Different air-conditioning systems

Factors affecting comfort air-conditioning

1. Temperature of air
2. Humidity of air
3. Purity of air
4. Motion of air

1. Temperature of air

The control of temperature means the maintenance of any desired temperature within the enclosed space even though the temperature of the outside air is above or below the desired room temperature.

This can be achieved by addition of heat or removal of heat from the room space as and when required.

Human being feels comfortable when the air is at 21oC with 56% relative humidity.

2. Humidity of air

The control of humidity means the addition or removal of moisture content during summer or winter respectively to provide comfortable living conditions.

Control of humidity also increases the efficiency of the workers.

For summer air conditioning , the relative humidity should not be less than 60%.

For winter air conditioning, the relative humidity it should not be more than 40%.

3. Purity of air;

Proper filteration, cleaning and purification of air is necessary to keep the living space free from dust and other impurities.

2. Motion of air

There should be equi-ditribution of air throughout the space to be air conditioned.

Equipment used in an air conditioning system;

1. Circulation fan
2. Air conditioning unit
3. Supply duct
4. Supply outlets
5. Return outlets
6. Filters

Classifications of air conditioning systems

According to the purpose	According to the season of the year	According to the arrangement of the system
1. Comfort air conditioning	1. Winter air conditioning	1. Unitary air conditioning
2. Industrial conditioning	2. Summer air conditioning	2. Central air conditioning
	3. Year-round air conditioning	

Comfort air conditioning

In this type, the air is brought to the required DBT and RH.

This system can be adopted for small cabins, office halls or big halls like cinema houses.
If sufficient data of the required condition is not given, we can assume 20% DBT and 50% RH.

The sensible heat factor for different conditions or given below;

1. For residence or private office : 0.9
2. For restaurant or busy office : 0.8
3. Auditorium or cinema hall : 0.7
4. Ball room dance hall etc : 0.6

Industrial air conditioning

Some of the electronic and other machines need a particular DBT and RH. These machines require a particular method of psychrometry process also.

Summer air conditioning (General)

In this type, generally air is cooled and humidified.

Air conditioning systems

A. Summer air conditioning

(i)Summer air conditioning for hot and dry outdoor conditions

(ii)Summer air conditioning for hot and humid outdoor conditions

(iii)Summer air conditioning with single cooling coil and mixing

(iv)Summer air conditioning with single cooling coil and bypass mixing

(v)Summer air conditioning with single cooling coil and absorbent dehumidification

(vi) Summer air conditioning with evaporative cooling

B. Winter Air-conditioning

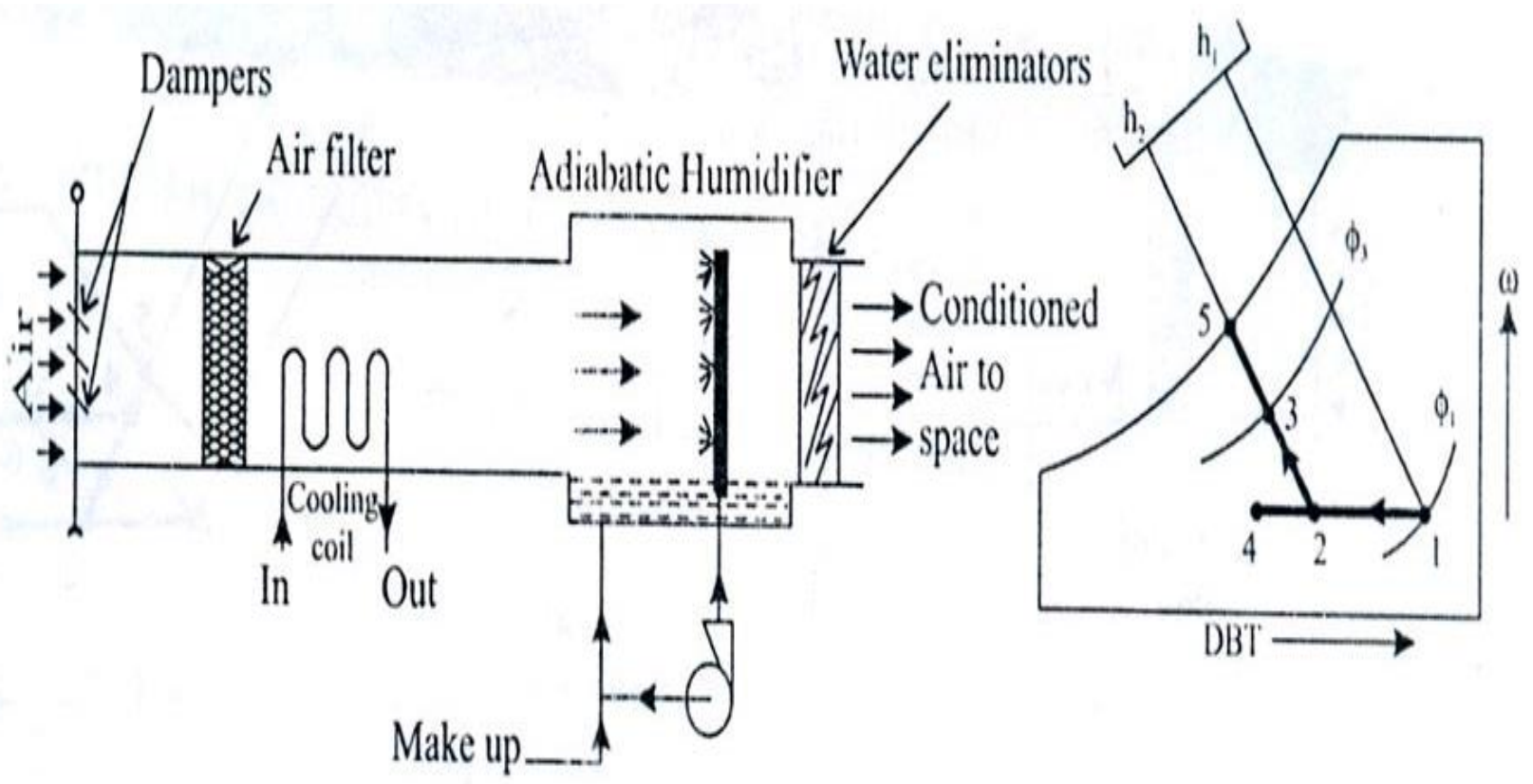
(i) Winter air conditioning for mild cold weather

(ii) Winter air conditioning with double reheat coil and air washer

(iii) Winter air conditioning using 100% outdoor air with preheating by waste heat from exhaust

C. Year Round Air conditioning

Summer air conditioning for hot and dry outdoor conditions



Point 1: Atmospheric condition
Point 2: Exit of cooling coil
Point 3: Required comfort condition
Point 4: Cooling coil temperature
Point 5: Saturation temperature

By pass factor(BPF) = distance (4-2)/ distance (4-1)

