Wet Scrubber: Adiabatic Saturation Temperature and Water Evaporated

Outlet temperature and humidity of flue gas leaving a wet scrubber (adiabatic saturation) and the water it evaporates, with IF97 water properties.

Method: Adiabatic saturation energy balance; saturation pressure and vapour enthalpy from IAPWS-IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Dry flue gas flow	100.00	t/h
Gas in	180.00	°C
Humidity in (kg water per kg dry gas)	0.10000	kg/kg
Dry gas specific heat	1.0500	kJ/(kg·K)
Dry gas molar mass	30.000	kg/kmol
Gas pressure (absolute)	100.00	kPa
Make-up water temperature	30.000	°C

Calculated results

Parameter	Value	Unit
Gas out (saturated)	61.076	°C
Humidity out	0.15924	kg/kg
Water evaporated	5.9241	t/h

Notes for this case

• Water vapour enthalpy from IAPWS-IF97 at low partial pressure (ideal-gas behaviour). The saturated plume condenses: reheat or line the stack.

Formula and method

$$c_{p,g}T_1 + Y_1 h_v(T_1) + (Y_s - Y_1)h_l(T_w) = c_{p,g}T_s + Y_s h_v(T_s), \quad Y_s = \frac{M_w}{M_g}\frac{p_s(T_s)}{p - p_s(T_s)}$$

Variables

$\dot{m}_g$	Dry flue gas flow	kg/s
T_1	Gas in	K
Y_1	Humidity in (kg water per kg dry gas)	kg/kg
$c_{p,g}$	Dry gas specific heat	J/(kg·K)
M_g	Dry gas molar mass	kg/kmol
p	Gas pressure (absolute)	Pa
T_w	Make-up water temperature	K
T_s	Gas out (saturated)	K
Y_s	Humidity out	kg/kg
$\dot{m}_v$	Water evaporated	kg/s

Method and standards

Adiabatic saturation energy balance per kg of dry gas, solved by bisection for the saturation temperature. Saturation pressure from IAPWS-IF97; the vapour enthalpy h_v is the IF97 value at 700 Pa (low partial pressure, ideal-gas behaviour) and the make-up water enthalpy h_l the IF97 liquid value at 101.325 kPa.

Assumptions and limits

- Adiabatic; ideal-gas vapour.
- One dry-gas specific heat from the inlet temperature down to saturation; the true mean over a wide range (up to 500 °C) differs by a few per cent.
- The saturation temperature is searched between 0.35 °C and the lower of the gas inlet temperature and the boiling point at the gas pressure; inputs with no solution in that range are rejected.

References

• Adiabatic saturation energy balance; saturation pressure and vapour enthalpy from IAPWS-IF97

Report details

Report reference	FCC-ZE5P-RSFG (the same inputs always give the same reference)
Generated	17 November 2026, 19:49 UTC
Calculator	Wet Scrubber: Adiabatic Saturation Temperature and Water Evaporated
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
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/boilers-power-plant/emissions-stacks/wet-scrubber-saturation

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.