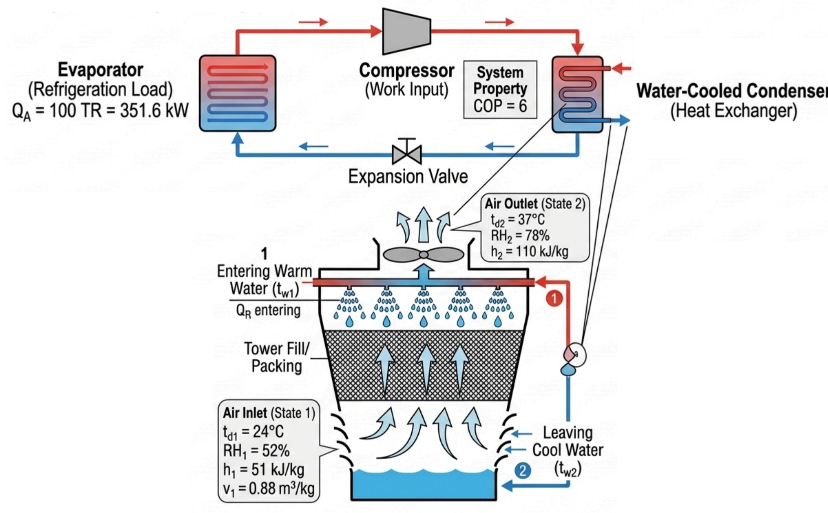

Step 1: Calculate Heat Rejection Rate (Q_R) from the Refrigeration Cycle

The cooling tower's job is to reject the total heat coming out of the refrigeration system's condenser (**Q_R**). This heat is composed of two parts: the heat absorbed from the refrigerated space (evaporator capacity, Q_A = 100 TR) plus the mechanical work input from the compressor (W_C).

First, we convert the cooling load from tons of refrigeration to kilowatts:

$$Q_A = (100\ TR)\left(\frac{3.516\ kW}{1\ TR}\right) = 351.6\ kW$$

Using the fundamental definition of the Coefficient of Performance (COP):

$$\text{COP} = \frac{Q_A}{W_C} \qquad \Rightarrow \qquad W_C = \frac{Q_A}{COP}$$

By energy balance around the cycle, the condenser heat rejection rate is:

$$Q_R = Q_A + W_C$$

$$Q_R = Q_A + \frac{Q_A}{COP}$$

$$Q_R = Q_A\left(1 + \frac{1}{COP}\right) = 351.6\ kW\left(1 + \frac{1}{6}\right) = 410.2\ kW$$

Step 2: Determine Air Mass Flow Rate (m_a) via Cooling Tower Energy Balance

Assuming negligible heat loss to the surroundings, the heat rejected by the condenser water (Q_R) is entirely absorbed by the air stream passing through the tower (Q_{air}). The air enters at State 1 and leaves at State 2, experiencing an increase in total enthalpy.

$$Q_R = m_a\left(h_2 - h_1\right)$$

$$410.2\ kW = m_a(110 - 51)\frac{kJ}{kg}$$

$$m_a = 6.9525\frac{kg}{s}$$

Step 3: Calculate Volumetric Flow Rate of Air (V_a)

To find the volumetric flow rate at the tower inlet, we multiply the mass flow rate by the specific volume of the air at entering conditions (v_1 = 0.88 m^3/kg):

$$V_a = m_a v_1 = \left(6.9525\frac{kg}{s}\right)\left(0.88\frac{m^3}{kg}\right) = 6.118\frac{m^3}{s}$$

This problem highlights that a cooling tower's size is not merely determined by the building's refrigeration load (Q_A). It is fundamentally bound to the **efficiency (COP)** of the chiller machinery. If a chiller has a poor COP, it wastes more electrical energy as compressor heat, forcing engineers to buy a larger, more expensive cooling tower with higher volumetric air fan requirements to handle the extra thermal waste.