Centrifugal Pump Radial Thrust (Stepanoff)

Radial hydraulic force on the impeller of a volute pump away from its best-efficiency flow, by the Stepanoff thrust factor, for shaft and bearing checks.

Method: Stepanoff radial thrust factor for volute casings

Input parameters

Unit system: SI

Parameter	Value	Unit
Pump head at the operating flow	55.000	m
Impeller outside diameter	320.00	mm
Impeller width at the outlet, including the shrouds	35.000	mm
Flow as a share of the best-efficiency flow	50.000	%
Thrust factor at shut-off About 0.36 for a single volute; double volutes and diffusers are much lower (about 0.1 or less).	0.36000	
Liquid density	998.00	kg/m³

Calculated results

Parameter	Value	Unit
Radial thrust factor at this flow	0.27000	
Radial thrust	1.6278	kN

Notes for this case

• A single volute is designed for uniform pressure round the impeller only at the best-efficiency flow. At lower and higher flows the pressure varies round the casing and pushes the impeller sideways: F = K ρ g H D_2 B_2, with K = K_0 [1 − (Q/Q_BEP)²] and K_0 ≈ 0.36 at shut-off. The largest force is at shut-off, which is why single-volute pumps should not run long at low flow: the shaft deflects, wear rings rub and bearings and seals fail.

Formula and method

$$F_r = K\rho g H D_2 B_2, \quad K = K_0 \left[1 - \left(\frac{Q}{Q_{BEP}}\right)^2\right]$$

Variables

H	Pump head at the operating flow	m
D_2	Impeller outside diameter	m
B_2	Impeller width at the outlet, including the shrouds	m
Q/Q_{BEP}	Flow as a share of the best-efficiency flow	-
K_0	Thrust factor at shut-off	-
ρ	Liquid density	kg/m³
K	Radial thrust factor at this flow	-
F_r	Radial thrust	N

Method and standards

Radial thrust.

Assumptions and limits

- Stepanoff's empirical factor; steady force only.

References

Stepanoff radial thrust factor for volute casings

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/mechanical/pumps/pump-radial-thrust

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Reopens the calculator with the inputs of this report.