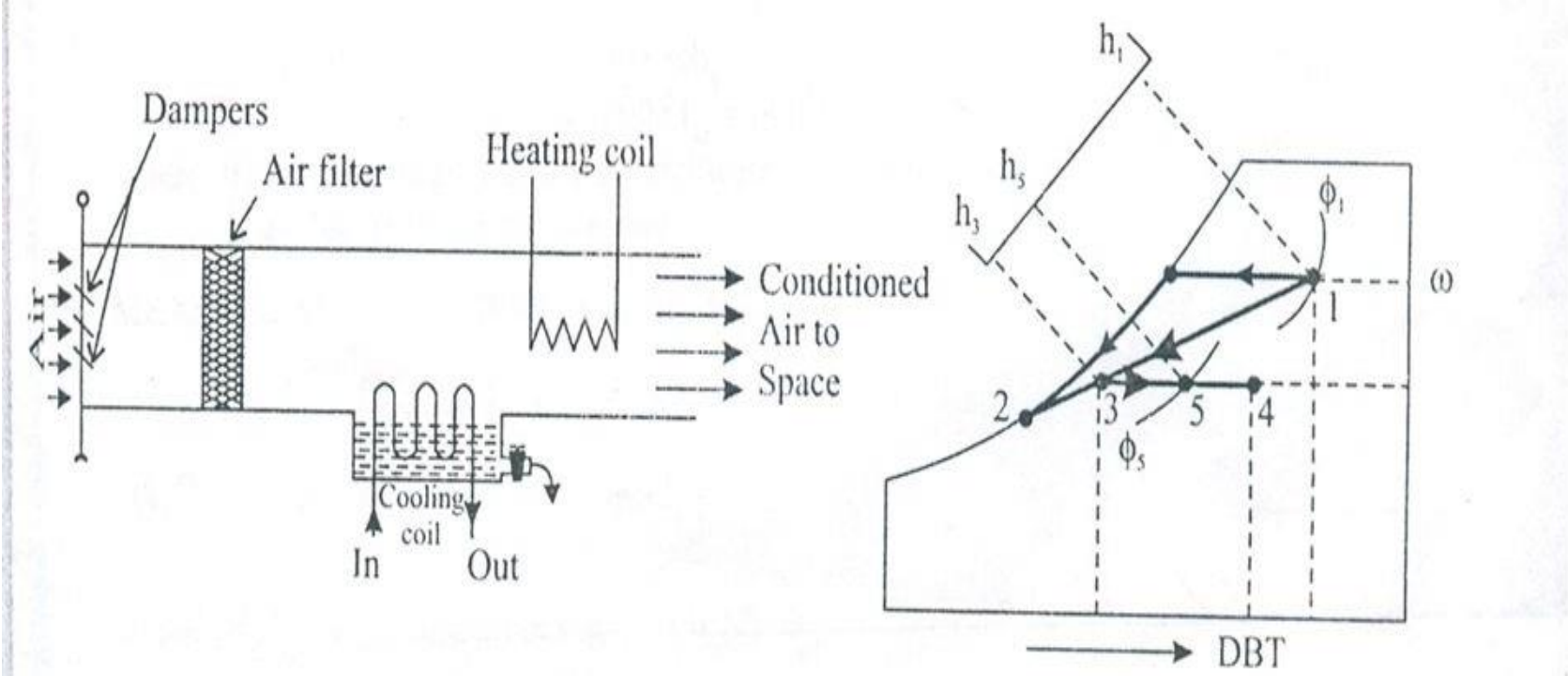
Efficiency of adiabatic humidifier $= (T_2-T_3)/(T_2-T_5)\ x100$

Capacity of cooling coil $= V(h_3-h_1) / (v_s x3.5)$

V= Quantity of air supply, m^3/sec
v_s= Specific volume of air m^3/kg

Mass flow rate of air handled $= V(\omega_3 - \omega_2) / (v_s\, x\, 1000)$ kg/sec

Summer air conditioning for hot and humid outdoor conditions



Point 1: Atmospheric condition

Point 2: Cooling coil surface temperature below dew point temperature

Point 3: Exit of dehumification coil

Point 4: Heating coil surface temperature

Point 5: Required comfort condition

- **By pass factor for cooling coil** = distance (2-3)/ distance (2-1)

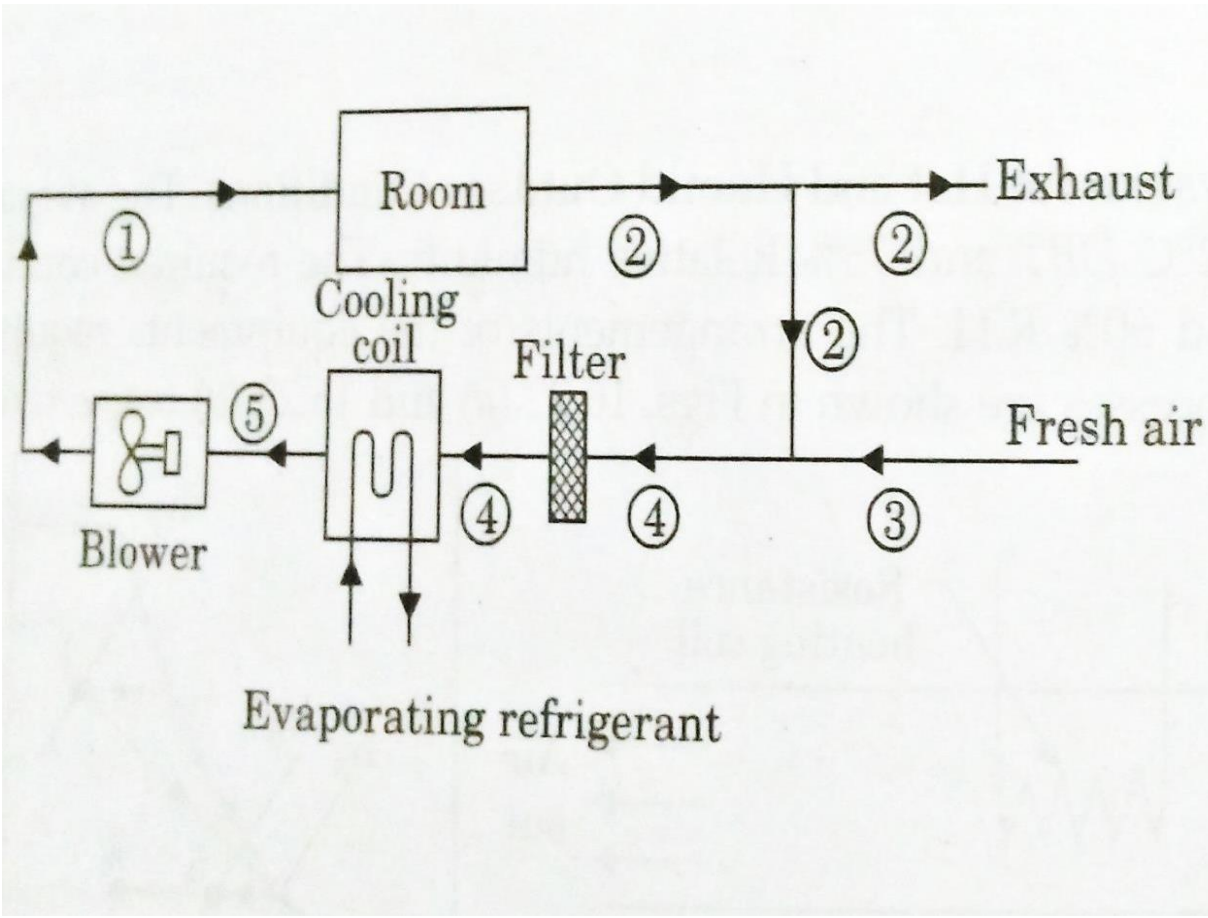
- **Capacity of cooling coil** = $V(h_1-h_3) / (v_s x 3.5)$ kJ/sec

