Impeller Trimming: Diameter for a New Duty Point

Impeller diameter that moves a centrifugal pump onto a lower duty point, by the affinity laws along the system parabola, with the power saving.

Method: Affinity laws for impeller diameter along the system parabola

Input parameters

Unit system: SI

Parameter	Value	Unit
Full impeller diameter	260.00	mm
Shut-off head of the full impeller	62.000	m
Flow at a known point on the full-diameter curve	100.00	m³/h
Head at that point	50.000	m
Duty flow wanted	85.000	m³/h
Duty head wanted	40.000	m

Calculated results

Parameter	Value	Unit
Trimmed impeller diameter	230.36	mm
Trim ratio	88.600	%
Full-diameter point on the same system parabola	95.937	m³/h
Head at that point	50.955	m
Power at the trimmed duty as a share of the full-impeller power on the same parabola	69.551	%

Notes for this case

• The full-diameter curve is taken as H = H₀ − aQ² through the shut-off head and the known point. By the affinity laws a smaller impeller moves each point along a parabola through the origin (Q □ D, H □ D²), so the full-diameter point on the parabola through the duty point fixes the trim ratio D₂/D₁ = Q_d/Q*. The affinity laws overestimate the trim a little for large cuts: trim in steps, more than about 20 % is rarely advisable, and efficiency falls slightly.

Formula and method

$$H = H_0 - aQ^2, \quad a = \frac{H_0 - H_1}{Q_1^2}, \quad Q^* = \sqrt{\frac{H_0}{a + H_d/Q_d^2}}, \quad \frac{D_2}{D_1} = \frac{Q_d}{Q^*}$$

Variables

D_1	Full impeller diameter	m
H_0	Shut-off head of the full impeller	m
Q_1	Flow at a known point on the full-diameter curve	m³/s
H_1	Head at that point	m
Q_d	Duty flow wanted	m³/s
H_d	Duty head wanted	m
D_2	Trimmed impeller diameter	m
D_2/D_1	Trim ratio	-
Q^*	Full-diameter point on the same system parabola	m³/s
H^*	Head at that point	m

$(D_2/D_1)^3$	Power at the trimmed duty as a share of the full-impeller power on the same parabola	-

Method and standards

Impeller trim.

Assumptions and limits

- Parabolic pump curve; affinity laws; efficiency held.

References

Affinity laws for impeller diameter along the system parabola

Report details

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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/impeller-trim-diameter

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Reopens the calculator with the inputs of this report.