

# Refrigeration & Air Conditioning

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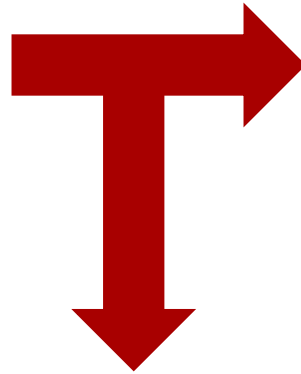
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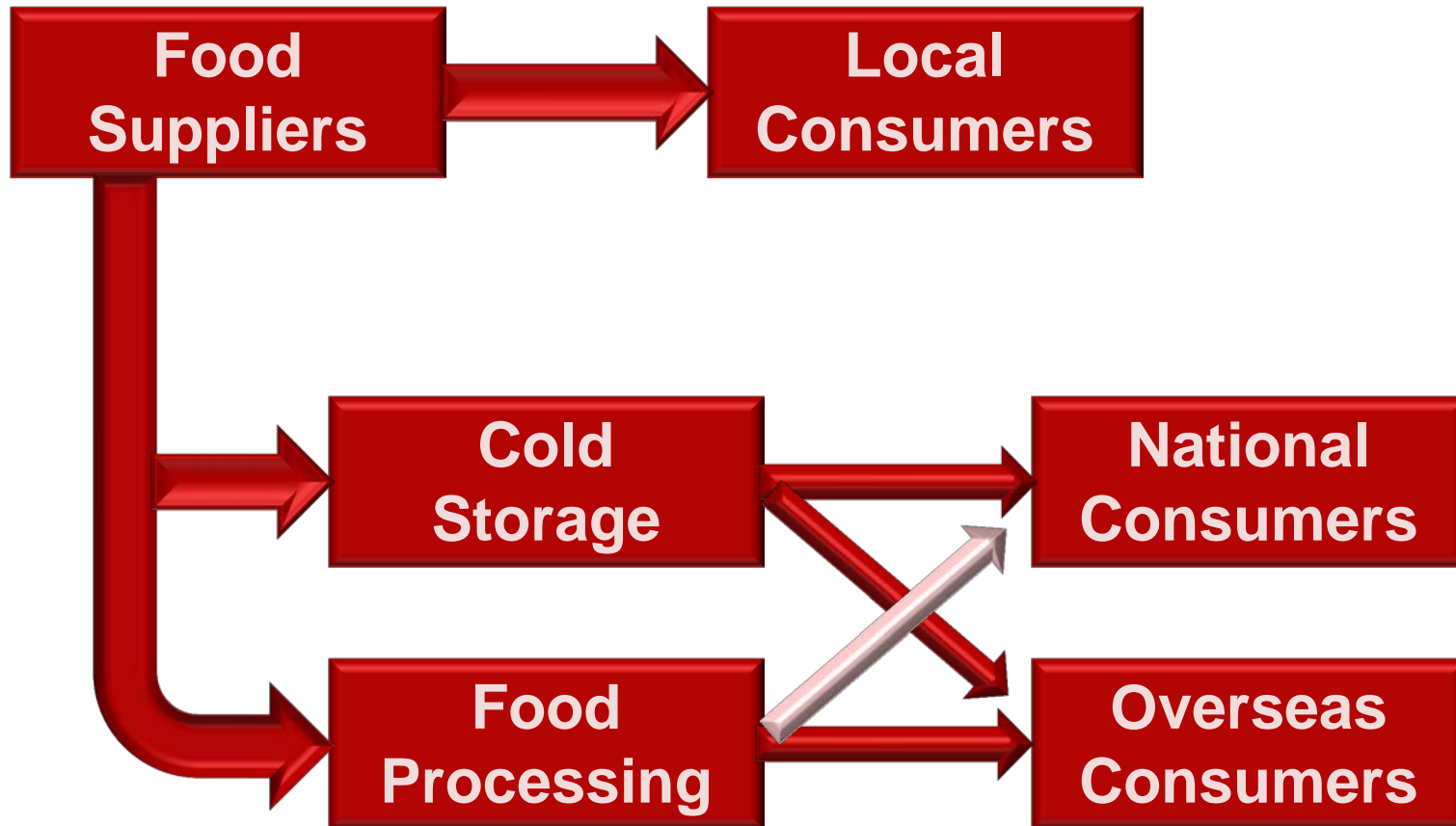
# What is Refrigeration?



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# What is Refrigeration?



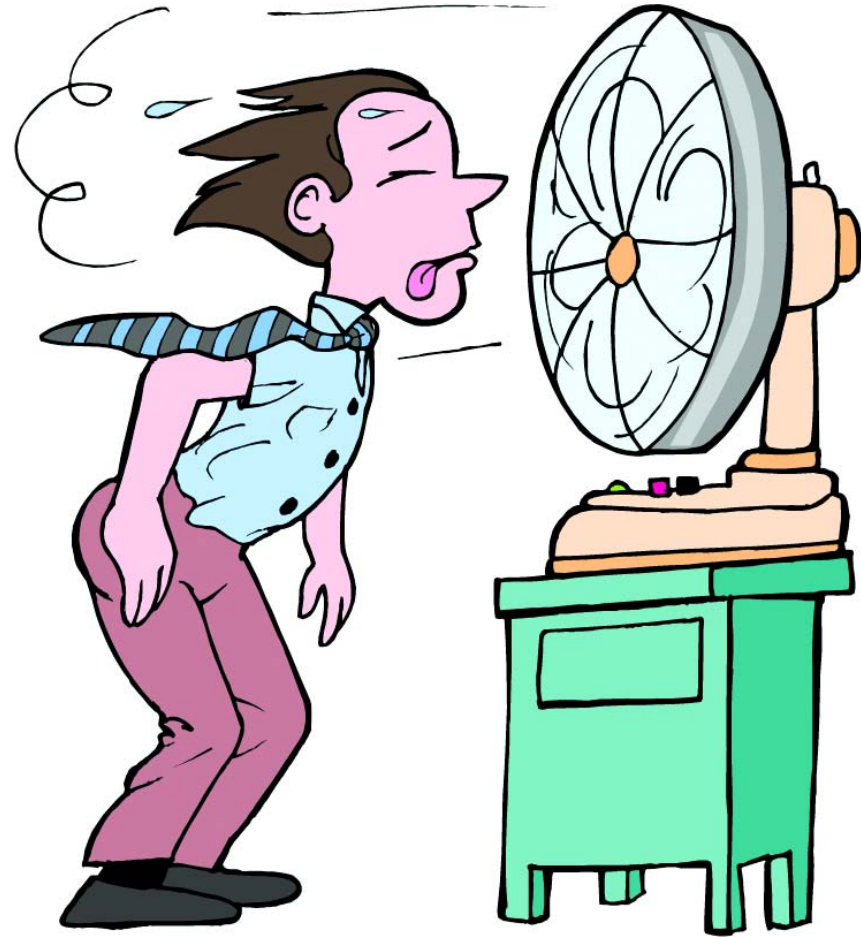
# What is Refrigeration?