- **By pass factor for heating coil** =

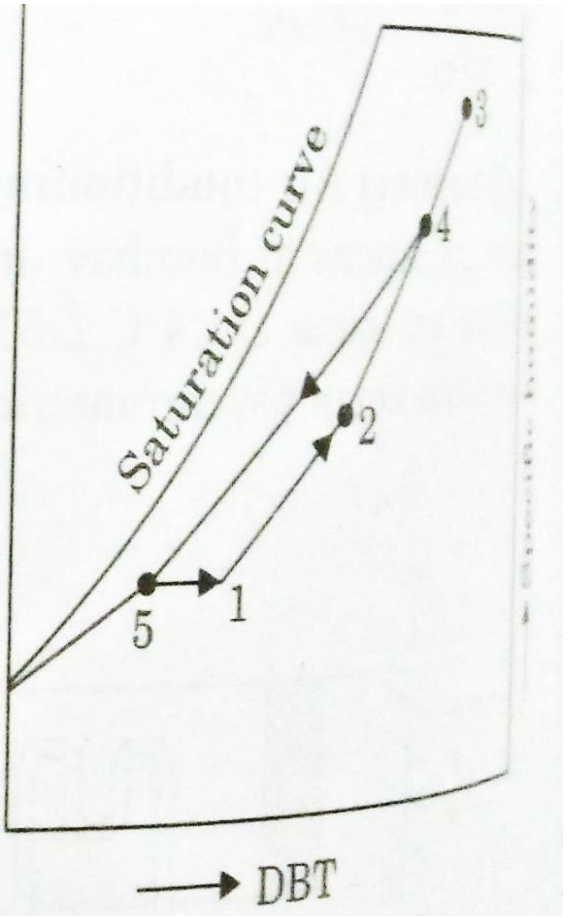
  distance (5-4)/ distance (3-4)

