Reactor Coolant Pump Coastdown Flow after a Trip

Flow and speed decay of a reactor coolant pump after loss of power from its rotating inertia and rated power, with the half-flow time and the integrated flow.

Method: Pump coastdown with torque proportional to speed squared

Input parameters

Unit system: SI

Parameter	Value	Unit
Rotating inertia of pump, motor and flywheel	3,500.0	kg·m²
Rated speed	1,190.0	rpm
Shaft power at rated speed and flow	5.5000	MW
Time after the trip	10.000	s

Calculated results

Parameter	Value	Unit
Half-flow (half-speed) time I ω₀²/P₀	9.8823	s
Flow fraction at t	49.704	%
Stored kinetic energy at rated speed	27.176	MJ
Integrated flow (equivalent full-flow seconds)	6.9086	s
Time to 10 % flow	88.940	s

Notes for this case

• Hydraulic torque □ ω² gives Iω̇ = −(P₀/ω₀)(ω/ω₀)², so ω/ω₀ = W/W₀ = 1/(1 + t/t_p) with t_p = Iω₀²/P₀ (flow □ speed by the affinity laws). Friction torque, loop inertia and natural circulation make the real tail differ.

Formula and method

$$\frac{W}{W_0} = \frac{\omega}{\omega_0} = \frac{1}{1 + t/t_p}, \quad t_p = \frac{I\omega_0^2}{P_0}, \quad \int_0^t \frac{W}{W_0}\,dt = t_p \ln\left(1 + \frac{t}{t_p}\right)$$

Variables

I	Rotating inertia of pump, motor and flywheel	kg·m²
n_0	Rated speed	rad/s
P_0	Shaft power at rated speed and flow	W
t	Time after the trip	s
t_p	Half-flow (half-speed) time I ω₀²/P₀	s
W/W_0	Flow fraction at t	-
E_k	Stored kinetic energy at rated speed	J
$\int W/W_0\,dt$	Integrated flow (equivalent full-flow seconds)	s
$t_{10\%}$	Time to 10 % flow	s

Method and standards

Pump coastdown.

Assumptions and limits

- Torque □ ω²; no friction or loop inertia.

References

Pump coastdown with torque proportional to speed squared

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/nuclear-power/reactor-coolant-pump-coastdown

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Reopens the calculator with the inputs of this report.