

$\xi_2 =$

	0
0	1000
1	1000.0002
2	1000.0008
3	1000.0018
4	1000.0032
5	1000.0049
6	1000.0071
7	1000.0097
8	1000.0126
9	1000.016
10	1000.0197
11	1000.0239
12	1000.0284
13	1000.0334
14	1000.0387
15	...

$$F(x) := \begin{pmatrix} 1 \\ x \\ x^2 \\ x^3 \\ x^4 \\ x^5 \\ x^6 \\ x^7 \\ x^8 \\ x^9 \\ x^{10} \\ x^{11} \\ x^{12} \\ x^{13} \end{pmatrix}$$

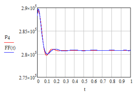
$$S := \mathrm{linfit}\left(t, p_4, F\right)$$

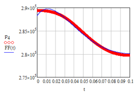
$$g(u) := F(u)\cdot S$$

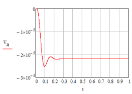
$S =$

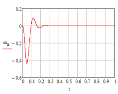
	0
0	288289.1901
1	286365.1896
2	$-1.6746\cdot10^{7}$
3	$2.8642\cdot10^{8}$
4	$-2.5651\cdot10^{9}$
5	$1.4134\cdot10^{10}$
6	$-5.1618\cdot10^{10}$
7	$1.2975\cdot10^{11}$
8	$-2.2818\cdot10^{11}$
9	$2.8045\cdot10^{11}$
10	$-2.3613\cdot10^{11}$
11	$1.2982\cdot10^{11}$
12	$-4.1988\cdot10^{10}$
13	$6.0592\cdot10^{9}$

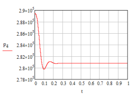
$$FF(t) := S_0 + S_1\cdot t + S_2\cdot t^2 + S_3\cdot t^3 + S_4\cdot t^4 + S_5\cdot t^5 + S_6\cdot t^6 + S_7\cdot t^7 + S_8\cdot t^8 + S_9\cdot t^9 + S_{10}\cdot t^{10} + S_{11}\cdot t^{11} + S_{12}\cdot t^{12} + S_{13}\cdot t^{13}$$

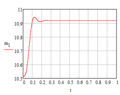


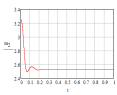


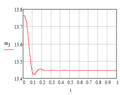


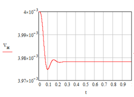


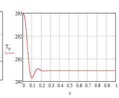


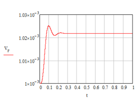


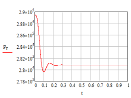


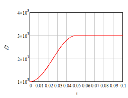












1) $\frac{V_ж}{c^2}\cdot\left(\frac{d}{dt}p4\right) = m_1 + m_2 - m_3 - m_д$ $\qquad$ $\left(\frac{d}{dt}p4\right) = \frac{\left(m_1 + m_2 - m_3 - m_д\right)}{\frac{V_ж}{c^2}}$

2) $T_{\text{газ}} = T_{\text{газ}0} \cdot \left(\frac{p_4}{p_{4_0}}\right)^{\frac{k-1}{k}}$

3) $m_{\text{д}} = \rho_{\text{ж}} \cdot \left(\frac{d}{dt} V_{\text{д}}\right)$ $\qquad \frac{d}{dt} V_{\text{д}} = \frac{m_{\text{д}}}{\rho_{\text{ж}}}$

4) $V_{\text{ж}} = V_{\text{ж}0} + V_{\text{д}}$

5) $V_{\text{газ}} = V_{\text{г}0} - V_{\text{д}}$

6) $p_{\text{газ}} = \frac{m_{\text{газ}}}{V_{\text{газ}}} \cdot R \cdot T_{\text{газ}}$

7) $p_4 - p_{\text{газ}} - \xi_{\text{д}} \cdot m_{\text{д}} \cdot |m_{\text{д}}| - j_{\text{д}} \cdot \left(\frac{d}{dt} m_{\text{д}}\right) = 0$ $\qquad \frac{d}{dt} m_{\text{д}} = \frac{\left(p_4 - p_{\text{газ}} - \xi_{\text{д}} \cdot m_{\text{д}} \cdot |m_{\text{д}}|\right)}{j_{\text{д}}}$

8) $p_1 - p_4 - \xi_1 \cdot m_1^2 - j_1 \cdot \left(\frac{d}{dt} m_1\right) = 0$ $\qquad \frac{d}{dt} m_1 = \frac{\left(p_1 - p_4 - \xi_1 \cdot m_1^2\right)}{j_1}$

9) $p_4 - p_3 - \xi_3 \cdot m_3^2 - j_3 \cdot \left(\frac{d}{dt} m_3\right) = 0$ $\qquad \frac{d}{dt} m_3 = \frac{\left(p_4 - p_3 - \xi_3 \cdot m_3^2\right)}{j_3}$

10) $p_2 - p_4 - \xi_2 \cdot m_2^2 - j_2 \cdot \left(\frac{d}{dt} m_2\right) = 0$ $\qquad \frac{d}{dt} m_2 = \frac{\left(p_2 - p_4 - \xi_2 \cdot m_2^2\right)}{j_2}$

11) $\xi_2(t) := \begin{cases} 0 & \text{if } t < 0 \\ 1 & \text{if } t \ge 0 \end{cases}$