Capacity of heating coil = $V (h_5-h_3)/v_s$ kJ/sec

Summer air conditioning with single cooling coil and mixing

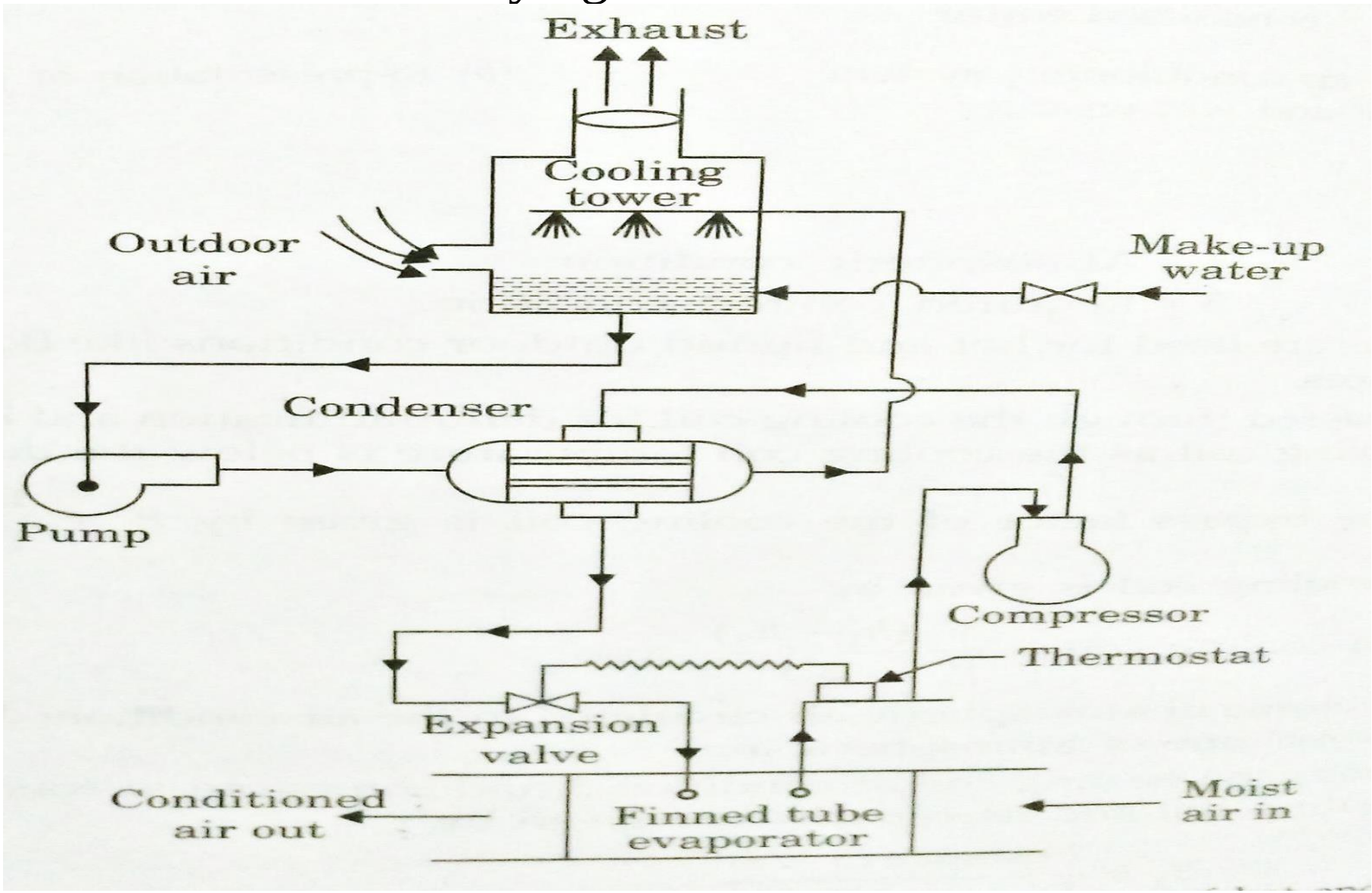


Arrangement for the components for the given A C system

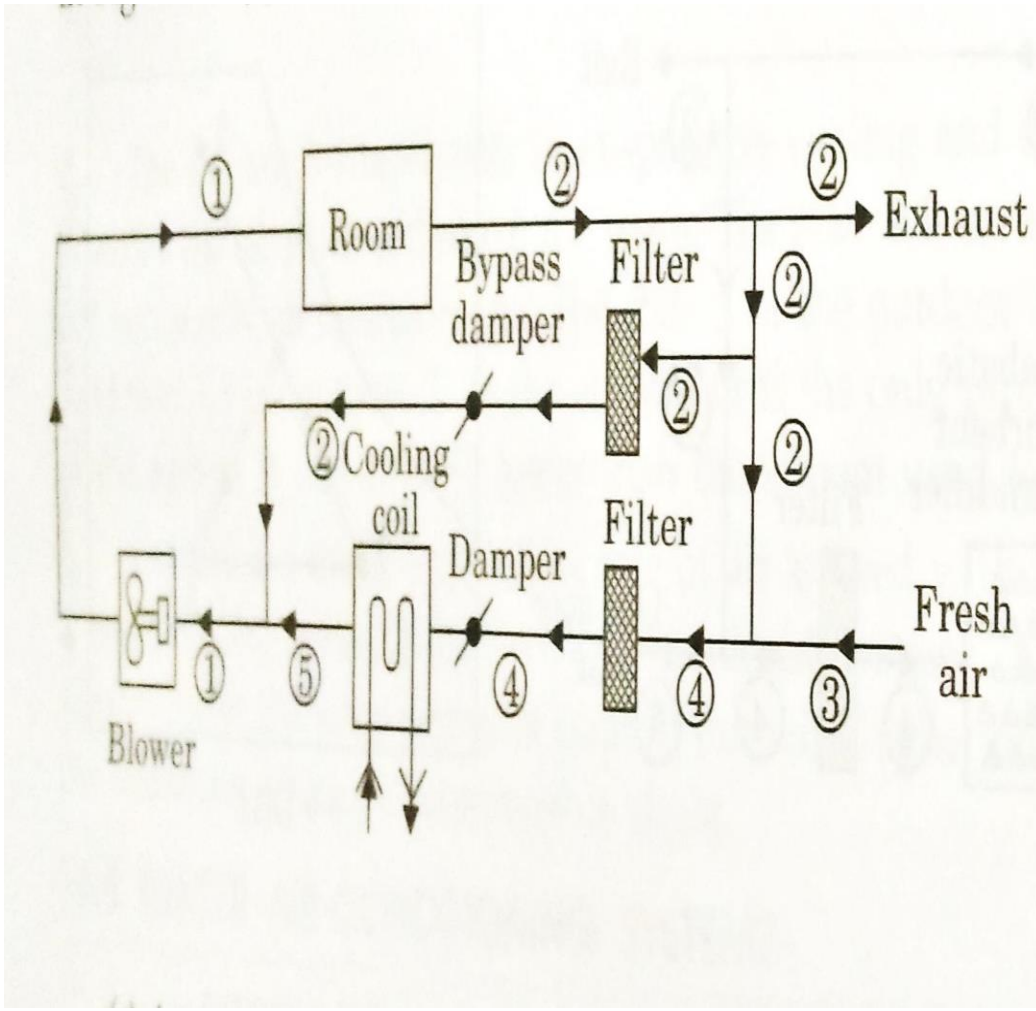


Psychrometry process for the given A C system

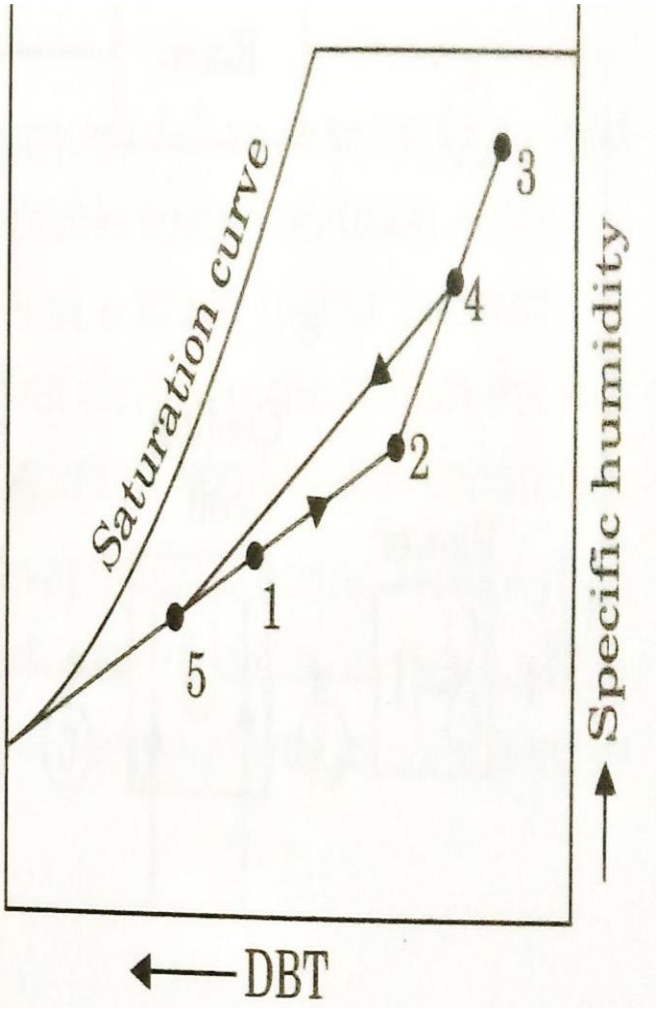
Direct expansion refrigerant system for cooling and dehumidifying of hot and moist air



