

HDPE PENSTOCK LOSSES & THICKNESS CALCULATION

SITE NAME

Sample

Quantity

Symbol

Unit

PENSTOCK LOSS CALCULATIONS

Input Data

Flow	Q	10 l/s
Gross head	H _g	30 m
Penstock length	L	80 m
Penstock internal diameter	d	100 mm

Calculations

Velocity in penstock	$V = 1.273 \cdot \left(\frac{Q}{d^2}\right) =$	1.2732 m/s
Friction head loss in penstock	$H_f = 12 \cdot 8 \times \left(\frac{V^2 \cdot L}{d}\right) \times \frac{1}{\left(\log\left[\frac{1}{19d} + \frac{1}{(93 \cdot 8 \cdot V \cdot d)^{0.9}}\right]\right)^2} =$	1.6969 m
Net head at end of penstock	$H_n = H_g - H_f =$	28.303 m
Penstock efficiency	$\eta_{pen} = \frac{H_n}{H_g} \times 100 =$	94.344 %

PENSTOCK THICKNESS CALCULATIONS

Input Data

Penstock thickness	t	12 mm
% of flow stopped	z	50 %
valve closure time	T _{close}	0.5 s
Overall safety factor	SF _{tot}	4

Calculations

Wave velocity in penstock	$V_{wave} = \sqrt{\frac{5 \times 10^5 \cdot t}{(0.24t + d)}} =$	241.52 m/s
Penstock critical time	$T_{crit} = \frac{2L}{V_{wave}} =$	0.6625 s
Surge head for T _{close} ≤ T _{crit}	$H_{surge} = \frac{V_{wave} \cdot z \cdot V}{980} =$	15.69 m
OR		
For T _{close} ≥ T _{crit}	$K_c = \left(\frac{L \cdot z \cdot V}{980 H_g \cdot T_{close}}\right)^2 =$	0.12
Surge head for T _{close} ≥ T _{crit}	$H_{surge} = H_g \cdot \left(\frac{K_c}{2} + \sqrt{K_c + \frac{K_c^2}{4}}\right) =$	- m
Total head at surge	$H_{tot} = H_{surge} + H_g =$	45.69 m
Required penstock thickness	$t_{req} = \frac{H_{tot} \cdot d \cdot SF_{tot}}{1,630} =$	11.194 mm

Values of Constants Used

Gravity	g	9.8 m/s
Bulk modulus of water	K_w	2.1 kN/mm ²
Density of water	ρ	1000 kg/m ³
Kinematic viscosity of water (5°C)	ν	1.53 cSt
Penstock roughness coefficient	k	0.2 mm
Penstock Young's Modulus	E_p	0.5 kN/mm ²
Penstock UTS	σ_{ult}	8 N/mm ²