Indicated Power of a Steam Engine or Reciprocating Machine

Indicated power of a single- or double-acting steam engine or reciprocating compressor from the mean effective pressure, bore, stroke and speed, with mechanical efficiency.

Method: Indicated power from the indicator diagram (textbook)

Input parameters

Unit system: SI

Parameter	Value	Unit
Mean effective pressure (from the indicator diagram)	3.0000	bar
Cylinder bore	250.00	mm
Stroke	350.00	mm
Speed	200.00	rpm
Cylinder	Double acting	
Piston rod diameter (double acting)	40.000	mm
Brake power measured (for mechanical efficiency)	25.000	kW

Calculated results

Parameter	Value	Unit
Indicated power, cover (head) end	17.181	kW
Indicated power, crank end	16.741	kW
Indicated power	33.921	kW
Mechanical efficiency (BP/IP for an engine, IP/BP for a compressor)	73.700	%
Mean piston speed 2 L N	2.3333	m/s

Notes for this case

- IP = p_m L A N per working side; the crank side loses the rod area.
- The same mean effective pressure is used for both ends; real indicator diagrams differ a little between cover and crank ends.

Formula and method

$$IP = p_m\, L\, A\, N \quad \text{per working side}$$

$$IP = p_m L N \left[A + \left(A - \frac{\pi d_r^2}{4} \right) \right] \ \text{(double acting)}, \quad \eta_m = \frac{BP}{IP} \ \text{(engine)}, \ \frac{IP}{BP} \ \text{(compressor)}$$

Variables

p_m	Mean effective pressure (from the indicator diagram)	Pa
D	Cylinder bore	m
L	Stroke	m
N	Speed	1/s
acting	Cylinder	-
d_r	Piston rod diameter (double acting)	m
BP	Brake power measured (for mechanical efficiency)	W
IP_h	Indicated power, cover (head) end	W
IP_c	Indicated power, crank end	W
IP	Indicated power	W
η_m	Mechanical efficiency (BP/IP for an engine, IP/BP for a compressor)	-

V_p	Mean piston speed 2 L N	m/s

Method and standards

Work per cycle is the indicator diagram area, p_m × L × A; multiplied by the working strokes per second.

Assumptions and limits

- One cylinder; multiply for several.
- Mean effective pressure from the indicator diagram, taken equal for the cover and crank ends; use the mean of both diagrams when they differ.
- When the brake (shaft) power is above the indicated power the machine is taken as a compressor and η_m = IP/BP; for an engine that reading would be an error.

References

- Indicated power from the indicator diagram (textbook)

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.