3 Cooling towers

Water results to be the most widespread utility in chemical plants since it is easily accessible, widely available and rather cheap (practically free whether no expensive pretreatments are required).
Water can enter the process plant in two forms for different purposes:

- Steam: as heating duty;
- Cool water: as cooling duty.

Cooling water temperature increases along the progress of the process until the downstream battery limit. Directly contacting hot water with dry air, cooling towers are aimed to reduce the water outlet temperature below the air temperature itself at the cost of a water loss by evaporation. This operation is performed both in case of recycle and in once-through processes respectively to reuse water as cooling utility or to discharge it in the environment according to the legislation constraints.

3.1 Cooling tower packing design

A 20000 kg/h water stream at 50 °C, coming from a heat exchanger, should be cooled down to 25 °C as required by the law. For this purpose a packed bed cooling tower, where direct contacting between water and air takes place, will be used. The dry air is collected from the external environment at 20°C and 50% of relative humidity with a 15000 kg/h flowrate.

The packing height and the air wet bulb calculations are requested.

The chemico-physical properties are listed in Table 3.1. The vapor pressure linearization in the range $[25, 50]$ °C states as:

$$P_{ev}(mmHg) = -49.705 + 2.71 \cdot T(^{\circ}\mathrm{C}) \tag{3.1.1}$$

Property	**Value**	**Unit**
$< c_u >$	0.26	$kcal/(kg \cdot K)$
c_P^L	1	$kcal/(kg \cdot K)$
ΔH_{ev}	580	$kcal/kg$
$h_g \cdot a$	4000	$kcal/(m \cdot h \cdot K)$
$h_l \cdot a$	30000	$kcal/(m \cdot h \cdot K)$

Table 3.1: Chemico-physical properties