Summer air conditioning with single cooling coil and bypass mixing

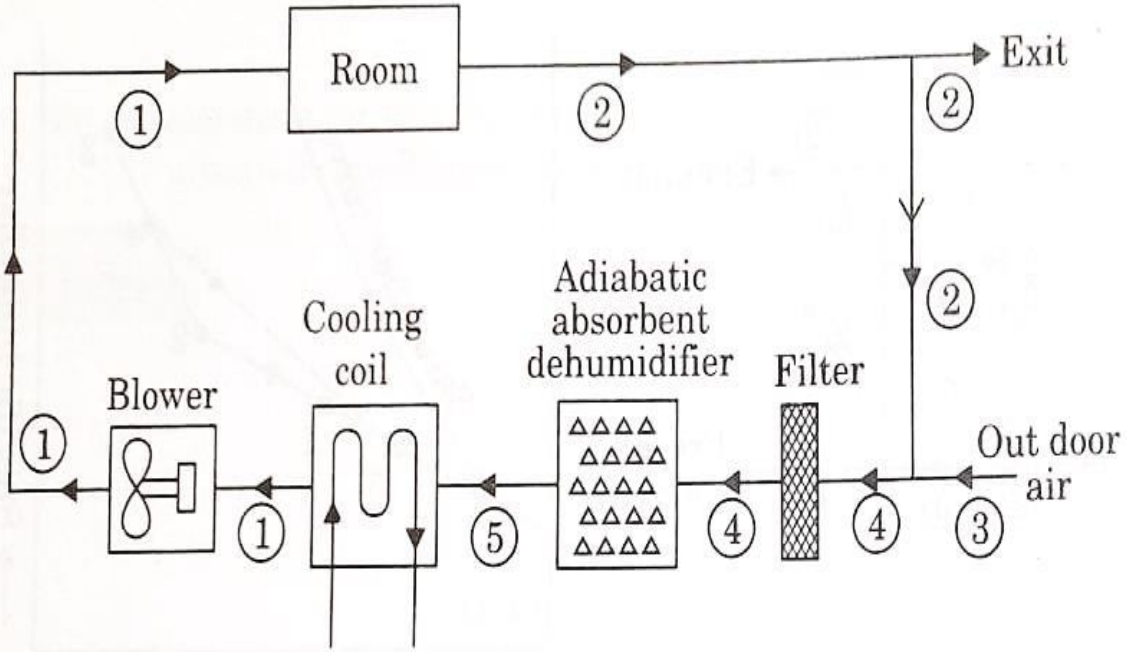


Arrangement for the components for the given A C system

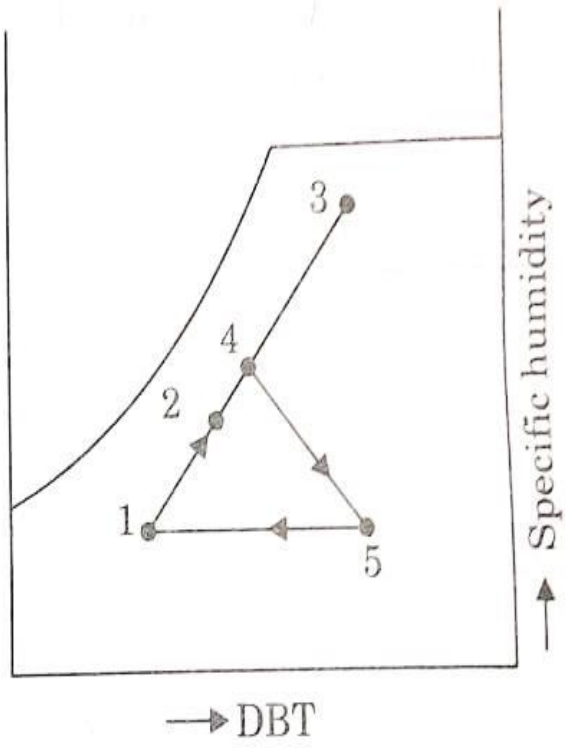


Psychrometry process for the given A C system

Summer air conditioning with single cooling coil and absorbent dehumidification



(a) Arrangement of the components for the given air-condition system

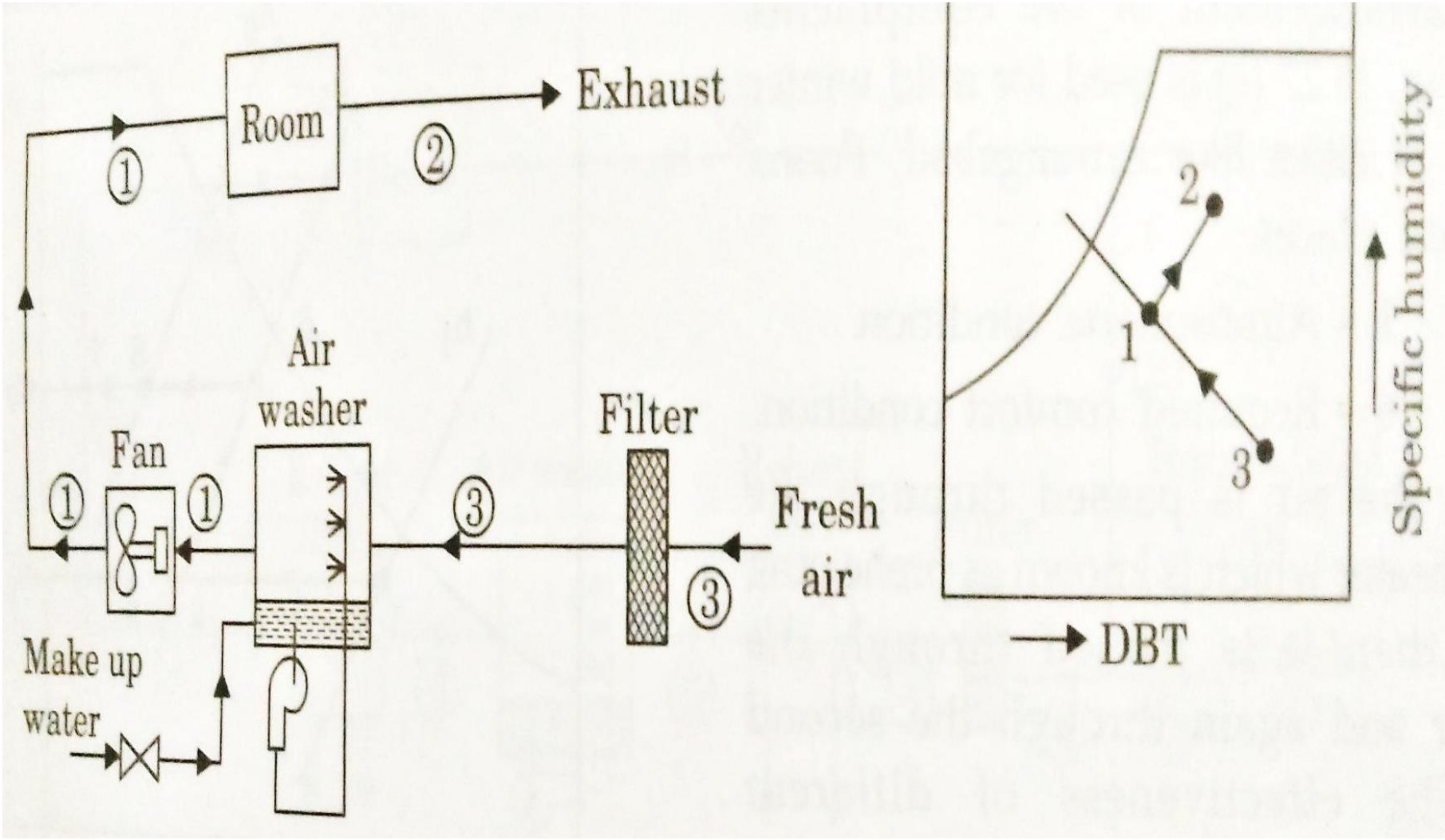


(b) Psychrometric processes for given system

Arrangement for the components for the given A C system

Psychrometry process for the given A C system

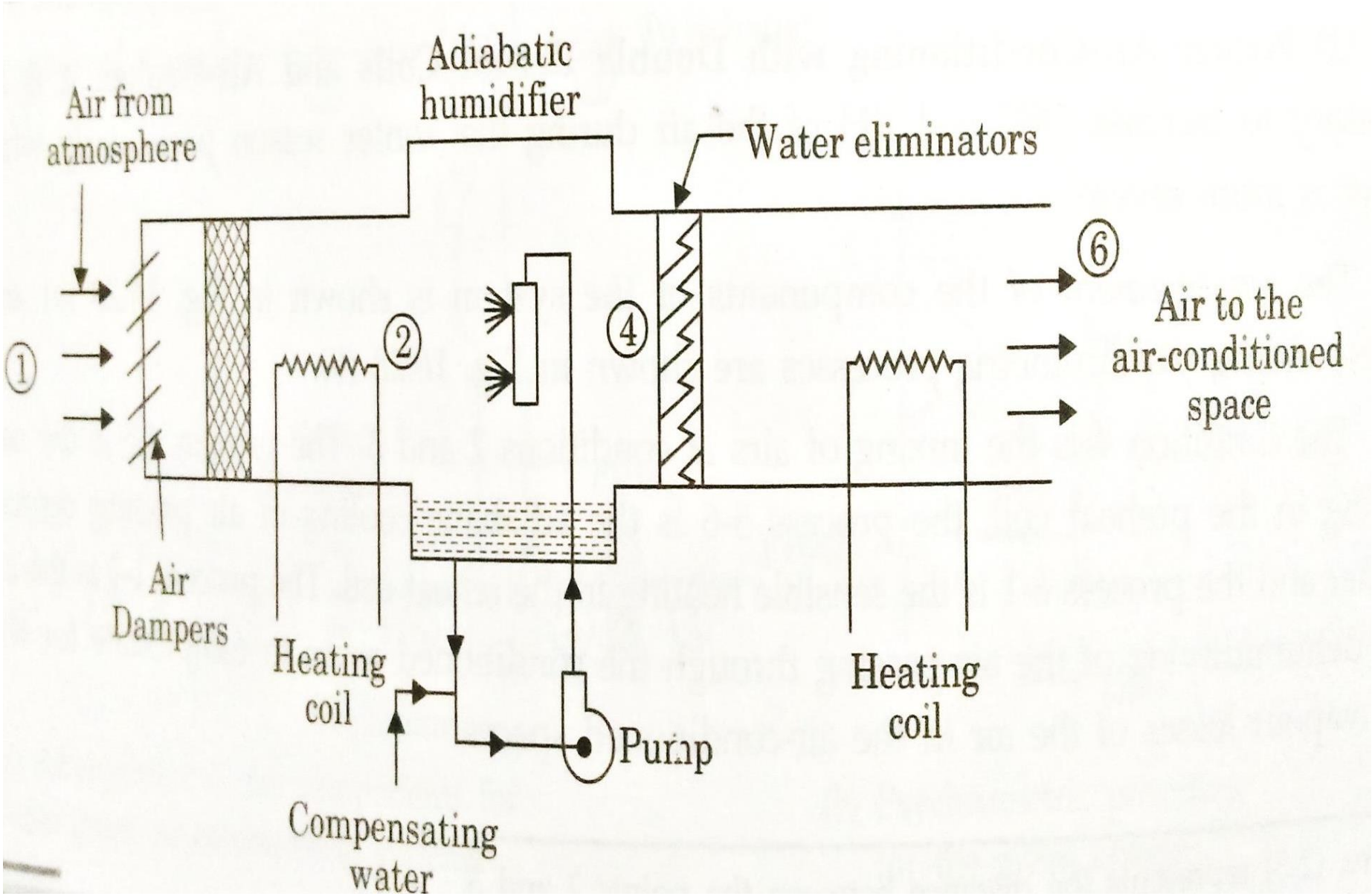
Summer air conditioning with evaporative cooling

