Two Pumps in Parallel or Series (Operating Point)

Operating flow and head of one pump and of two identical pumps in parallel or in series on a system curve with static head, and the flow gained.

Method: Karassik et al.; Pump Handbook (parallel and series operation); ANSI/HI 1.3

Input parameters

Unit system: SI

Parameter	Value	Unit
Two pumps	In parallel	
Pump shut-off head (zero flow)	60.000	m
Rated flow	100.00	m³/h
Head at rated flow	50.000	m
Static head of the system	20.000	m
A known flow of the system	100.00	m³/h
Head the system needs at that flow	50.000	m

Calculated results

Parameter	Value	Unit
Flow with two pumps	110.94	m³/h
Head with two pumps	56.923	m
Flow through each pump	55.470	m³/h
Flow gained over one pump	10.940	%
Flow with one pump	100.00	m³/h
Head with one pump	50.000	m

Formula and method

$$H_{pump} = H_0 - a\,Q^2, \quad a = \frac{H_0 - H_r}{Q_r^2} \qquad H_{sys} = H_s + k\,Q^2, \quad k = \frac{H_d - H_s}{Q_d^2}$$

$$Q_1 = \sqrt{\frac{H_0 - H_s}{a + k}} \qquad \text{parallel}: \; Q_2 = \sqrt{\frac{H_0 - H_s}{a/4 + k}} \qquad \text{series}: \; Q_2 = \sqrt{\frac{2H_0 - H_s}{2a + k}}$$

$$H_1 = H_s + k\,Q_1^2 \qquad H_2 = H_s + k\,Q_2^2 \qquad \Delta Q = \frac{Q_2}{Q_1} - 1$$

Variables

mode	two pumps in parallel or in series	–
H_0	shut-off head of one pump	m
Q_r	rated flow of one pump	m³/s
H_r	head at rated flow	m
H_s	static head of the system	m
Q_d	a known flow of the system	m³/s
H_d	head the system needs at that flow	m
Q_2	flow with two pumps	m³/s
H_2	head with two pumps	m

Q_{each}	flow through each pump	m³/s
ΔQ	flow gained over one pump	–
Q_1	flow with one pump	m³/s
H_1	head with one pump	m

Method and standards

Intersection of the combined pump curve with the system curve, the method of Karassik's Pump Handbook: in parallel the flows add at equal head, in series the heads add at equal flow. Both curves are represented by parabolas through the points you enter.

Assumptions and limits

- Identical pumps; the parabola through shut-off and the rated point approximates the real curve near the rated point.
- System curve with constant static head and losses proportional to Q².
- Check that each pump in parallel stays above its minimum flow and each pump alone stays inside its curve.

References

• Karassik et al.
• Pump Handbook (parallel and series operation); ANSI/HI 1.3

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

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Reopens the calculator with the inputs of this report.