- Artificial withdrawal of heat
- Producing in a substance or within a space a temperature lower than that which would exist under the natural influence of the surrounding
- Dehumidifying



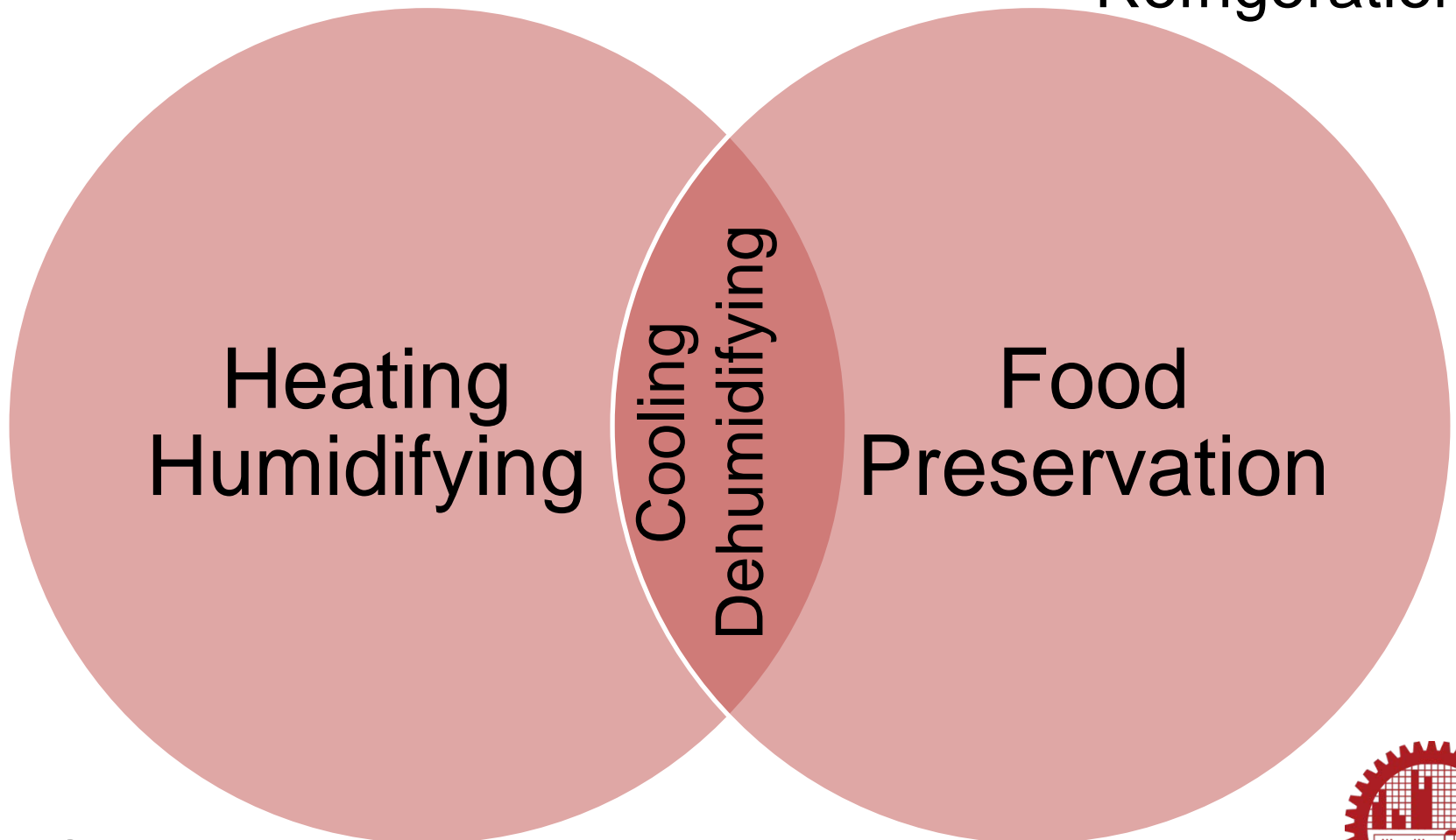
# What is Air Conditioning?

- Artificial tampering of the conditions of air
  - Cooling
  - Heating
  - Ventilation
  - Filtration
  - Air circulation
  - Dehumidifying



# Relationship of Ref. & A/C

Refrigeration



Air Conditioning



# Classification of Application

- Domestic Refrigeration
- Commercial Refrigeration
- Industrial Refrigeration
- Marine & Transportation Refrigeration
- Comfort Air Conditioning
- Industrial Air Conditioning



# Comfort V<sub>S</sub> Industrial A/C

- Comfort air-conditioning is for human comfort.
  - control of space temperature
  - Humidity
  - air-motion and
  - cleaning/filtering of air.
- Industrial air-conditioning does not have the primary function of conditioning air for human comfort.





# Comfort $V_S$ Industrial A/C (cont.)

- Functions of industrial air-conditioning include:
  - control of moisture of hygroscopic materials
  - govern the chemical/bio-chemical reaction rates
  - limit the variation of size of precision manufacturing items because of thermal expansion and contraction
  - provide clean, filtered air for production of quality products
  - ensure space temperature/humidity/air-motion for production requirement.



# Food Preservation by Refrigeration

- Involves the use of low temperature as a means of eliminating or retarding the activity of spoilage agents
- Frozen storage requires freezing of the product and storage at some temperature between  $-12^{\circ}$  to  $-23^{\circ}$  C
- Factors affecting the quality of frozen product:
  - Nature and composition of product to be frozen
  - Care in selecting, handling & preparing the product for freezing
  - Freezing method
  - Storage condition



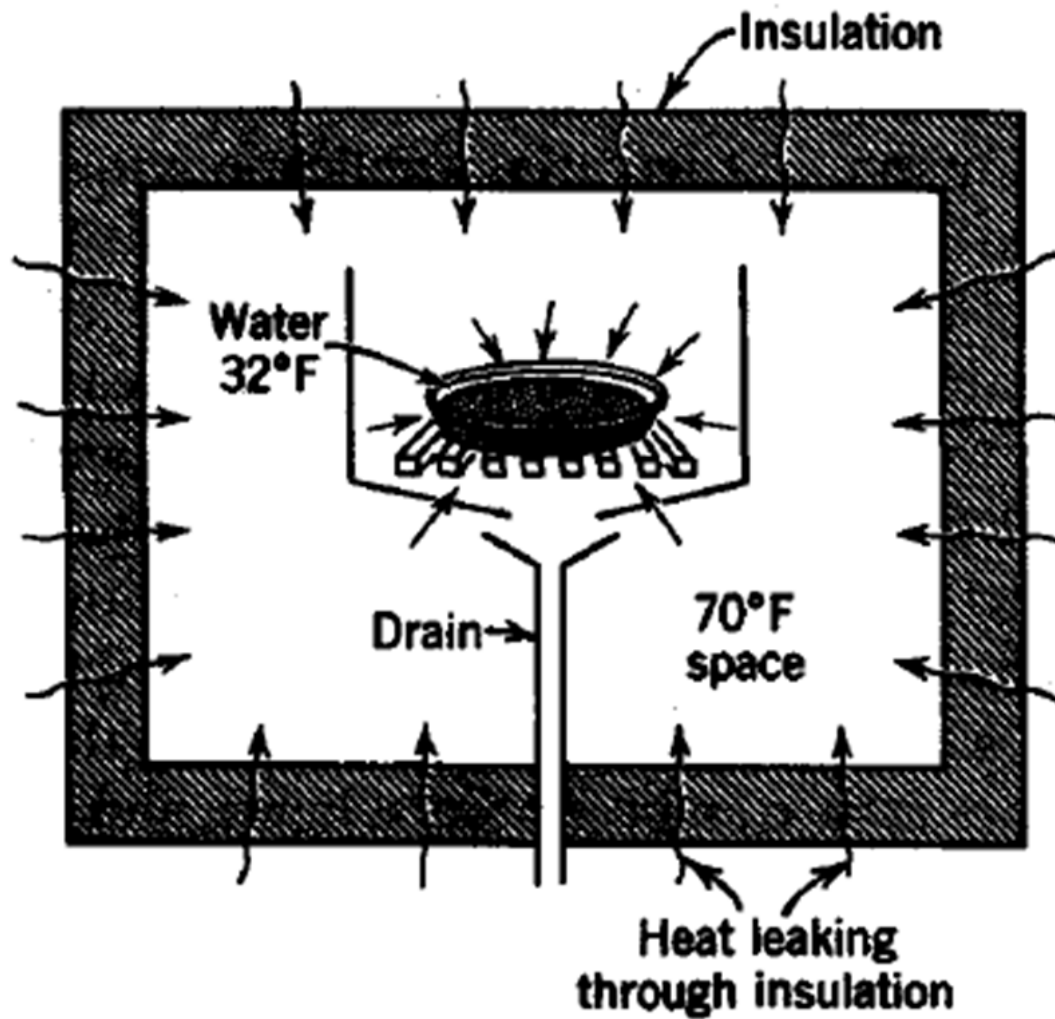
# Commercial/Industrial Application

- Ice rinks
- Low temperature liquid storage /transportation
- De-waxing of oil
- Separation and condensation of gases
- Solidification and separation of solid
- Low temperature testing
- Removal of heat of reaction
- etc.



