Steam Turbine Exhaust Annulus Velocity and Leaving Loss

Exhaust volume flow, annulus velocity and leaving loss of a condensing turbine's last stage from exhaust flow, pressure, wetness and annulus area.

Method: Kinetic energy of the exhaust; Δh = c²/2; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Exhaust steam flow	100.00	t/h
Exhaust pressure (absolute)	8.5000	kPa
Exhaust dryness fraction	90.000	%
Total exhaust annulus area	6.0000	m²

Calculated results

Parameter	Value	Unit
Specific volume	15.386	m³/kg
Exhaust volume flow	427.38	m³/s
Annulus velocity	71.231	m/s
Leaving loss per kg	2.5369	kJ/kg
Leaving loss	70.470	kW

Notes for this case

- Low annulus velocity (below about 120 m/s, an indicative level): at low load the last stage may run in recirculation (turn-up) with blade heating.

Formula and method

$$\dot{V} = \dot{m}\, v(p, x), \quad c = \frac{\dot{V}}{A}, \quad \Delta h_{LL} = \frac{c^2}{2}, \quad P_{LL} = \dot{m}\frac{c^2}{2}$$

Variables

$\dot{m}$	Exhaust steam flow	kg/s
p	Exhaust pressure (absolute)	Pa
x	Exhaust dryness fraction	-
A	Total exhaust annulus area	m²
v	Specific volume	m³/kg
$\dot{V}$	Exhaust volume flow	m³/s
c	Annulus velocity	m/s
Δh_{LL}	Leaving loss per kg	J/kg
P_{LL}	Leaving loss	W

Method and standards

The leaving loss is the kinetic energy of the steam leaving the last stage, c²/2, with the axial velocity found from the volume flow (IF97 specific volume of the wet exhaust) and the annulus area.

Assumptions and limits

- Axial exhaust; uniform velocity; no swirl and no diffuser recovery, so the makers' leaving-loss curves differ.
- The 300 m/s and 120 m/s warning levels are indicative, not sourced limits.

References

- Kinetic energy of the exhaust

- $\Delta h = c^2/2$
- with IAPWS-IF97 specific volume (Babcock & Wilcox, Steam: Its Generation and Use, 41st ed. (2005), ch. 2)

Report details

Report reference	FCC-BRGS-VPFE (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/boilers-power-plant/turbines-cycles/turbine-exhaust-leaving-loss

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.