Pump Saving: Throttling Valve vs Variable Speed Drive

Power and energy saved by running a pump on a variable speed drive instead of throttling, from the system curve (static and design heads) and the throttled power.

Method: System curve H = H_s + (H_d − H_s)(Q/Q_d)²; hydraulic power ρgQH; saving against measured throttled power

Input parameters

Unit system: SI

Parameter	Value	Unit
Reduced flow	70.000	m³/h
Design flow	100.00	m³/h
System head at design flow	50.000	m
Static head of the system	15.000	m
Measured input power when throttled	17.000	kW
Pump efficiency at the VFD point	72.000	%
Motor efficiency	93.000	%
Drive efficiency	97.000	%
Liquid density	1,000.0	kg/m³
Hours per year at this flow	6,000.0	h
Electricity price per kWh	8.0000	

Calculated results

Parameter	Value	Unit
System head at the reduced flow	32.150	m
Input power with the VFD	9.4387	kW
Power saved	7.5613	kW
Energy saved per year	45.368	MWh
Cost saved per year	362,945	

Notes for this case

- Static head limits the saving: the cube law applies only to pure friction systems.

Formula and method

$$H = H_s + (H_d - H_s)\left(\frac{Q}{Q_d}\right)^2, \quad P_v = \frac{\rho g Q H}{\eta_p \eta_m \eta_v}$$

Variables

Q	Reduced flow	m³/s
Q_d	Design flow	m³/s
H_d	System head at design flow	m
H_s	Static head of the system	m
P_t	Measured input power when throttled	W
η_p	Pump efficiency at the VFD point	-
η_m	Motor efficiency	-
η_v	Drive efficiency	-

ρ	Liquid density	kg/m³
t	Hours per year at this flow	s
C	Electricity price per kWh	-
H	System head at the reduced flow	m
P_v	Input power with the VFD	W
ΔP	Power saved	W
ΔE	Energy saved per year	J
ΔC	Cost saved per year	-

Method and standards

System curve and hydraulic power.

Assumptions and limits

- Steady duty at the reduced flow, below the design flow (above it the system curve is extrapolated).
- The pump efficiency at the reduced-speed point is your input, read from the pump curve; it is not estimated by the affinity laws.

References

- System curve H = H_s + (H_d − H_s)(Q/Q_d)²; hydraulic power ρgQH; saving against measured throttled power

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/environmental/carbon-energy/pump-throttling-vs-vfd

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Reopens the calculator with the inputs of this report.