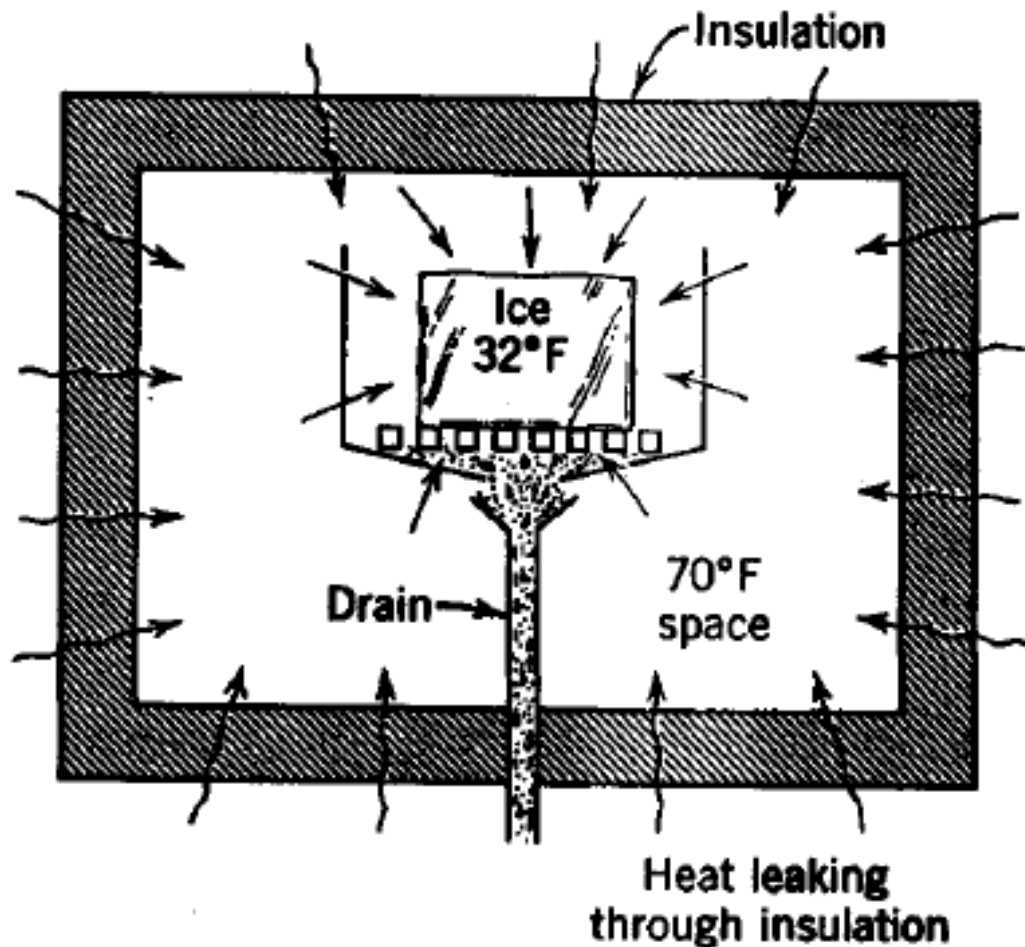
# VAPOR COMPRESSION REFRIGERATION





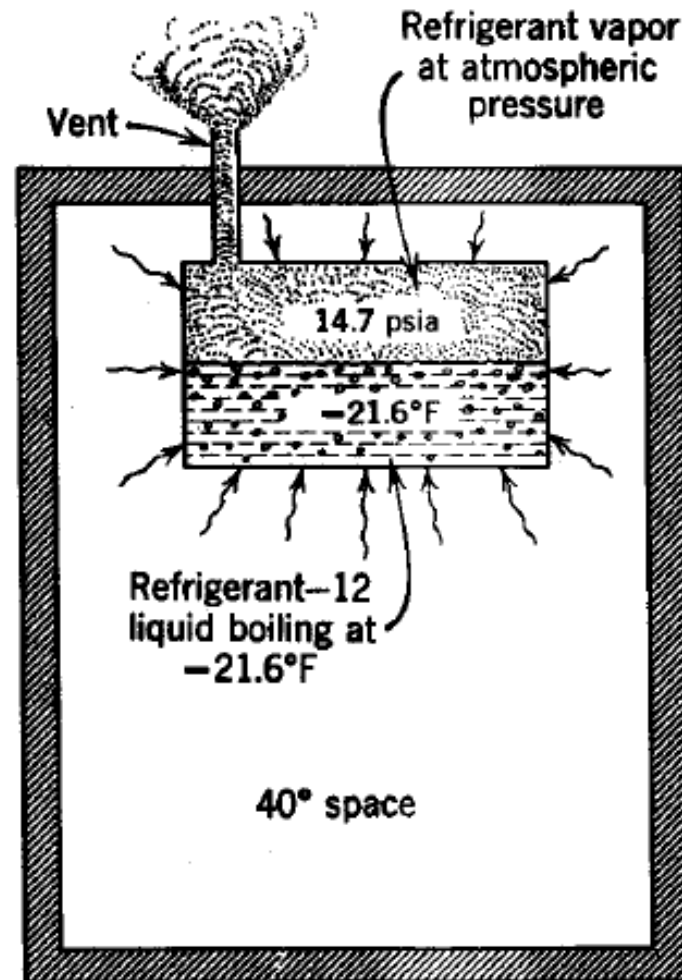
Heat flows from warm space to colder water. Water temperature rises as space temperature decreases. Refrigeration will not be continuous





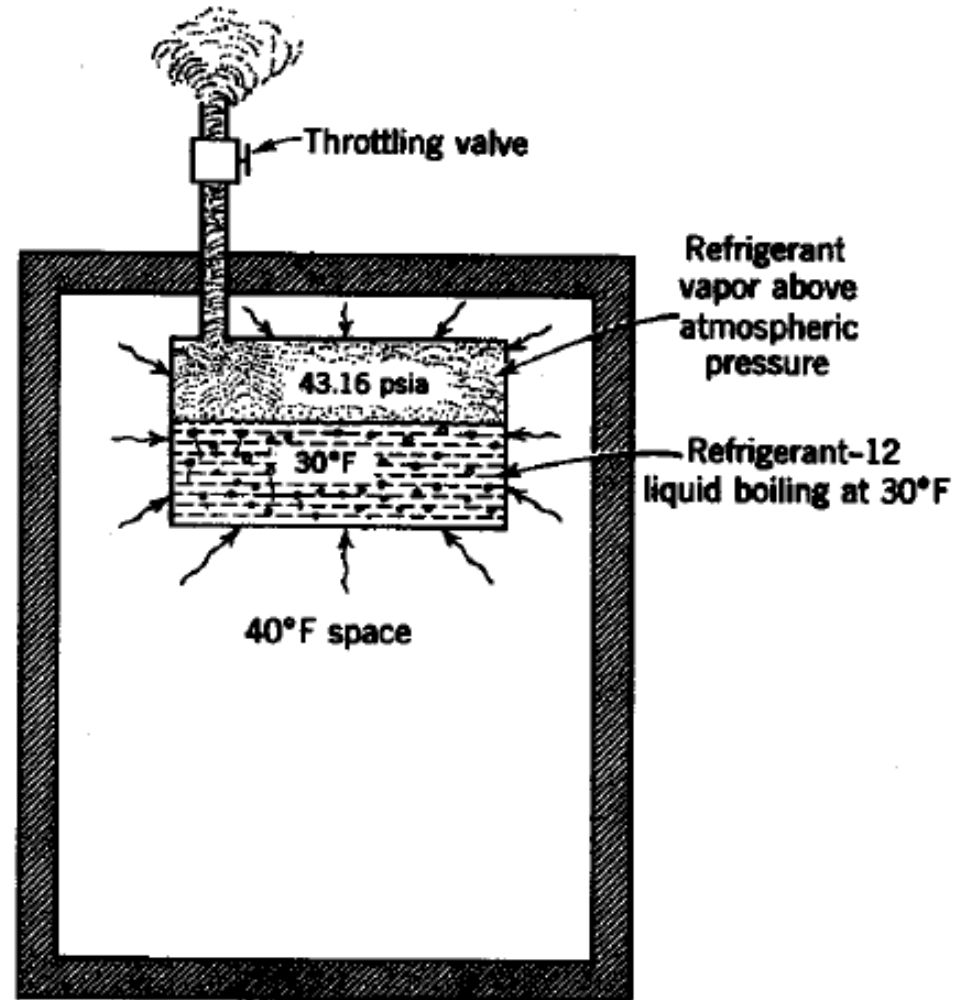
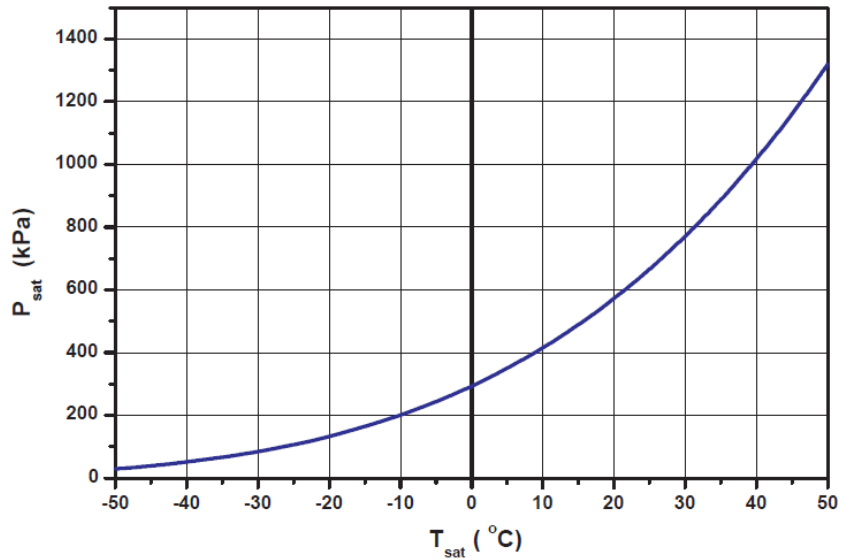
Heat flows from warm space to cold ice. Temperature of space decreases as ice melts. Temperature of ice remains at 32F (0C). Heat absorbed by ice leaves space in water going out the drain.





