Air Preheater X-Ratio and Gas- and Air-Side Effectiveness

X-ratio (air to gas heat capacity rate) and gas-side and air-side effectiveness of an air preheater from its four terminal temperatures (no leakage correction).

Method: Energy balance definitions: X = (T_g,in − T_g,out)/(T_a,out − T_a,in); effectiveness on the gas-in to air-in span

Input parameters

Unit system: SI

Parameter	Value	Unit
Gas in	340.00	°C
Gas out	150.00	°C
Air in	30.000	°C
Air out	280.00	°C

Calculated results

Parameter	Value	Unit
X-ratio (ṁc_p)air/(ṁc_p)gas	0.76000	
Gas-side effectiveness	61.290	%
Air-side effectiveness	80.645	%

Notes for this case

- Leakage of cold air into the gas lowers the measured gas exit temperature; correct it before judging performance.

Formula and method

$$X = \frac{T_{g,in} - T_{g,out}}{T_{a,out} - T_{a,in}}, \quad \varepsilon_g = \frac{T_{g,in} - T_{g,out}}{T_{g,in} - T_{a,in}}, \quad \varepsilon_a = \frac{T_{a,out} - T_{a,in}}{T_{g,in} - T_{a,in}}$$

Variables

$T_{g,in}$	Gas in	K
$T_{g,out}$	Gas out	K
$T_{a,in}$	Air in	K
$T_{a,out}$	Air out	K
X	X-ratio (ṁc_p)air/(ṁc_p)gas	-
ε_g	Gas-side effectiveness	-
ε_a	Air-side effectiveness	-

Method and standards

Definitions from an energy balance with no leakage: the X-ratio equals the ratio of air to gas heat capacity rates because the heat the gas gives up is the heat the air takes. Both effectivenesses are referred to the gas-in to air-in span.

Assumptions and limits

- Constant specific heats; no leakage. With air leaking into the gas the measured gas outlet is low, which makes the X-ratio from temperatures read high; correct the gas outlet temperature for leakage first.
- Temperatures that cross (gas out below air in, or air out above gas in) are rejected: each effectiveness must stay at or below 1.

References

- Energy balance definitions: X = (T_g,in − T_g,out)/(T_a,out − T_a,in); effectiveness on the gas-in to air-in span

Report details

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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/air-preheater-x-ratio

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.