Thermocompression Limit by the Exhaust Balance

Most motive steam a thermocompressor can use before exhaust escapes, the vapour it then draws and the least vapour left for the condenser (Hugot 32.58–32.62).

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Number of effects	4.0000	
Entrainment ratio	1.8000	
Total evaporation	80,000	kg/h
Vapour bled from effect 1	11,000	kg/h
Vapour bled from effect 2	3,500.0	kg/h
Vapour bled from effect 3	6,000.0	kg/h
Exhaust steam produced by the drives	25,000	kg/h
Exhaust used by the pans	4,000.0	kg/h
Exhaust used by the heaters	3,000.0	kg/h

Calculated results

Parameter	Value	Unit
Most motive steam	9,310.3	kg/h
Vapour then aspirated	16,759	kg/h
Least vapour to the condenser	6,810.3	kg/h

Notes for this case

- Beyond q_max the extra motive steam only pushes exhaust out of the roof; a regulator on exhaust pressure should hold the thermocompressor at or below it.

Formula and method

$$q \le \frac{E + (n-1)P_1 + (n-2)P_2 + (n-3)P_3 - n(M - C - R)}{n + \mu}, \quad y = \mu q$$

$$x \ge \frac{E - P_1 - 2P_2 - 3P_3 - \mu(P_1 + P_2 + P_3) + \mu(M - C - R)}{n + \mu}$$

Variables

n	Number of effects	-
μ	Entrainment ratio	-
E	Total evaporation	kg/s
P_1	Vapour bled from effect 1	kg/s
P_2	Vapour bled from effect 2	kg/s
P_3	Vapour bled from effect 3	kg/s
M	Exhaust steam produced by the drives	kg/s
C	Exhaust used by the pans	kg/s
R	Exhaust used by the heaters	kg/s
q_{max}	Most motive steam	kg/s

y_{max}	Vapour then aspirated	kg/s
x_{min}	Least vapour to the condenser	kg/s

Method and standards

Hugot's exhaust balance with a first-effect thermocompressor.

Assumptions and limits

- Thermocompressor on the first effect.
- Bleeding from effects 1 to 3 only (no P_4 input for 5 effects). With 3 effects P_3 is bled from the last effect: it does not change q_max but reduces the vapour to the condenser.
- A negative x_min (bleeding beyond what the evaporator supplies) is rejected.

References

- Hugot
- Handbook of Cane Sugar Engineering
- 3rd ed. (Elsevier, 1986)
- ch. 32
- installation of a thermo-compressor
- eqns 32.52–32.62
- pp. 603–606

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/sugar-ethanol/evaporation/thermocompression-limit

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.