Air Preheater Heat Balance (Air Outlet Temperature)

Air preheater duty and hot air temperature from the flue gas and air flows and temperatures, with the gas-side effectiveness and the X-ratio.

Method: ASME PTC 4.3-2017 Air Heaters (gas-side effectiveness, X-ratio); first law heat balance

Input parameters

Unit system: SI

Parameter	Value	Unit
Flue gas flow (wet)	133,200	kg/h
Mean specific heat of the wet flue gas	1.0850	kJ/(kg·K)
Gas temperature in	330.00	°C
Gas temperature out	150.00	°C
Air flow (including its moisture)	118,800	kg/h
Mean specific heat of the air	1.0150	kJ/(kg·K)
Air temperature in	30.000	°C

Calculated results

Parameter	Value	Unit
Hot air temperature out	245.74	°C
Air preheater duty	7,226.1	kW
Gas-side effectiveness	60.000	%
X-ratio (air heat capacity ÷ gas heat capacity)	0.83435	

Formula and method

$$\dot{Q} = \dot{m}_g c_{p,g} (T_{g,1} - T_{g,2}) \qquad T_{a,2} = T_{a,1} + \frac{\dot{Q}}{\dot{m}_a c_{p,a}}$$

$$\varepsilon_g = \frac{T_{g,1} - T_{g,2}}{T_{g,1} - T_{a,1}} \qquad X = \frac{\dot{m}_a c_{p,a}}{\dot{m}_g c_{p,g}}$$

Variables

$\dot{m}_g$	flue gas flow	kg/s
$c_{p,g}$	mean specific heat of flue gas	J/(kg·K)
$T_{g,1}$	gas temperature in	K
$T_{g,2}$	gas temperature out	K
$\dot{m}_a$	air flow	kg/s
$c_{p,a}$	mean specific heat of air	J/(kg·K)
$T_{a,1}$	air temperature in	K
$T_{a,2}$	hot air temperature out	K
$\dot{Q}$	air preheater duty	W
ε_g	gas-side effectiveness	–
X	X-ratio, air heat capacity over gas heat capacity	–

Method and standards

A first-law heat balance across the air preheater, with the gas-side effectiveness and X-ratio as defined in ASME PTC 4.3 (Air Heaters). Leakage is not corrected here; use the air heater leakage calculator for the no-leakage gas outlet temperature.

Assumptions and limits

- No leakage and no heat loss from the casing; steady flow.
- Mean specific heats over the temperature ranges. Gas flow and its specific heat are on a wet basis (total gas including water vapour); the air flow includes its moisture.
- Crossed temperatures are rejected: the gas cannot leave colder than the air enters, and the air cannot leave hotter than the gas enters.

References

ASME PTC 4.3-2017 Air Heaters (gas-side effectiveness, X-ratio), first law heat balance

Report details

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Release checks	3 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/boiler-auxiliaries/air-preheater-heat-balance

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.