Superheater Steam Mass Flux and Velocity

Steam mass flux and velocity in superheater tubes from the steam flow, number of parallel tubes, bore and the steam state (IF97 density).

Method: Continuity G = ṁ/(n π d²/4); steam density from IAPWS-IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Steam flow	60.000	t/h
Parallel tubes	48.000	
Tube bore	38.100	mm
Steam pressure (absolute)	67.000	bar
Steam temperature	430.00	°C

Calculated results

Parameter	Value	Unit
Steam density	22.408	kg/m³
Mass flux	304.56	kg/(m²·s)
Steam velocity	13.591	m/s

Notes for this case

- Too low a mass flux overheats tubes; too high costs pressure drop. Designs balance the two pass by pass.

Formula and method

$$G = \frac{\dot{m}_s}{n\pi d_i^2/4}, \quad v = \frac{G}{\rho}$$

Variables

$\dot{m}_s$	Steam flow	kg/s
n	Parallel tubes	-
d_i	Tube bore	m
p	Steam pressure (absolute)	Pa
T	Steam temperature	K
ρ	Steam density	kg/m³
G	Mass flux	kg/(m²·s)
v	Steam velocity	m/s

Method and standards

Continuity: mass flux is the steam flow over the total bore area of the parallel tubes; velocity is the mass flux over the IAPWS-IF97 steam density at the pressure and temperature entered.

Assumptions and limits

- Uniform distribution between the tubes; whole number of tubes.
- One steam state: the density changes along a superheater, so enter the state where you want the velocity (the outlet, hottest steam, gives the highest velocity; the inlet the lowest).
- Notes appear for zero flow and for a velocity outside 10–25 m/s.

References

- Continuity G = ṁ/(n π d²/4); steam density from IAPWS-IF97

Report details

Report reference	FCC-GAB2-KJ1S (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/furnace-heating-surfaces/superheater-steam-velocity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.