The Refrigerant 134a liquid vaporizes as it takes in heat from the  $40^{\circ}\text{F}$  space. The heat taken in by the refrigerant leaves the space in the vapor escaping through the vent

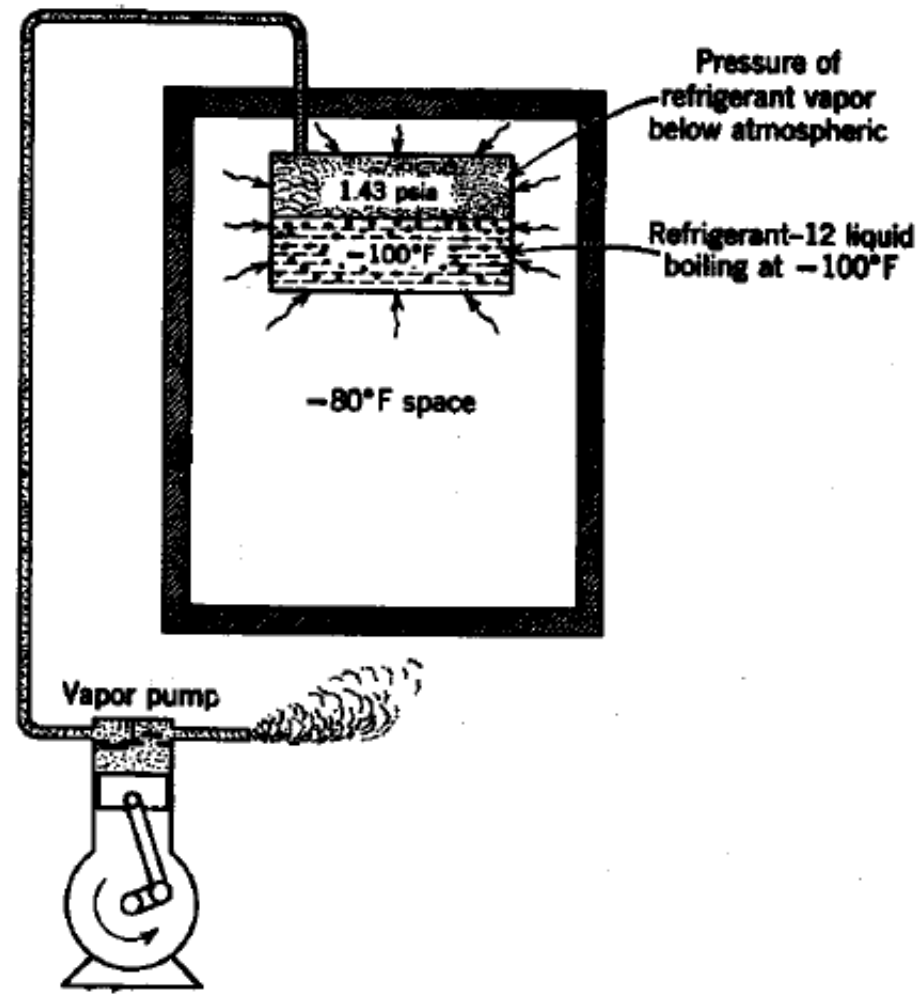




The boiling temperature of the liquid refrigerant in the evaporator is controlled by controlling the pressure of the vapor over the liquid with the throttling valve in the vent.

