# Compressor Intercooler Duty, Condensate and Cooling Water

Heat removed in an air compressor intercooler or aftercooler, the condensate formed from the humid air at the cooler pressure and the cooling water flow.

**Method:** Humid-air energy balance of a compressor cooler

## Input parameters

Unit system: SI

| Parameter | Value | Unit |
|---|---|---|
| Dry air mass flow | 3,600.0 | kg/h |
| Inlet humidity ratio | 0.012000 | kg/kg |
| Cooler pressure (absolute) | 700.00 | kPa |
| Air temperature entering the cooler | 150.00 | °C |
| Air temperature leaving the cooler | 35.000 | °C |
| Dry air specific heat | 1.0050 | kJ/(kg·K) |
| Cooling water temperature rise | 10.000 | K |

## Calculated results

| Parameter | Value | Unit |
|---|---|---|
| Saturation humidity ratio at outlet | 0.005041 | kg/kg |
| Condensate formed | 25.051 | kg/h |
| Sensible heat removed | 118.16 | kW |
| Latent heat from condensation | 16.825 | kW |
| Total cooler duty | 134.98 | kW |
| Cooling water flow | 11,608 | kg/h |

### Notes for this case

• Humid air as an ideal mixture: W_sat = (M_w/M_a)p_s/(p − p_s) at the outlet temperature (IAPWS-IF97 saturation); water above that condenses, releasing latent heat. Vapour c_p 1,870 J/(kg·K) and cooling water c_p 4,186 J/(kg·K).

## Formula and method

$$W_{sat} = \frac{M_w}{M_a}\frac{p_s(T_{out})}{p - p_s}, \quad \dot{m}_c = \dot{m}_{da}(W_1 - W_{sat}), \quad \dot{Q} = \dot{Q}_s + \dot{m}_c h_{fg}$$

### Variables

| | | |
|---|---|---|
| $\dot{m}_{da}$ | Dry air mass flow | kg/s |
| $W_1$ | Inlet humidity ratio | kg/kg |
| $p$ | Cooler pressure (absolute) | Pa |
| $T_{in}$ | Air temperature entering the cooler | K |
| $T_{out}$ | Air temperature leaving the cooler | K |
| $c_p$ | Dry air specific heat | J/(kg·K) |
| $\Delta T_w$ | Cooling water temperature rise | K |
| $W_{sat}$ | Saturation humidity ratio at outlet | kg/kg |
| $\dot{m}_c$ | Condensate formed | kg/s |
| $\dot{Q}_s$ | Sensible heat removed | W |
| $\dot{Q}_l$ | Latent heat from condensation | W |

| | | |
|---|---|---|
| $\dot{Q}$ | Total cooler duty | W |
| $\dot{m}_w$ | Cooling water flow | kg/s |

### Method and standards

Cooler energy balance.

### Assumptions and limits

- Ideal humid air; condensate leaves at the outlet temperature.

### References

Humid-air energy balance of a compressor cooler

## Report details

| | |
|---|---|
| Report reference | FCC-1P5W-4QY0 (the same inputs always give the same reference) |
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| 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/mechanical/compressors/compressor-intercooler-duty

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.