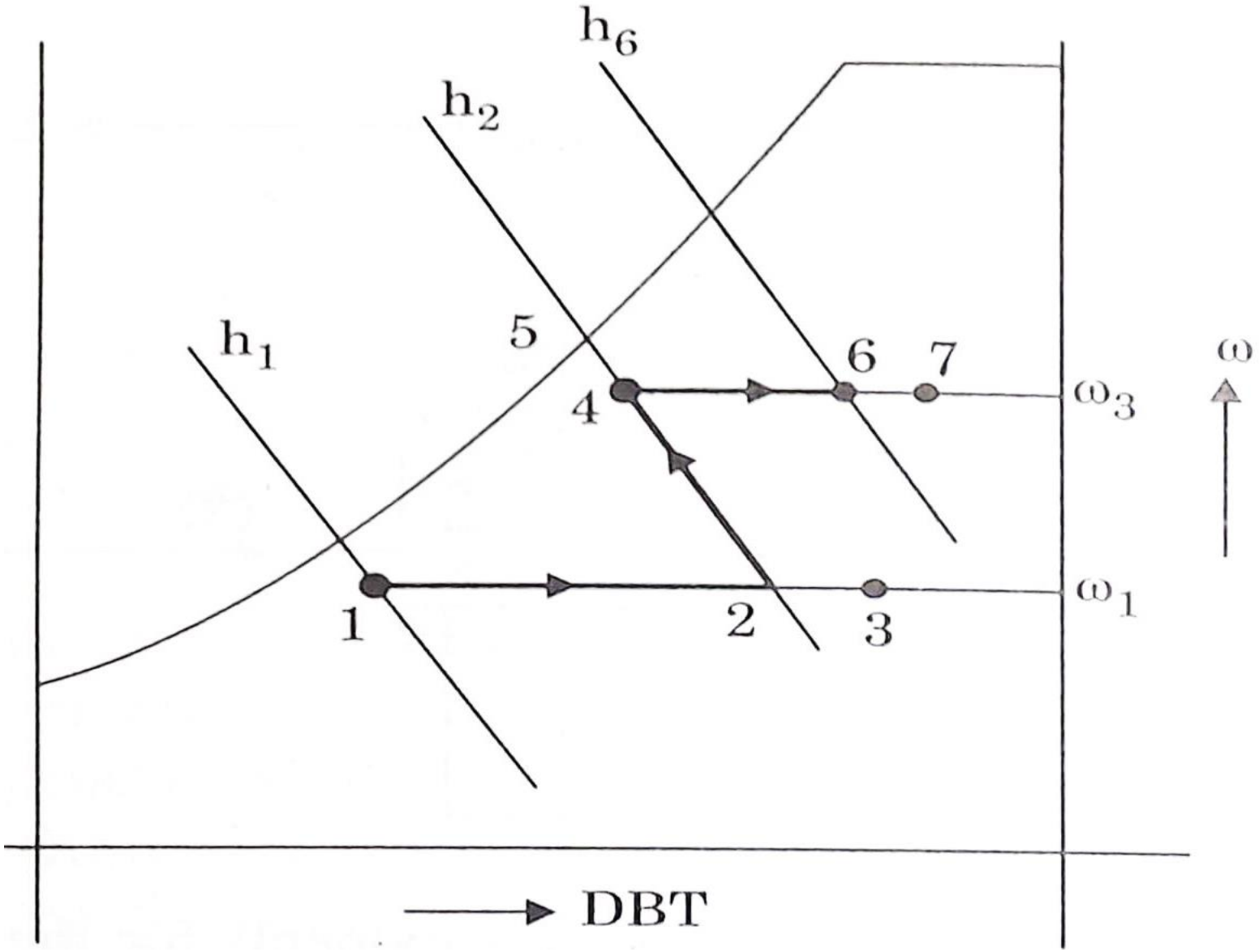


Arrangement for the components for the given A C system

Psychrometry process for the given A C system

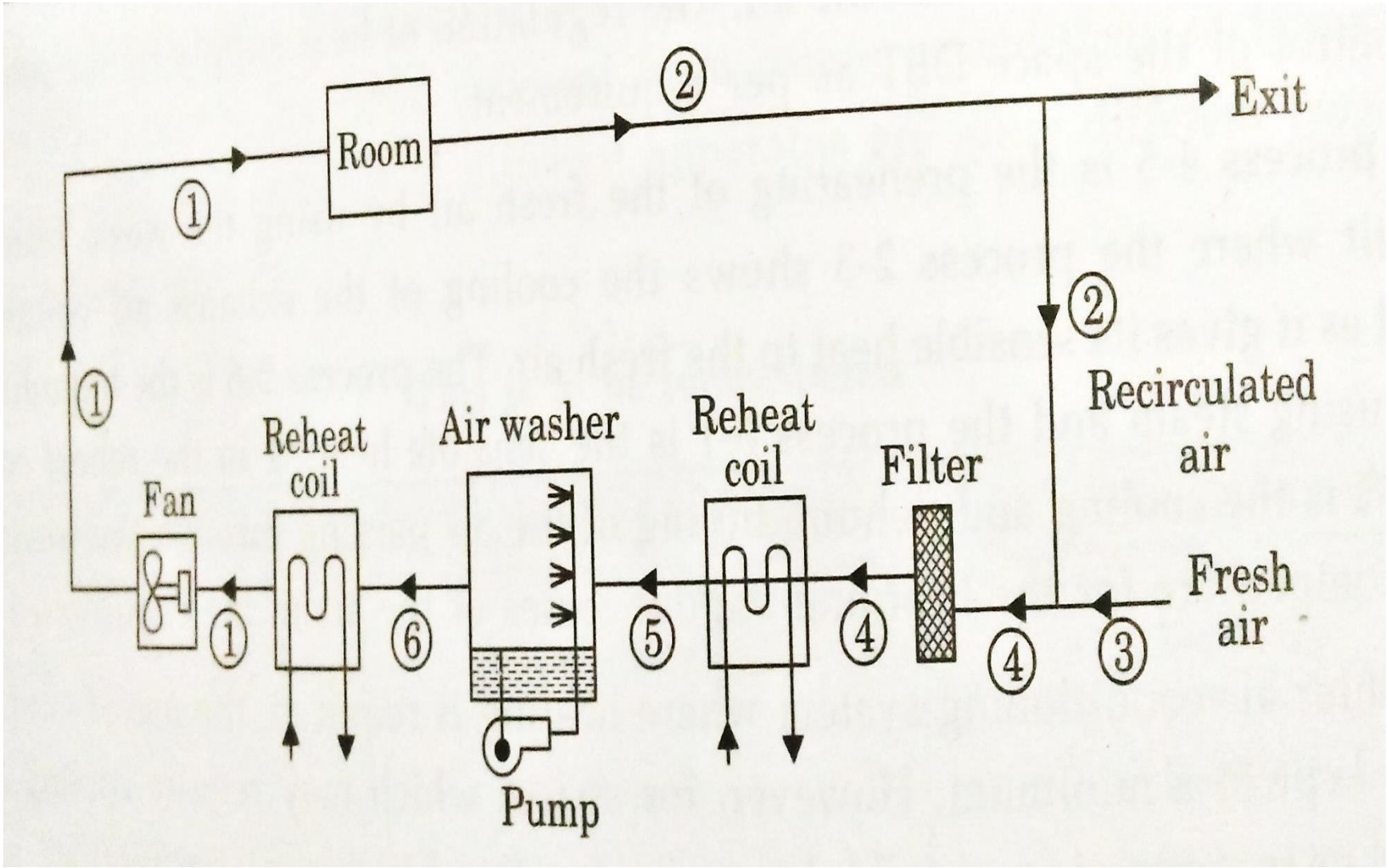
Winter air-conditioning

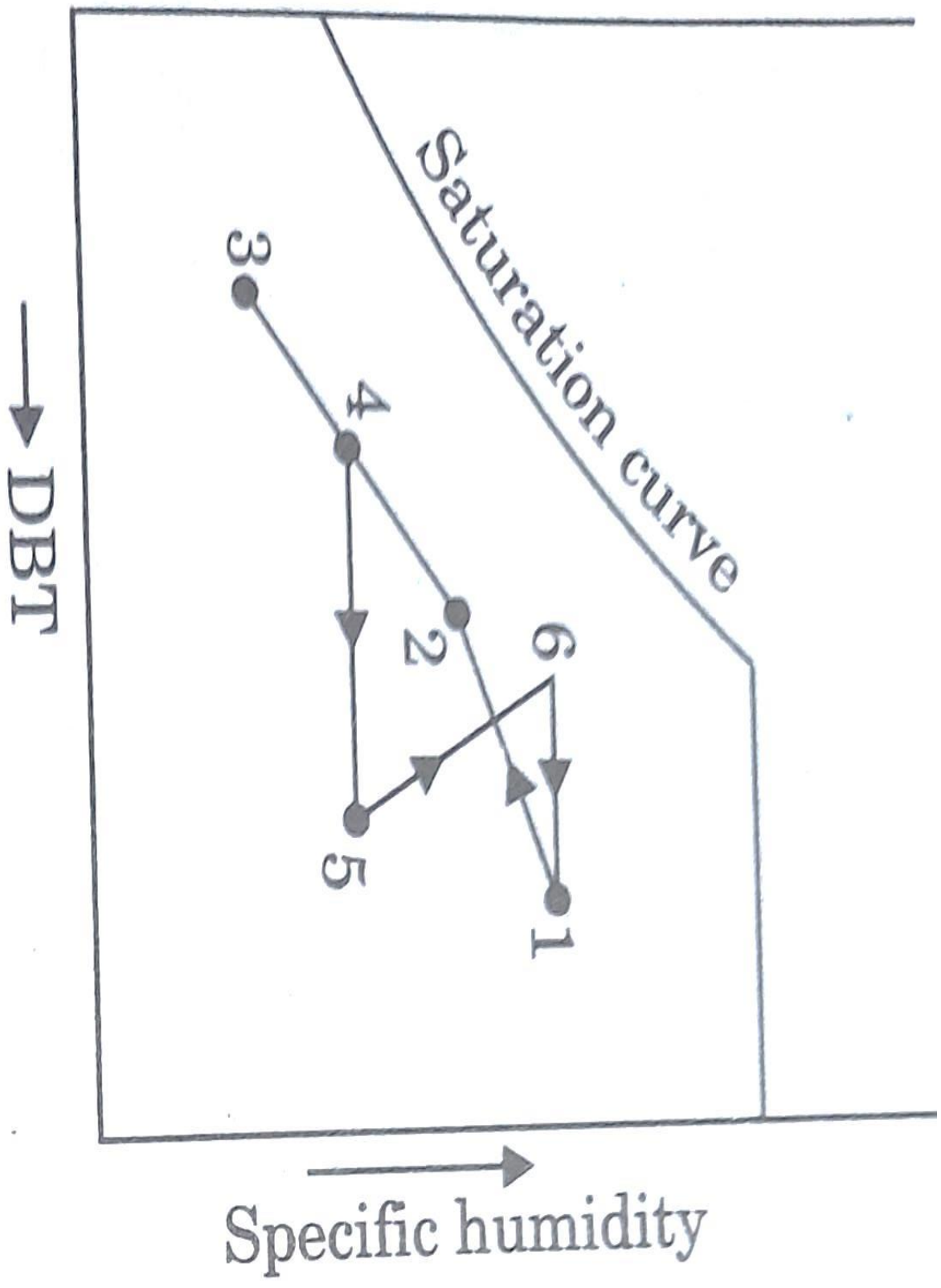




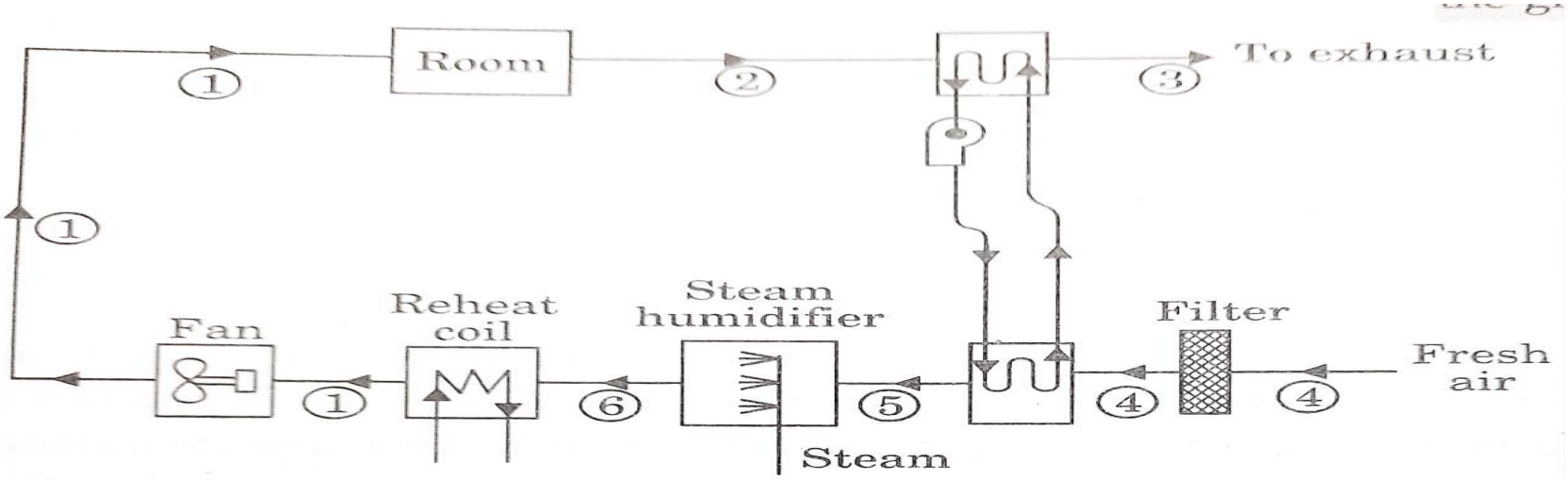
Psychrometry process for the given A C system

Winter AC with double reheat coil and air washer




Saturation curve
3
4
2
6
5
1
DBT
Specific humidity

Winter air conditioning using 100% outdoor air with preheating by waste heat from exhaust



(a) Arrangement of the components for the given air-conditioning systems (b)

Process 1-2 : cooling and dedumification of air passing through the conditioned space to compensate for the heat and vapour losses of the air in the conditioned space.

Process 2-3 : cooling of the exhaust air before being exhausted as it gives its sensible heat to the fresh air.

Process 3 : to exhaust

Process 4-5 is the preheating of the fresh air by using the waste heat in the exhaust air