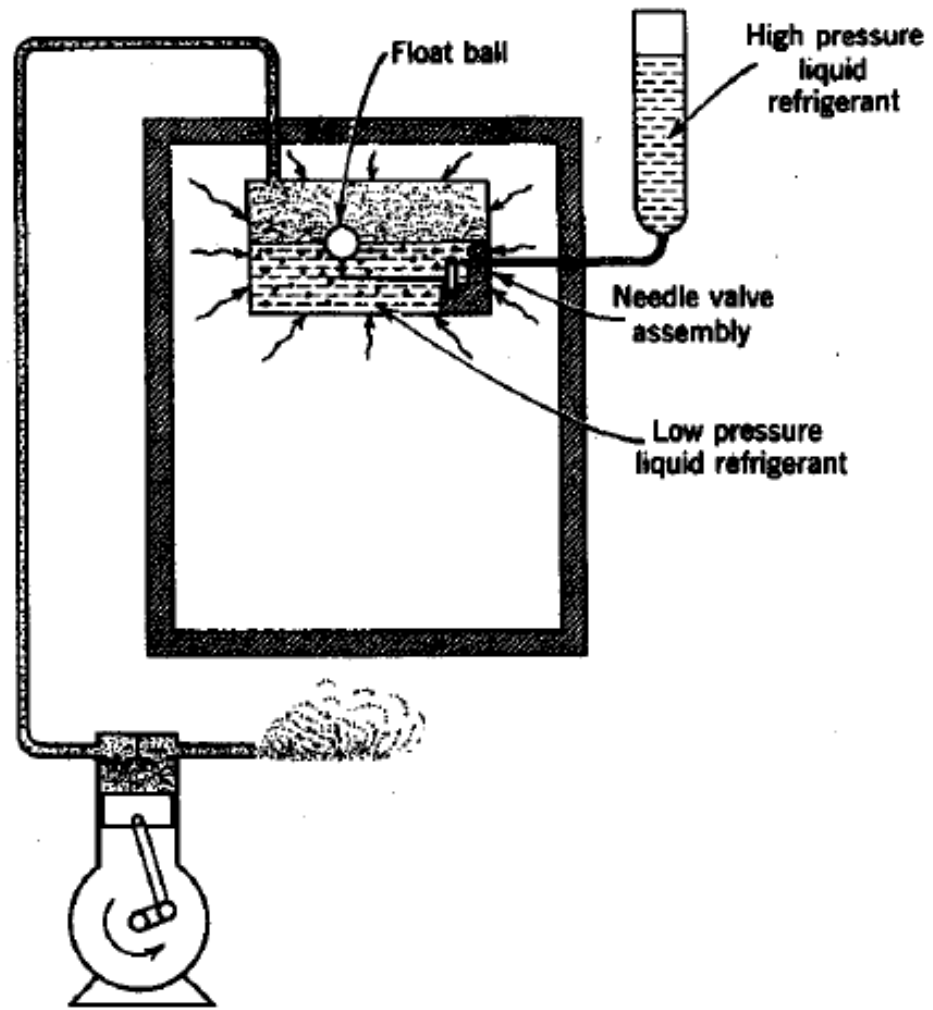






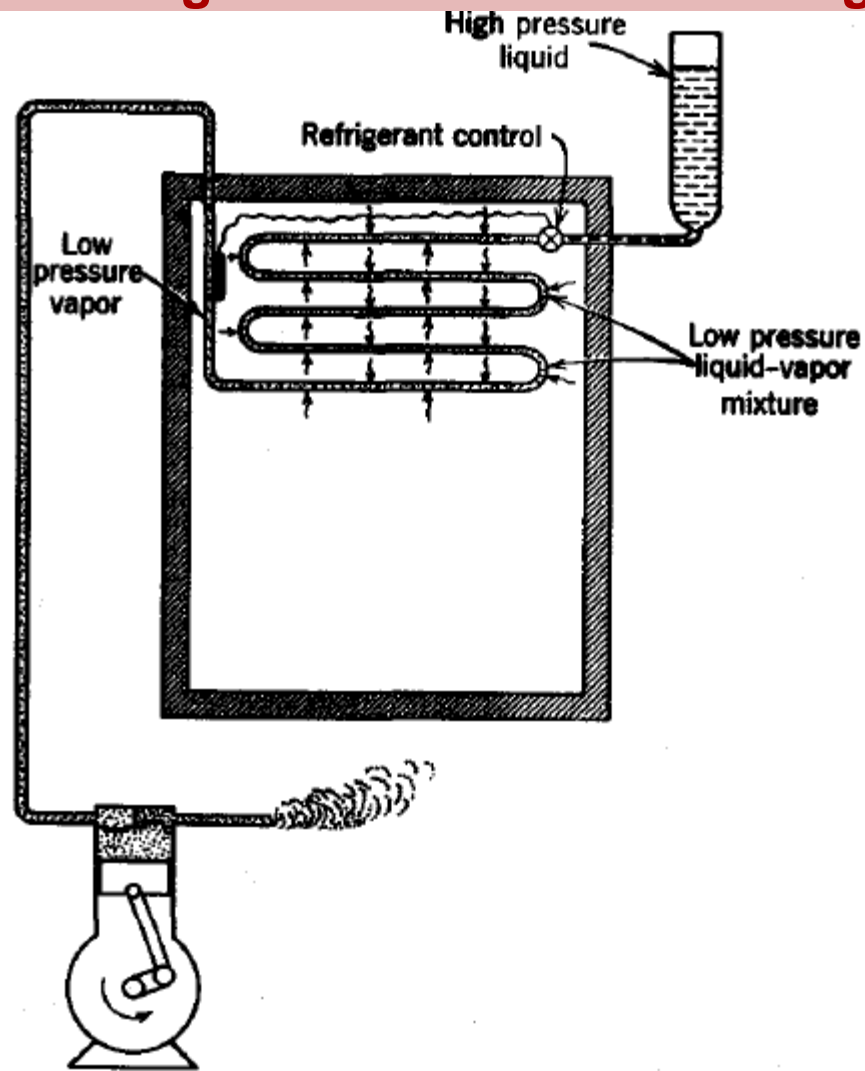
Pressure of refrigerant in evaporator reduced below atmospheric by action of a vapor pump.





Float valve assembly maintains constant liquid level in evaporator. The pressure of the refrigerant is reduced as the refrigerant passes through the needle valve.

