Positive Displacement Pump: Slip, Volumetric and Overall Efficiency

Theoretical flow, slip, volumetric efficiency, hydraulic power and overall and mechanical efficiency of a positive displacement pump from a test.

Method: Positive displacement pump definitions (Perry's Chemical Engineers' Handbook, 9th ed. (McGraw-Hill, 2019), sec. 10, positive displacement pumps)

Input parameters

Unit system: SI

Parameter	Value	Unit
Displacement per revolution	0.25000	L
Speed	600.00	rpm
Measured delivery	8.5000	m³/h
Differential pressure	10.000	bar
Shaft power	3.2000	kW

Calculated results

Parameter	Value	Unit
Theoretical flow	9.0000	m³/h
Slip	0.50000	m³/h
Volumetric efficiency	94.444	%
Hydraulic power	2.3611	kW
Overall efficiency	73.785	%
Mechanical efficiency	78.125	%

Notes for this case

- Slip rises with differential pressure and falls with viscosity: compare tests at the same conditions.

Formula and method

$$Q_t = V_d N, \quad S = Q_t - Q, \quad \eta_v = \frac{Q}{Q_t}, \quad \eta_o = \frac{Q \Delta p}{P_s}, \quad \eta_m = \frac{\eta_o}{\eta_v}$$

Variables

V_d	Displacement per revolution	m³
N	Speed	1/s
Q	Measured delivery	m³/s
Δp	Differential pressure	Pa
P_s	Shaft power	W
Q_t	Theoretical flow	m³/s
S	Slip	m³/s
η_v	Volumetric efficiency	-
P_h	Hydraulic power	W
η_o	Overall efficiency	-
η_m	Mechanical efficiency	-

Method and standards

Definitions.

Assumptions and limits

- Steady test conditions.

References

• Positive displacement pump definitions (Perry's Chemical Engineers' Handbook, 9th ed. (McGraw-Hill, 2019), sec. 10, positive displacement pumps)

Report details

Report reference	FCC-742P-Y0FQ (the same inputs always give the same reference)
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Release checks	2 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/positive-displacement-pump-slip

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.