1

, :

$$m\frac{d^2H}{dt^2} = \mathbf{F}$$

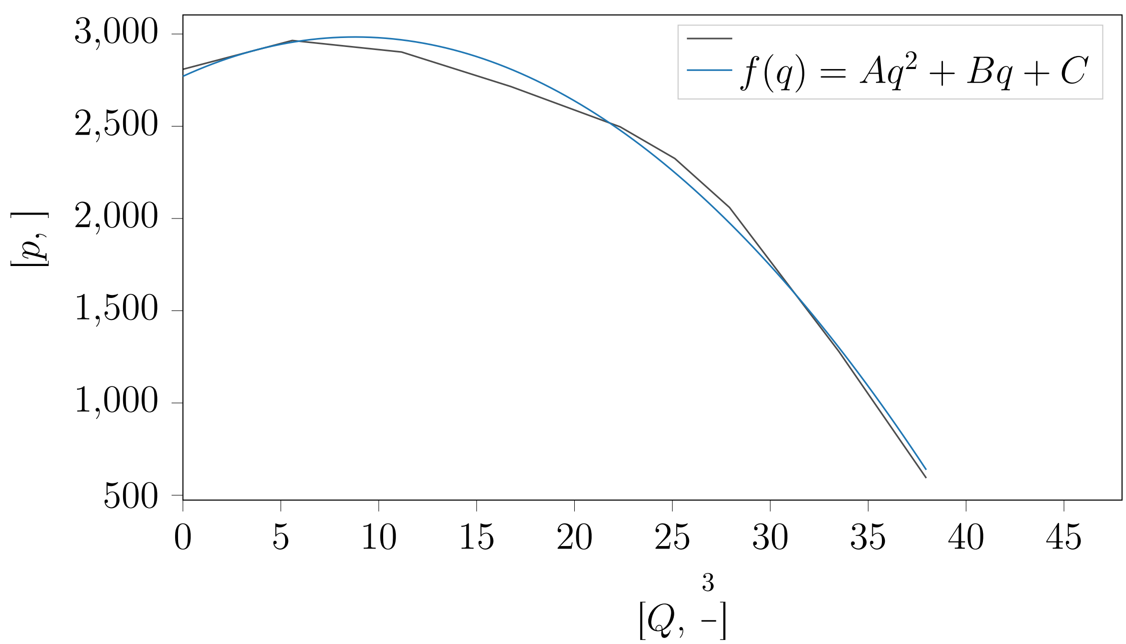
$$\frac{dp}{dt} = \frac{np_a}{W}\left(Q_{in} - Q_{out} - \frac{dW}{dt}\right) \tag{1.1}$$

$$I_z\frac{d^2\varphi}{dt^2} = \mathbf{M}$$

2

1: , . initials.xlsx

p,	2809	2965	2902	2715	2497	2325	2060	1280	593
Q, $\frac{3}{c}$	0	6	11	17	22	25	28	34	38



. 1: $p(Q_{in})$. $f(q) = -2.756q^2 + 48.46q + 2771$.

, :

$$\frac{1}{2}Q_0 - \left.\frac{\partial Q}{\partial p}\right|_0 p_0 > 0, \quad (Q_0, p_0) \tag{2.1}$$

$p(Q_{in})$ $Q_{in}(p)$, $f(q) = p$. :

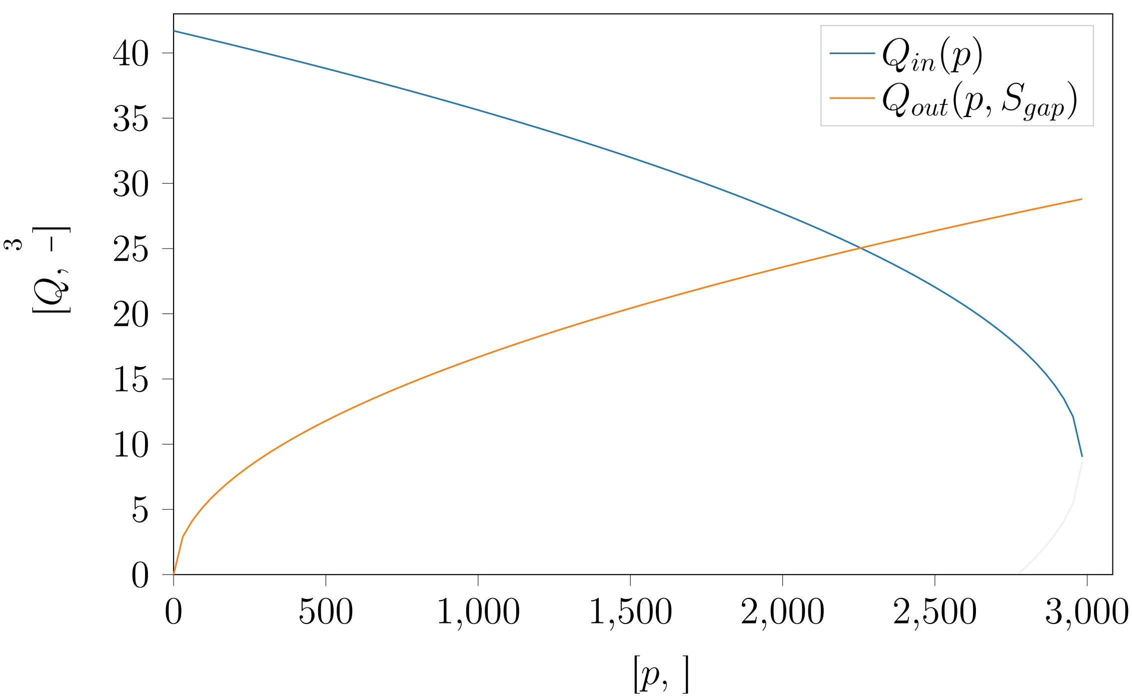
$$Q_{in}(p) = \frac{-B - \sqrt{B^2 - 4A(C-p)}}{2A}, \quad A, B, C \quad f(q) \tag{2.2}$$

Q_{out}, , :

$$Q_{out} = Q_{out}(p, S_{gap}) = \chi\sqrt{\frac{2p}{\rho_a}}S_{gap} \tag{2.3}$$

Q_{in}, , :

$$Q_{in} = Q_{in}(p) \tag{2.4}$$



. 2: $Q_{in}(p)$ $Q_{out}(p, S_{gap})$ 1 .

