Surface Condenser Test: TTD, Subcooling, Duty and UA

Terminal and initial temperature differences, condensate subcooling, duty, LMTD and UA of a surface condenser from a test of pressure and water temperatures.

Method: Babcock & Wilcox; Steam: Its Generation and Use; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Condenser pressure (absolute)	8.5000	kPa
Cooling water inlet	28.000	°C
Cooling water outlet	38.000	°C
Condensate (hotwell) temperature	41.500	°C
Cooling water flow	10,000	t/h
Condenser surface area	3,000.0	m²

Calculated results

Parameter	Value	Unit
Saturation temperature	42.665	°C
Terminal temperature difference	4.6645	K
Initial temperature difference	14.665	K
Condensate subcooling	1.1645	K
Duty	116.28	MW
LMTD	8.7302	K
Overall coefficient	4,439.7	W/(m²·K)

Formula and method

$$TTD = T_s - t_2, \quad ITD = T_s - t_1, \quad Q = \dot{m}_w c_p (t_2 - t_1), \quad \Delta T_{lm} = \frac{t_2 - t_1}{\ln \frac{T_s - t_1}{T_s - t_2}}, \quad U = \frac{Q}{A\,\Delta T_{lm}}$$

Variables

p_c	Condenser pressure (absolute)	Pa
t_1	Cooling water inlet	K
t_2	Cooling water outlet	K
T_c	Condensate (hotwell) temperature	K
$\dot{m}_w$	Cooling water flow	kg/s
A	Condenser surface area	m²
T_s	Saturation temperature	K
TTD	Terminal temperature difference	K
ITD	Initial temperature difference	K
ΔT_{sub}	Condensate subcooling	K
Q	Duty	W
ΔT_{lm}	LMTD	K
U	Overall coefficient, on the outside tube area	W/(m²·K)
c_p	specific heat of water, 4186	J/(kg·K)

Method and standards

Heat and mass balance definitions; condensing side at saturation.

Assumptions and limits

- Steady load; c_p of water 4.186 kJ/(kg·K) (about 0.2 % above the IF97 value at 30–40 °C).
- The area must be the outside tube surface the condenser maker quotes.

References

• Babcock & Wilcox
• Steam: Its Generation and Use
• 41st ed. (2005)
• ch. 21 (condenser performance)
• Saturation from IAPWS-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/condensers-cooling/condenser-performance-test

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Reopens the calculator with the inputs of this report.