Economiser Surface Area (LMTD Method)

Economiser duty from the feedwater temperature rise, the flue gas outlet temperature and the counterflow surface area from U and LMTD, with the approach (IAPWS-IF97).

Method: LMTD method; IAPWS R7-97 IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Feedwater flow	50,400	kg/h
Feedwater pressure (absolute)	70.000	bar
Feedwater in	150.00	°C
Feedwater out	230.00	°C
Flue gas flow	133,200	kg/h
Mean specific heat of the flue gas	1.0900	kJ/(kg·K)
Gas temperature entering	380.00	°C
Overall heat transfer coefficient (on the area A, with fouling) Referred to the surface the area is quoted on (usually the gas-side surface) and including fouling; a clean-tube U undersizes economisers on coal.	50.000	W/(m²·K)

Calculated results

Parameter	Value	Unit
Surface area needed	780.84	m²
Economiser duty	4,966.5	kW
Gas temperature leaving	256.85	°C
Log mean temperature difference (counterflow)	127.21	K
Approach to saturation at the outlet	55.830	K

Notes for this case

- Supercritical pressure: there is no saturation temperature, so the approach is not defined.

Formula and method

$$\dot{Q} = \dot{m}_w (h_{w,2} - h_{w,1}) \qquad T_{g,2} = T_{g,1} - \frac{\dot{Q}}{\dot{m}_g c_{p,g}} \qquad LMTD = \frac{(T_{g,1} - T_{w,2}) - (T_{g,2} - T_{w,1})}{\ln \frac{T_{g,1} - T_{w,2}}{T_{g,2} - T_{w,1}}} \qquad A = \frac{\dot{Q}}{U\, LMTD}$$

Variables

$\dot{m}_w$	feedwater flow	kg/s
p_w	feedwater pressure	Pa
$T_{w,1}$	water in	K
$T_{w,2}$	water out	K
$\dot{m}_g$	gas flow	kg/s
$c_{p,g}$	gas specific heat	J/(kg·K)
$T_{g,1}$	gas in	K
U	overall coefficient	W/(m²·K)
A	surface area	m²
$\dot{Q}$	duty	W
$T_{g,2}$	gas out	K

$LMTD$	log mean temperature difference	K
ΔT_{sat}	approach to saturation	K
$h_{w,1}, h_{w,2}$	water enthalpies (IF97)	J/kg

Method and standards

Water duty from FireCAD's IAPWS-IF97 enthalpies, gas heat balance with mean specific heat, counterflow LMTD.

Assumptions and limits

- Counterflow, constant U and gas specific heat; water single-phase.
- U is referred to the area quoted (usually the gas-side surface) and must include fouling.
- Warnings appear when the water leaves within 20 K of saturation or the cold-end difference is under 10 K.
- At or above the critical pressure (22.064 MPa) there is no saturation temperature, so the approach is not shown.

References

• LMTD method
• IAPWS R7-97 IF97

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/boilers-power-plant/furnace-heating-surfaces/economiser-surface-area

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Reopens the calculator with the inputs of this report.