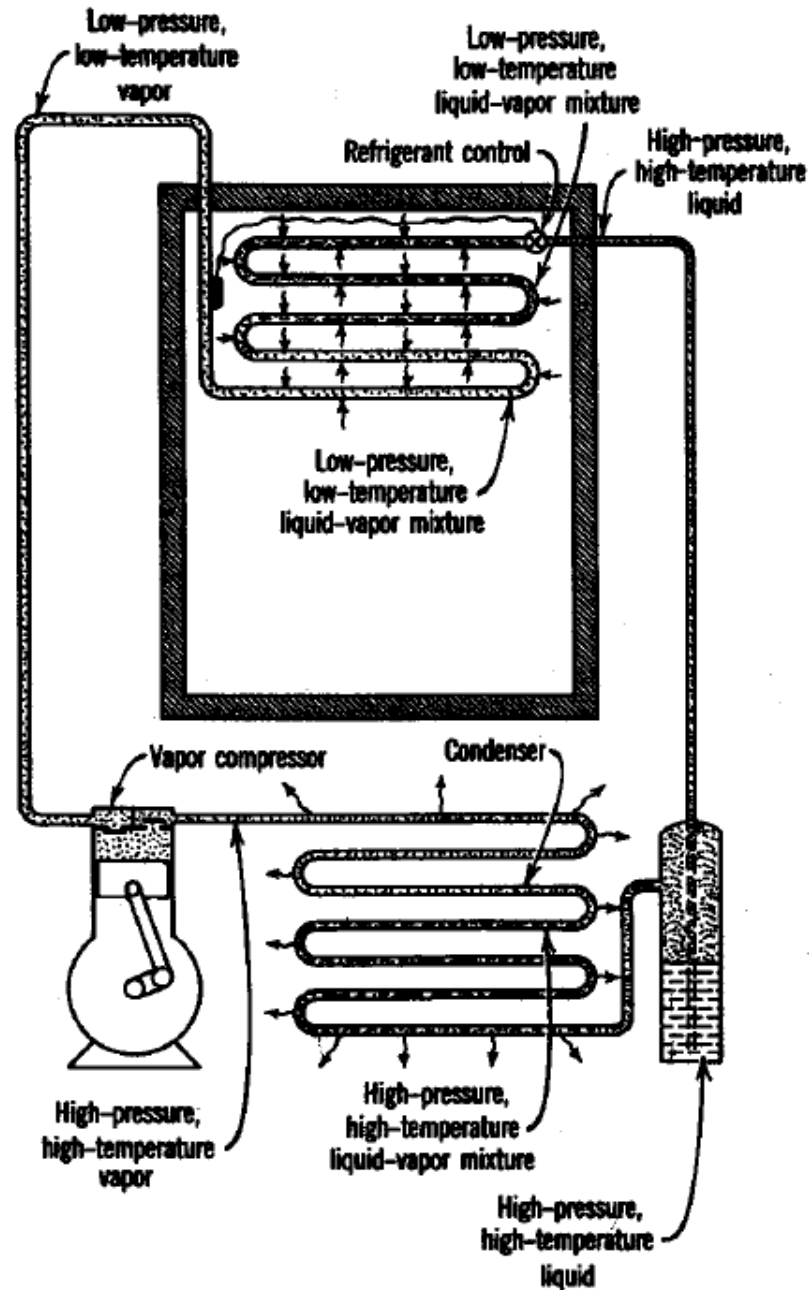


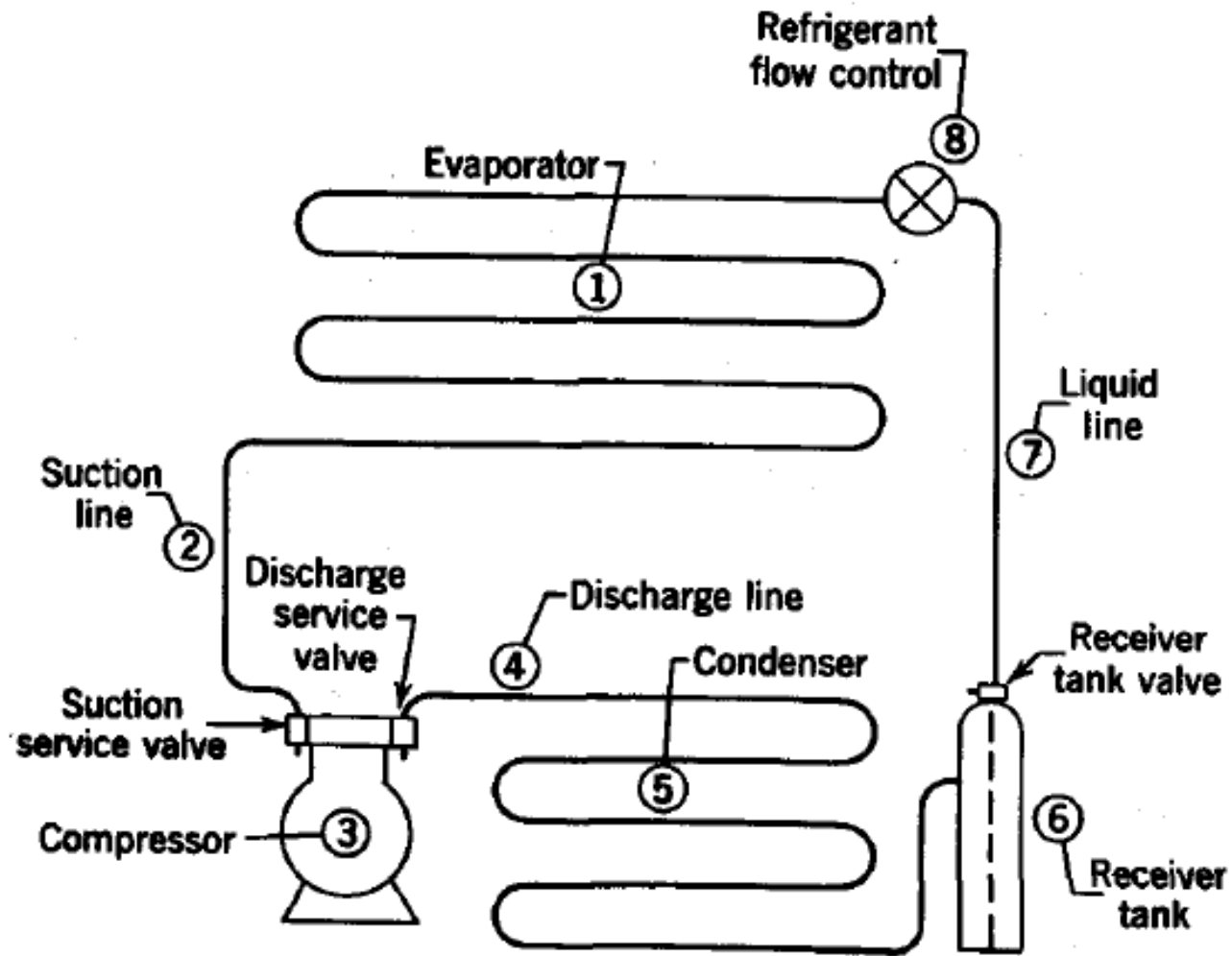


Serpentine coil evaporator with thermostatic expansion valve refrigerant control.



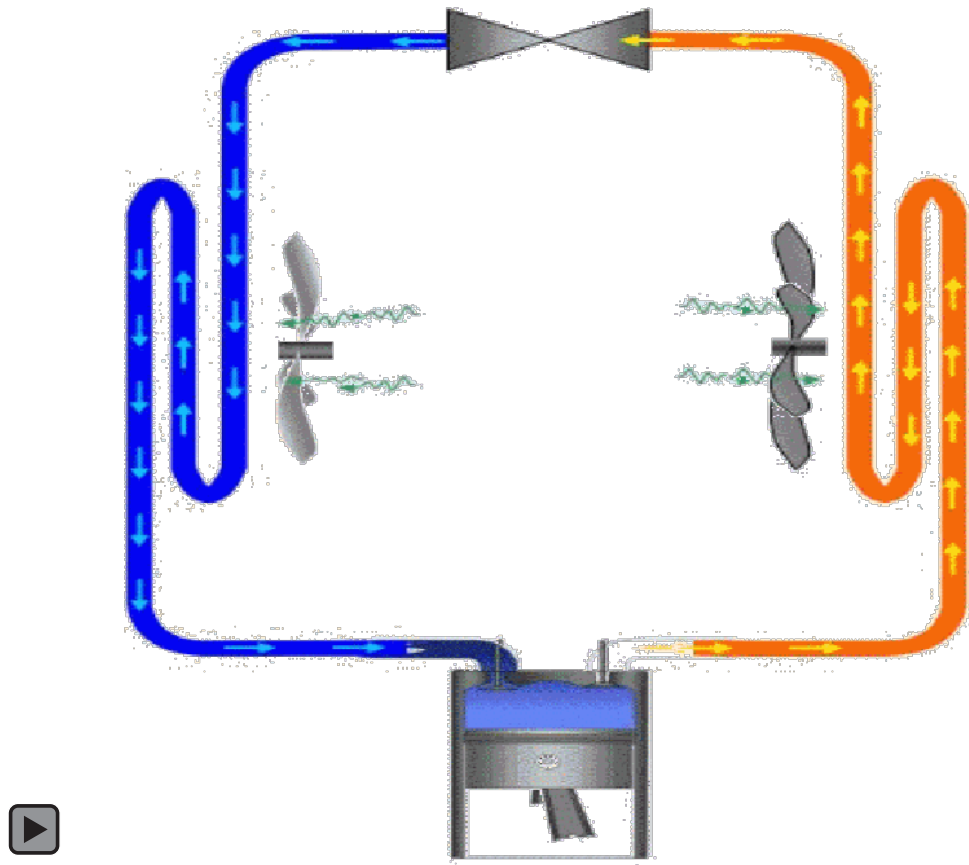
Collecting and condensing the refrigerant vapor. Refrigerant absorbs heat in evaporator and gives off heat in the condenser.





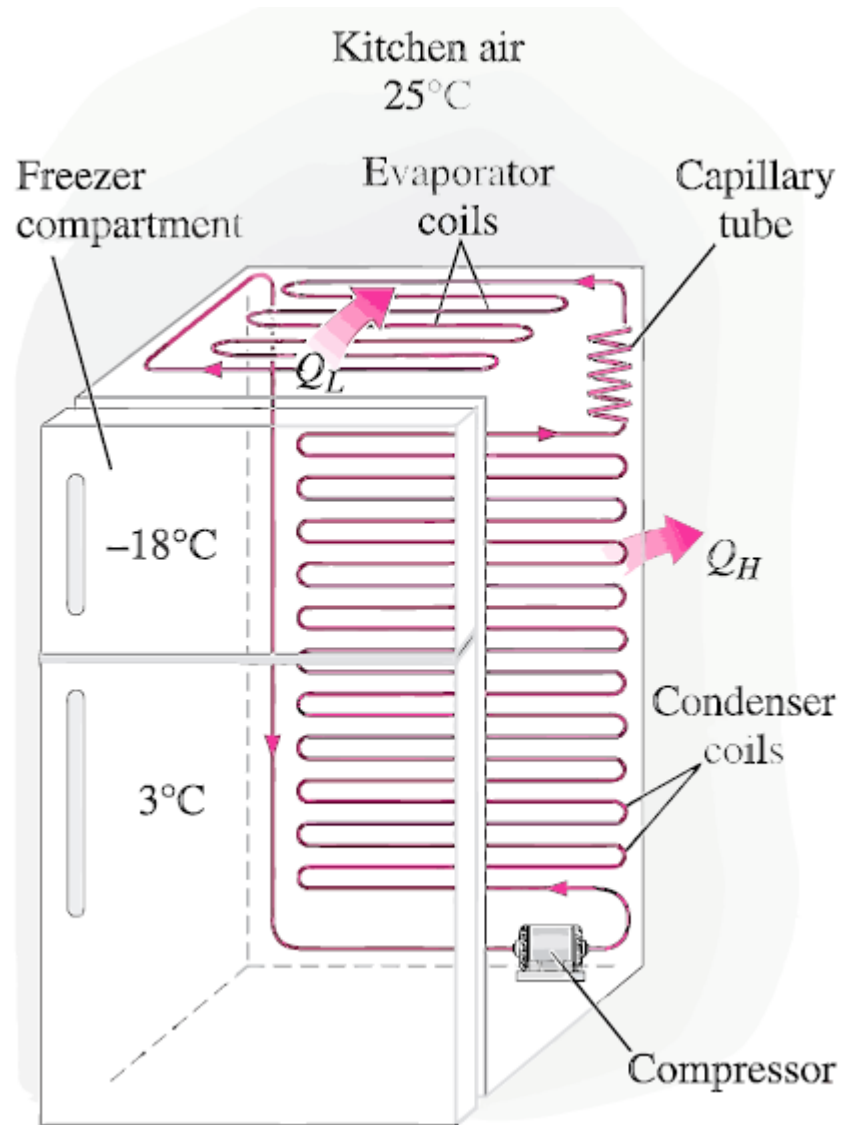
Flow diagram of simple vapor compression system showing the principle parts