3

. N (N,). :

$$d_L = \frac{L}{N} \tag{3.1}$$

y. $y = 0$. $(y > 0)$, :

$$S_{wash} = S_{wash}(d_L) = d_L \cdot b \tag{3.2}$$

, , :

$$F_{contact} = \theta \cdot \rho_w \frac{V^2}{2} S_{wash}, \quad V = \sqrt{V_x^2 + V_y^2} \tag{3.3}$$

, :

$$F_{wave} = \int\limits_{\mathcal{R}_+^1} F_{contact} \, \mathrm{d}d_L \tag{3.4}$$

:

$$M_{contact} = \int\limits_0^L \int\limits_{\mathcal{R}_+^1} d_{segment} \cdot F_{contact} \, \mathrm{d}d_L \mathrm{d}x \tag{3.5}$$

$d_{segment}$ - .

$$d_{segment}(x) = x - \frac{L}{2} \tag{3.6}$$

$d_{segment} > 0$, , $d_{segment} < 0$.

3.1

$y(x)$:

$$W_{shaped} = \int\limits_{x_c+0}^{x_c+L} \int\limits_{\mathcal{R}_+^1} S_{wash} \left[H - y(x) \right] \, \mathrm{d}d_L \mathrm{d}x \tag{3.1.1}$$

x_c - OX, $H - y(x)$. :

$$I(x) = \begin{cases} 0.01, & \text{H-d} > \text{y(x)} \\ 0, & \end{cases} \tag{3.1.2}$$

$I(x)$ 1 , (H d) $y(x)$. :

$$S_{gap} = \int\limits_{x_c+0}^{x_c+L} \int\limits_{\mathcal{R}_+^1} d_L \cdot I(x) \, \mathrm{d}d_L \mathrm{d}x \tag{3.1.3}$$

4

4.1

$\Psi(x,t)$ ( ) λ ν:

$$\Psi(x,t) = A\cos(\frac{2\pi x}{\lambda} + 2\pi\nu t + \varphi_0) = A\cos(kx + \omega t + \varphi_0) \tag{4.1.1}$$

$k = \dfrac{2\pi}{\lambda}$ - , $\omega = 2\pi\nu$ - . .

$$c = \sqrt{\frac{\lambda}{2\pi}g} = \sqrt{\frac{g}{k}} \tag{4.1.2}$$

5

F **M** 1.1 :

$$\begin{gathered} F = pS - mg + F_{wave} \\ M = pS \cdot l_{AC} + M_{contact} \end{gathered} \tag{5.1}$$

, , :

$$\frac{dW}{dt} = S\frac{dH}{dt} + S \cdot l_{AC}\frac{d\varphi}{dt} - \frac{d(W - W_{shaped})}{dt} \tag{5.2}$$

5.2 ($W_{wave} = W - W_{shaped}$).
1.1, . , , :

$$\begin{gathered} \frac{dV_y}{dt} = \frac{pS - mg + F_{wave}}{m} \\ \frac{dH}{dt} = V_y \\ \frac{dW}{dt} = S\frac{dH}{dt} + S \cdot l_{AC}\frac{d\varphi}{dt} - \frac{d(W - W_{shaped})}{dt} \\ \frac{dp}{dt} = \frac{np_a}{W}\left(Q_{in} - Q_{out} - \frac{dW}{dt}\right) \\ \frac{dV_\varphi}{dt} = \frac{pS \cdot l_{AC} + M_{contact}}{I_z} \\ \frac{d\varphi}{dt} = V_\varphi \end{gathered} \tag{5.3}$$

5.1

- :

(($\mathbf{y}, \mathbf{f}, \mathbf{k}_i \in \mathcal{R}^n, x, h \in \mathcal{R}^1$)

$$\mathbf{y}' = \mathbf{f}(x, \mathbf{y}), \quad \mathbf{y}(x_0) = \mathbf{y}_0 \tag{5.1.1}$$

:

$$\mathbf{y}_{n+1} = \mathbf{y}_n + \frac{h}{6}(\mathbf{k}_1 + 2\mathbf{k}_2 + 2\mathbf{k}_3 + \mathbf{k}_4) \tag{5.1.2}$$

:

$$\begin{aligned}
\mathbf{k}_1 &= \mathbf{f}(x_n, \mathbf{y}_n) \\
\mathbf{k}_2 &= \mathbf{f}(x_n + \frac{h}{2}, \mathbf{y}_n + \frac{h}{2}\mathbf{k}_1) \\
\mathbf{k}_3 &= \mathbf{f}(x_n + \frac{h}{2}, \mathbf{y}_n + \frac{h}{2}\mathbf{k}_2) \\
\mathbf{k}_4 &= \mathbf{f}(x_n + h, \mathbf{y}_n + h\mathbf{k}_3)
\end{aligned} \tag{5.1.3}$$