Tea Withering: Water Removed and Air Flow

Water to remove from green leaf during withering and the air flow and heater duty to do it, from leaf rate, moisture contents and air conditions.

Method: Psychrometrics: humidity ratio 0.621945 p_v/(p − p_v); humid enthalpy 1006 t + x(2 501 000 + 1860 t); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Green leaf rate	1,000.0	kg/h
Green leaf moisture (wet basis)	78.000	%
Withered leaf moisture (wet basis)	68.000	%
Ambient air temperature	22.000	°C
Ambient relative humidity	80.000	%
Air temperature after heating	30.000	°C
Air temperature leaving the leaf bed	23.000	°C
Pressure	1.0132	bar

Calculated results

Parameter	Value	Unit
Water removed	312.50	kg/h
Dry air flow	110,182	kg/h
Air volume flow at the fan (heated air)	96,644	m³/h
Relative humidity of the air leaving	90.973	%
Heater duty	252.36	kW
Withering loss as a share of green leaf	31.250	%

Notes for this case

• Withering removes part of the leaf's water so it rolls and ferments well: from about 78 % to 65–70 % moisture for black tea. The water removed follows from a balance on the leaf solids. Air passing through the troughs cools along a constant-enthalpy line, picking up water; its humidity rise sets the air flow. Warming humid air a few degrees greatly increases its drying capacity, but leaf temperature should stay below about 35 °C. In damp weather part of the air is recirculated and heated to keep its humidity pick-up useful.

Formula and method

$$\dot{m}_w = \dot{m}_g \frac{w_0 - w_1}{1 - w_1}, \quad h(T_{in}, x_a) = h(T_{out}, x_o), \quad \dot{m}_a = \frac{\dot{m}_w}{x_o - x_a}$$

Variables

$\dot{m}_g$	Green leaf rate	kg/s
w_0	Green leaf moisture (wet basis)	-
w_1	Withered leaf moisture (wet basis)	-
T_a	Ambient air temperature	K
φ_a	Ambient relative humidity	-
T_{in}	Air temperature after heating	K
T_{out}	Air temperature leaving the leaf bed	K
p	Pressure	Pa

$\dot{m}_w$	Water removed	kg/s
$\dot{m}_a$	Dry air flow	kg/s
$\dot{V}$	Air volume flow at the fan (heated air)	m³/s
φ_{out}	Relative humidity of the air leaving	-
$\dot{Q}$	Heater duty	W
m_w/m_g	Withering loss as a share of green leaf	-

Method and standards

Tea withering.

Assumptions and limits

- Adiabatic trough; steady state.

References

Psychrometrics: humidity ratio 0.621945 p_v/(p − p_v), humid enthalpy 1006 t + x(2 501 000 + 1860 t), saturation pressure from IAPWS-IF97

Report details

Report reference	FCC-5PZW-4R5X (the same inputs always give the same reference)
Generated	23 November 2026, 17:34 UTC
Calculator	Tea Withering: Water Removed and Air Flow
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
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/chemical/drying/tea-withering-air-flow

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.