Process 5-6 is the humidification of air by using steam

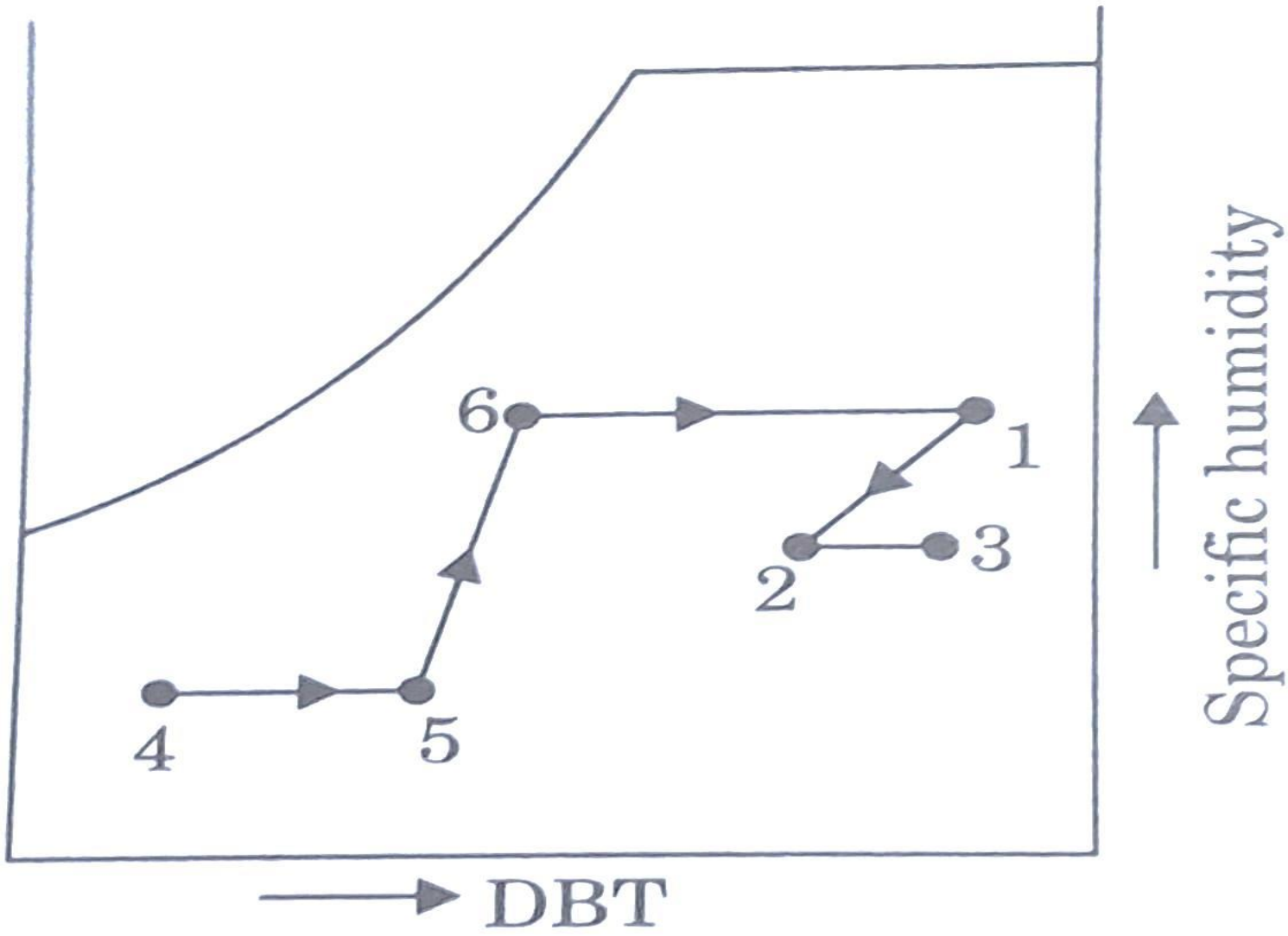
Process 6-1 is the sensibile heating in the reheat coil.

The air washer serves as a humidifying device to offset the moisture losses in the air conditioned space and in addition to this, it cleans the air.

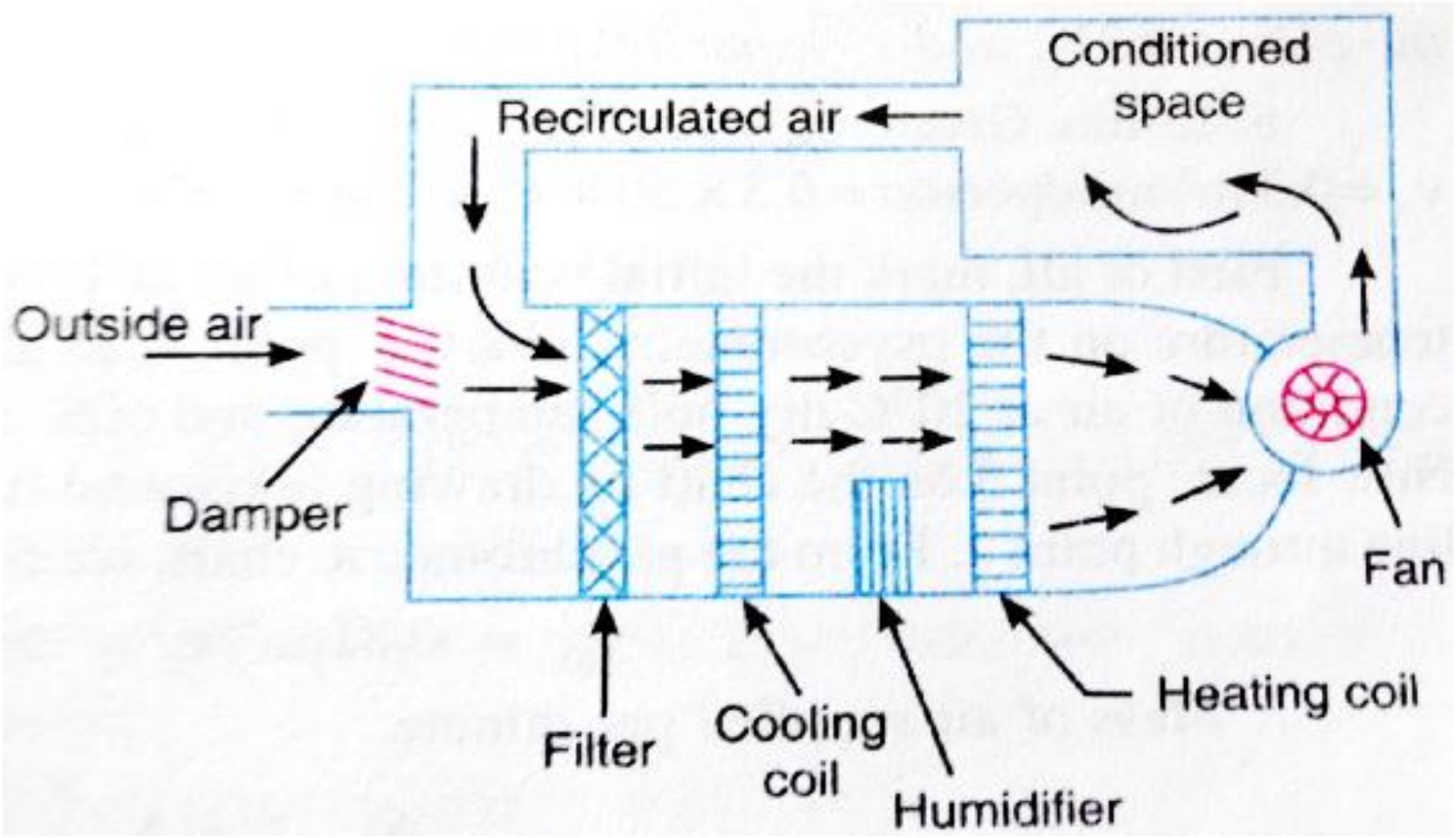
The regulation of heat supply by the reheat coil allows control of the space DBT as requirement.

In winter air conditioning system, where heating is required, the use of out door air should be kept to a minimum.

However, for spaces which may require cooling during the entire year, provision should be made for flexible use of outdoor air so that refrigerating equipment can be shut down during cold weather conditions


6
1
2
3
4
5
Specific humidity
DBT

Year round air conditioner



Problems

Problem 1:
Room air at 20 ^{o}C DBT and 50 % RH is mixed with outdoor air at 40^{o}C DBT and 30% RH in the ratio of 4:1. The mixture is passed through a cooling coil whose temperature is maintained constant at 10 ^{o}C whose bypass factor is 0.2. Find the following;

(i) Condition of the air before entering the coil
(ii) Condition of the air leaving the coil
(iii) If 250 m^3/min of air is supplied to the room find the refrigeration load on the cooling coil.