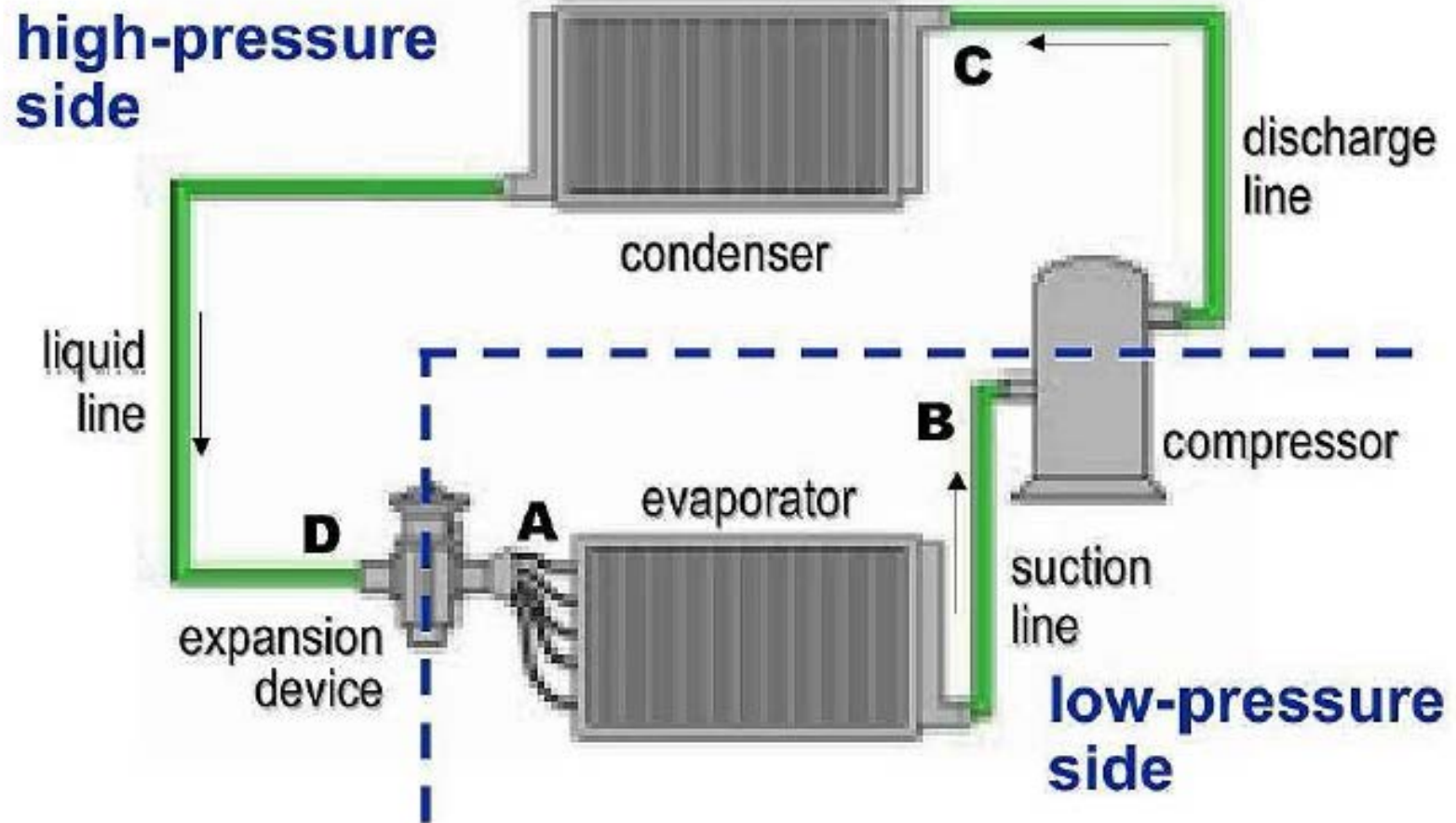




## Key Component of Refrigerator

1. Evaporator
2. Suction line
3. Vapor compressor
4. Hot gas/discharge line
5. Condenser
6. Receiver tank
7. Liquid line
8. Refrigerant flow control device

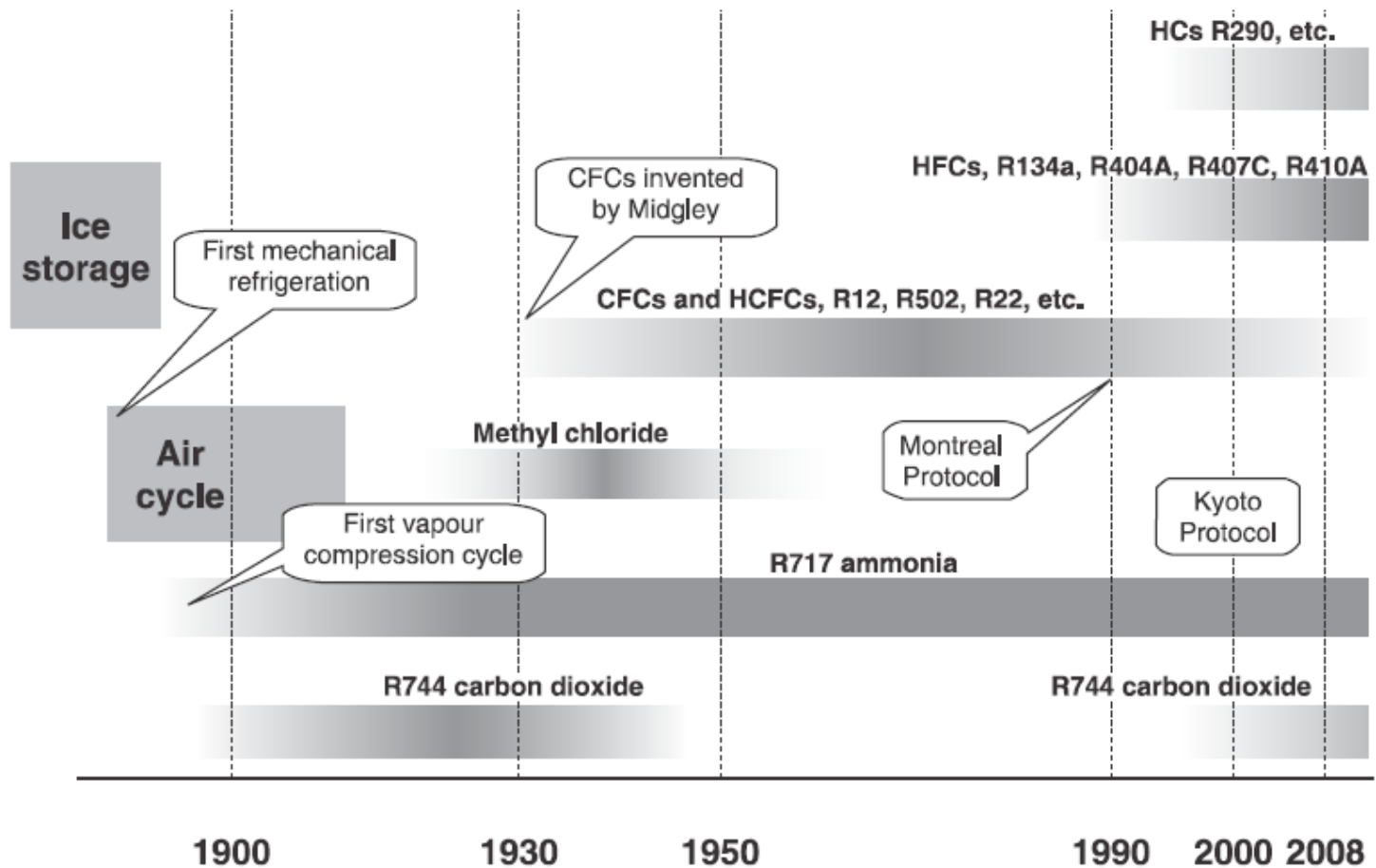






# REFRIGERANT





## Refrigerant

A refrigerant is any body or substance that acts as a cooling agent by absorbing heat from another body or substance.



