Sugar Dryer by Hugot: Air, Heat, Heater and Volume

Air, heat, steam and heater surface for a sugar dryer by Hugot's method (eqns 36.4–36.12) with saturated-air humidity from IF97, and the dryer volume for a moisture.

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Sugar to dry	30.000	t/h
Moisture of the wet sugar	1.0000	%
Ambient air	24.000	°C
Air leaving the dryer	40.000	°C
Air leaving the heater Hugot: 70–95 °C; not above 95–100 °C.	90.000	°C
Air flow	Counter-current (1500)	
Heating steam pressure (absolute)	5.0000	bar
Air heater coefficient	11.630	W/(m²·K)
Barometric pressure	101.33	kPa

Calculated results

Parameter	Value	Unit
Saturated humidity at ambient, kg/1000 kg	18.882	
Saturated humidity at dryer exit, kg/1000 kg	48.889	
Air	14,997	kg/h
Air volume at ambient	12,766	m³/h
Heat to the air heater	624.28	kW
Steam	1,066.2	kg/h
Air heater surface	566.01	m²
Dryer volume (t/(dr) = 1.35 per % moisture)	40.500	m³

Notes for this case

- Hugot's example: 30 t/h sugar at 1 % moisture, air 24 → 40 °C, parallel flow: about 30 000 kg/h of air. Keep air velocity below 2 m/s at the exit.
- Conservative assumptions, as Hugot: ambient air taken as saturated (H_0 at saturation) and all the moisture h removed (no final moisture).

Formula and method

$$A = \frac{1500\,Ph}{H_1 - H_0}\ (\text{counter}-\text{current}), \quad M = 1.25(q_1 + q_2 + q_3)$$

$$q_1 = Ac(t_1 - t_0), \quad q_2 = Ph(607 + 0.3t_1 - t_0), \quad q_3 = A\frac{H_0}{1000}c'(t_1 - t_0), \quad Q = \frac{M}{h_g - h_f}$$

$$S = \frac{M}{k\left(T - \frac{t_1+t_0}{2}\right)}, \quad V_d = 1.35\,Ph_{\%}$$

Variables

P	Sugar to dry	kg/s
h	Moisture of the wet sugar	-
t_0	Ambient air	K
t_e	Air leaving the dryer	K
t_1	Air leaving the heater	K
flow	Air flow	-
p_s	Heating steam pressure (absolute)	Pa
k	Air heater coefficient	W/(m²·K)
p_a	Barometric pressure	Pa
H_0	Saturated humidity at ambient, kg/1000 kg	-
H_1	Saturated humidity at dryer exit, kg/1000 kg	-
A	Air	kg/s
V	Air volume at ambient	m³/s
M	Heat to the air heater	W
Q	Steam	kg/s
S	Air heater surface	m²
V_d	Dryer volume (t/(dr) = 1.35 per % moisture)	m³
C	Specific heat of air, 0.24	kcal/(kg·°C)
c'	Specific heat of water vapour, 0.475	kcal/(kg·°C)
q_1, q_2, q_3	Heat to the air, to evaporate the water, and to the vapour in the air	kcal/h
$h_g - h_f$	Latent heat of the heating steam (IF97)	J/kg

Method and standards

Hugot's dryer method with IF97 saturation.

Assumptions and limits

- Hugot's assumptions on exit saturation; kcal forms converted to SI. In q_2, 607 and 0.3 are Hugot's kcal/kg latent-heat constants (water vapour from water at t_0).
- Conservative: ambient air taken as saturated, and all the moisture h is removed (no final moisture).
- The air must leave the heater hotter than it leaves the dryer; ambient air from 0 °C upwards (IF97 saturation over water).

References

• Hugot
• Handbook of Cane Sugar Engineering
• 3rd ed. (Elsevier, 1986)
• ch. 36
• sugar dryers
• eqns 36.4–36.12 and example
• pp. 821–830
• Saturation pressure from IAPWS-IF97; humidity ratio from molar masses

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/centrifugals-sugar-house/sugar-dryer-hugot

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.