Condenser Water and Approach by Hugot

Injection water per kg of vapour by Hugot (eqns 40.5–40.6) and by IF97, the outlet temperature by the approach rule and the air partial pressure.

Method: Hugot; Handbook of Cane Sugar Engineering; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Vapour to condense	11,000	kg/h
Condenser pressure (absolute)	13.337	kPa
Injection water temperature	30.000	°C
Approach factor (t_v − t_2)/(t_v − t_1) Hugot: counter-current condensers usually about 0.12; the approach t_v − t_2 never less than 2 °C.	12.000	%

Calculated results

Parameter	Value	Unit
Vapour temperature	51.556	°C
Water outlet temperature	48.969	°C
Water per kg vapour, Hugot (607 + 0.3t_v − t_2)/(t_2 − t_1)	30.233	
Water per kg vapour, mean form 572/(t_2 − t_1)	30.154	
Water per kg vapour, IF97	30.137	
Injection water (IF97)	331.50	t/h
Partial pressure of air at the air outlet (t_a = t_1)	9.0904	kPa

Notes for this case

- Hugot: keep the water rise t_2 − t_1 to at least 10 °C; the air leaves at about the injection water temperature in a counter-current condenser.

Formula and method

$$t_2 = t_v - k(t_v - t_1), \quad W_H = \frac{607 + 0.3t_v - t_2}{t_2 - t_1}, \quad W = \frac{h_g(t_v) - h_f(t_2)}{h_f(t_2) - h_f(t_1)}, \quad p_a = p - p_{sat}(t_1)$$

Variables

Q	Vapour to condense	kg/s
p	Condenser pressure (absolute)	Pa
t_1	Injection water temperature	K
k	Approach factor (t_v − t_2)/(t_v − t_1)	-
t_v	Vapour temperature	K
t_2	Water outlet temperature	K
W_H	Water per kg vapour, Hugot (607 + 0.3t_v − t_2)/(t_2 − t_1)	-
W_m	Water per kg vapour, mean form 572/(t_2 − t_1)	-
W	Water per kg vapour, IF97	-
$\dot{m}_w$	Injection water (IF97)	kg/s
p_a	Partial pressure of air at the air outlet (t_a = t_1)	Pa

Method and standards

Hugot's condenser heat balance with IF97 enthalpies.

Assumptions and limits

- Counter-current condenser; air leaves at the water inlet temperature.
- The approach factor must be below 1. Notes flag a water rise below 10 °C or an approach below 2 °C (Hugot).

References

• Hugot
• Handbook of Cane Sugar Engineering
• 3rd ed. (Elsevier, 1986)
• ch. 40
• eqns 40.5–40.15
• pp. 860–866
• Water and steam enthalpies from IAPWS-IF97

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/sugar-ethanol/vacuum-water/condenser-water-approach

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.