Transformer Losses, Efficiency and All-Day Efficiency

Efficiency of a transformer at any load from its no-load and load losses, the load for maximum efficiency, all-day efficiency and the energy lost in a year.

Method: Transformer loss model (no-load loss constant, load loss ∝ load²)

Input parameters

Unit system: SI

Parameter	Value	Unit
Rated power	1,000.0	kVA
No-load (core) loss	1.7000	kW
Load (copper) loss at rated current	10.500	kW
Load as a share of rating	75.000	%
Load power factor	0.90000	
Hours per day at that load (energised the rest of the day)	16.000	h

Calculated results

Parameter	Value	Unit
Efficiency at the load	98.886	%
Total loss at the load	7.6063	kW
Load share for maximum efficiency	40.237	%
Maximum efficiency (same power factor)	99.070	%
All-day efficiency	98.763	%
Energy lost per year	49,384	kWh

Notes for this case

- Losses at reference temperature; the load loss rises with winding temperature, and harmonics add stray losses.

Formula and method

$$\eta = \frac{x S_r \cos\varphi}{x S_r \cos\varphi + P_0 + x^2 P_k}$$

$$x_{max} = \sqrt{P_0 / P_k}$$

$$\eta_{ad} = \frac{x S_r \cos\varphi \, t_L}{x S_r \cos\varphi \, t_L + P_0 \cdot 24\,\mathrm{h} + x^2 P_k t_L}$$

Variables

S_r	rated power	VA
P_0	no-load (core) loss	W
P_k	load loss at rated current	W
x	load as a share of rating	-
$\cos\varphi$	load power factor	-
t_L	hours per day at that load	s
η	efficiency at the load	-
P_L	total loss at the load	W
x_{max}	load for maximum efficiency	-

η_{max}	maximum efficiency	-
η_{ad}	all-day efficiency	-
E_L	energy lost per year	J

Method and standards

No-load loss is constant whenever the transformer is energised; load loss varies with the square of the load current. Efficiency is output over output plus losses; maximum efficiency occurs where the two losses are equal. All-day efficiency counts 24 hours of core loss against the hours at load.

Assumptions and limits

- Losses from the test report at reference temperature.
- Harmonic and stray losses not included.
- One load level per day; rest of the day energised at no load.

References

- Transformer loss model (no-load loss constant, load loss ∝ load²)

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/electrical/transformers/transformer-losses-efficiency

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.