Condenser Back Pressure at Other Cooling Water Conditions

Condenser pressure at a new cooling water temperature, flow, load and tube plugging, scaled from a design point with U varying with water velocity.

Method: Effectiveness–NTU for a condenser (C_r = 0) scaled from a design point; IAPWS-IF97 saturation

Input parameters

Unit system: SI

Parameter	Value	Unit
Design heat load	116.00	MW
Design CW inlet	28.000	°C
Design CW outlet	38.000	°C
Design condenser pressure (absolute)	8.5000	kPa
New heat load	116.00	MW
New CW inlet	32.000	°C
CW flow ratio	100.00	%
Share of tubes plugged	0	%
Exponent of water velocity in U	0.50000	

Calculated results

Parameter	Value	Unit
New saturation temperature	46.665	°C
New condenser pressure	10.446	kPa
New CW outlet	42.000	°C
New NTU	1.1454	
UA ratio	1.0000	

Notes for this case

- U scales as water velocity^n (n about 0.5 for the water film share of resistance); fouling and air are taken as at design. Use the turbine's correction curves to turn the pressure change into output.

Formula and method

$$T_s = t_1 + \frac{Q}{\dot{m}_w c_p (1 - e^{-NTU})}, \quad NTU = \frac{UA}{\dot{m}_w c_p}, \quad \frac{UA}{UA_d} = (1 - f_{pl}) \left(\frac{\dot{m}/\dot{m}_d}{1 - f_{pl}} \right)^n$$

Variables

Q_d	Design heat load	W
$t_{1,d}$	Design CW inlet	K
$t_{2,d}$	Design CW outlet	K
p_d	Design condenser pressure (absolute)	Pa
Q	New heat load	W
t_1	New CW inlet	K
$\dot{m}/\dot{m}_d$	CW flow ratio	-
f_{pl}	Share of tubes plugged	-
n	Exponent of water velocity in U	-
T_s	New saturation temperature	K

p_c	New condenser pressure	Pa
t_2	New CW outlet	K
NTU	New NTU	-
UA/UA_d	UA ratio	-
$\dot{m}_w c_p \$, \$\dot{m}_{w,d} c_p$	cooling water heat capacity rate, new and design	W/K
$UA \$, \$UA_d$	overall conductance, new and design	W/K
NTU_d	design NTU	-
$T_{s,d}$	design saturation temperature	K

Method and standards

Effectiveness–NTU model of a condenser (condensing side at one temperature), with UA back-calculated from the design point and scaled with the water velocity. Scaling the whole UA by velocity to the power n is a FireCAD simplification: n about 0.5 stands for the water film being part of the total resistance. It is not the HEI correction method.

Assumptions and limits

- Clean as at design; single pressure shell.
- Water specific heat and the effect of cooling water inlet temperature on U (which HEI corrects for) are not modelled; at colder water the true U is lower.

References

• Effectiveness–NTU for a condenser (C_r = 0) scaled from a design point; IAPWS-IF97 saturation

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/condensers-cooling/condenser-back-pressure-off-design

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.