1) $\frac{V_{\text{ж}}}{c^2} \cdot \left(\frac{d}{dt} p4\right) = m_1 + m_2 - m_3 - m_{\text{д}}$ $\qquad \left(\frac{d}{dt} p4\right) = \frac{\left(m_1 + m_2 - m_3 - m_{\text{д}}\right)}{\frac{V_{\text{ж}0} + V_{\text{д}}}{c^2}}$

2) $T_{\text{газ}} = T_{\text{газ}0} \cdot \left(\frac{p_4}{p_{4_0}}\right)^{\frac{k-1}{k}}$

3) $m_{\text{д}} = \rho_{\text{ж}} \cdot \left(\frac{d}{dt} V_{\text{д}}\right)$ $\qquad \frac{d}{dt} V_{\text{д}} = \frac{m_{\text{д}}}{\rho_{\text{ж}}}$

4) $V_{\text{ж}} = V_{\text{ж}0} + V_{\text{д}}$

5) $V_{\text{газ}} = V_{\text{г}0} - V_{\text{д}}$

6) $p_{\text{газ}} = \frac{m_{\text{газ}}}{V_{\text{газ}}} \cdot R \cdot T_{\text{газ}}$

7) $p_4 - p_{\text{газ}} - \xi_{\text{д}} \cdot m_{\text{д}} \cdot |m_{\text{д}}| - j_{\text{д}} \cdot \left(\frac{d}{dt} m_{\text{д}}\right) = 0$ $\qquad \frac{d}{dt} m_{\text{д}} = \frac{\left[p_4 - \frac{m_{\text{газ}}}{V_{\text{г}0} - V_{\text{д}}} \cdot R \cdot \left[T_{\text{газ}0} \cdot \left(\frac{p_4}{p_{4_0}}\right)^{\frac{k-1}{k}}\right] - \xi_{\text{д}} \cdot m_{\text{д}} \cdot |m_{\text{д}}|\right]}{j_{\text{д}}}$

8) $p_1 - p_4 - \xi_1 \cdot m_1^2 - j_1 \cdot \left(\frac{d}{dt} m_1\right) = 0$ $\qquad \frac{d}{dt} m_1 = \frac{\left(p_1 - p_4 - \xi_1 \cdot m_1^2\right)}{j_1}$

9) $p_4 - p_3 - \xi_3 \cdot m_3^2 - j_3 \cdot \left(\frac{d}{dt} m_3\right) = 0$ $\qquad \frac{d}{dt} m_3 = \frac{\left(p_4 - p_3 - \xi_3 \cdot m_3^2\right)}{j_3}$

10) $p_2 - p_4 - \xi_2 \cdot m_2^2 - j_2 \cdot \left(\frac{d}{dt} m_2\right) = 0$ $\qquad \frac{d}{dt} m_2 = \frac{\left(p_2 - p_4 - \xi_2 \cdot m_2^2\right)}{j_2}$

11) $\xi_2(t) := \begin{cases} 0 & \text{if } t < 0 \\ 1 & \text{if } t \ge 0 \end{cases}$

$$\left(\frac{d}{dt} p4\right) = \frac{\left(m_1 + m_2 - m_3 - m_{\text{д}}\right)}{\frac{V_{\text{ж}0} + V_{\text{д}}}{c^2}}$$

$$\frac{d}{dt} V_{\text{д}} = \frac{m_{\text{д}}}{\rho_{\text{ж}}}$$

$$\frac{d}{dt} m_{\text{д}} = \frac{\left[p_4 - \frac{m_{\text{газ}}}{V_{\text{г}0} - V_{\text{д}}} \cdot R \cdot \left[T_{\text{газ}0} \cdot \left(\frac{p_4}{p_{4_0}}\right)^{\frac{k-1}{k}}\right] - \xi_{\text{д}} \cdot m_{\text{д}} \cdot |m_{\text{д}}|\right]}{j_{\text{д}}}$$

$$\frac{d}{dt} m_1 = \frac{\left(p_1 - p_4 - \xi_1 \cdot m_1^2\right)}{j_1}$$

$$\frac{d}{dt} m_3 = \frac{\left(p_4 - p_3 - \xi_3 \cdot m_3^2\right)}{j_3}$$

$$\frac{d}{dt} m_2 = \frac{\left(p_2 - p_4 - \xi_2 \cdot m_2^2\right)}{j_2}$$

$$D(T, nach) := \begin{bmatrix} \frac{\left(m_1 + m_2 - m_3 - m_{\text{д}}\right)}{\frac{V_{\text{ж}}}{c^2}} \\ \frac{m_{\text{д}}}{\rho_{\text{ж}}} \\ \frac{\left(p_4 - p_{\text{газ}} - \xi_{\text{д}} \cdot m_{\text{д}} \cdot |m_{\text{д}}|\right)}{j_{\text{д}}} \\ \frac{\left(p_1 - p_4 - \xi_1 \cdot m_1^2\right)}{j_1} \\ \frac{\left(p_4 - p_3 - \xi_3 \cdot m_3^2\right)}{j_3} \\ \frac{\left(p_2 - p_4 - \xi_2 \cdot m_2^2\right)}{j_2} \end{bmatrix}$$