# Ideal Properties for Refrigerant

- High latent heat of vaporization
- High suction gas density
- Positive but not excessive pressure at evaporating and condensing conditions
- Critical temperature and triple point well outside the working range
- Chemically stable, compatible with construction materials and miscible with lubricants
- Non-corrosive, non-toxic and non-flammable
- High dielectric strength
- Environmentally friendly
- Low Cost



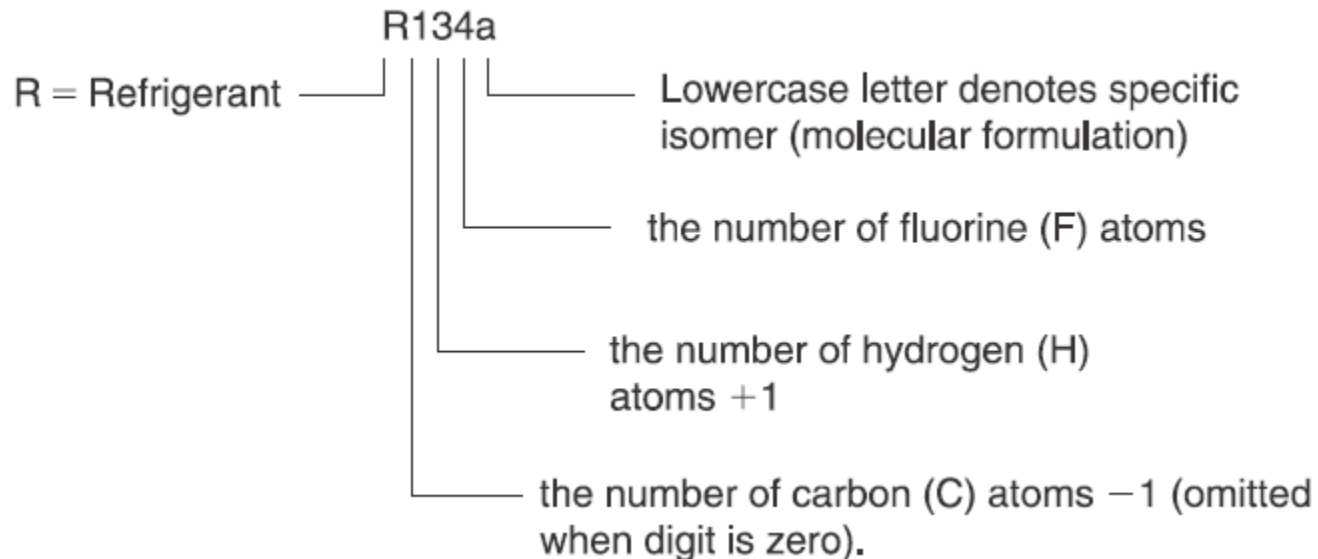
# Classification of Refrigerant

- A refrigerant may be a single chemical compound or a mixture (blend) of multiple compounds.
  - **Azeotropic Mixtures**: these are blends of multiple refrigerants that evaporate & condense as a single substance & do not change their volumetric composition or saturation temperature when they evaporate or condense at a constant pressure.
  - **Zeotropic Mixtures**: these are blends of multiple refrigerants that evaporate & condense as a single substance & do change their volumetric composition or saturation temperature when they evaporate or condense at a constant pressure.
  - **Blends**: mixtures of two or more chemical compounds are blends.



# Numbering of Refrigerant

- Halocarbon/Hydrocarbon

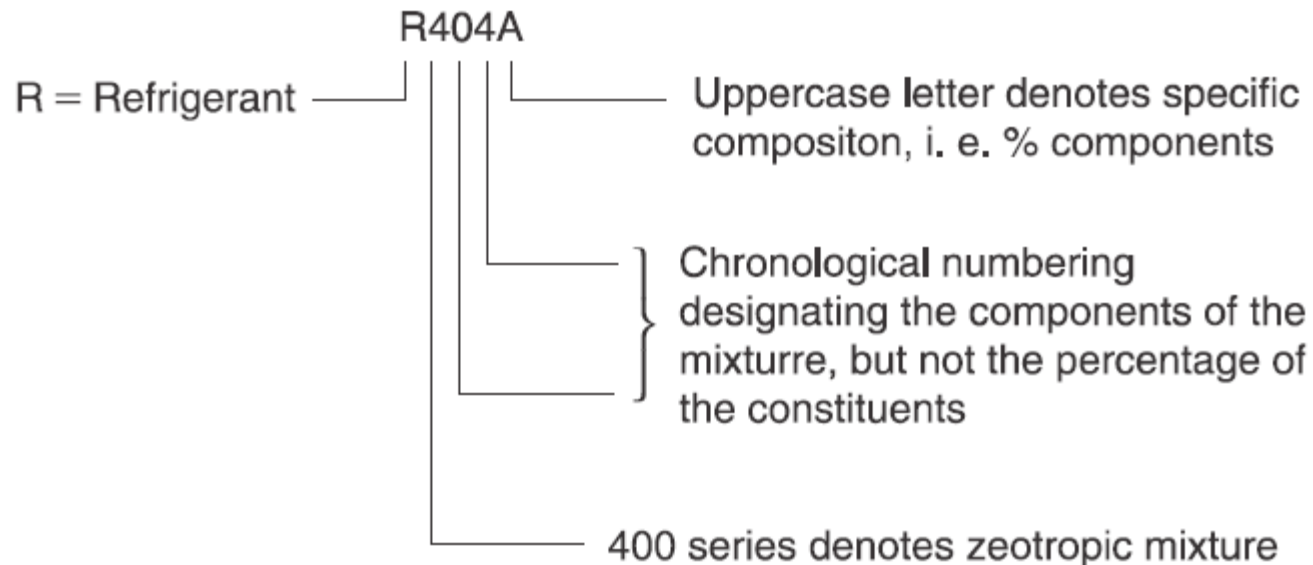


- $\text{CHCl}_2\text{CF}_3 \rightarrow 3\text{F} + 1\text{H} + 2\text{C} \rightarrow \text{R123}$
- $\text{CCl}_3\text{F} \rightarrow 1\text{F} + 0\text{H} + 1\text{C} \rightarrow \text{R11}$
- $\text{CHClF}_2 \rightarrow 2\text{F} + 1\text{H} + 1\text{C} \rightarrow \text{R22}$
- $\text{CH}_4 \rightarrow 0\text{F} + 4\text{H} + 1\text{C} \rightarrow \text{R50}$
- $\text{C}_3\text{H}_8 \rightarrow 0\text{F} + 8\text{H} + 3\text{C} \rightarrow \text{R290}$



# Numbering of Refrigerant (cont.)

- Zeotropic Mixture



- The numbers are in chronological order of the refrigerant's approval by ASHRAE. For example: R407A (R32/R125/R134a (20/40/40)), R407B (R32/R125/R134a (10/70/20)), R407C (R32/R125/R134a (23/25/52)), etc



# Numbering of Other Refrigerant

- **Azeotropic Mixtures**: are in 500 series. Example: R507 (R125/R134a (50/50)).
- **Organic Compounds**: are in 600 series; numbers are given in numerical order, for example R600a, isobutane.
- **Inorganic Compounds** are in 700 series; identifications are formed by adding the relative molecular mass of components to 700.

Chemical Name	Formula	Number
Ammonia	$NH_3$	717
Water	$H_2O$	718
Air	-	729
Carbon-di-oxide	$CO_2$	744
Sulphur-di-oxide	$SO_2$	764



# Performance Parameter

- **1 ton refrigeration**: heat absorbed by 1 ton (2000lb) of ice melting at 0°C in 24 hours
- 1 ton refrigeration = 3.516 kW
- Coefficient of Performance (COP)

$$COP = \frac{\text{Refrigeration Effect}}{\text{Net Work Required}}$$

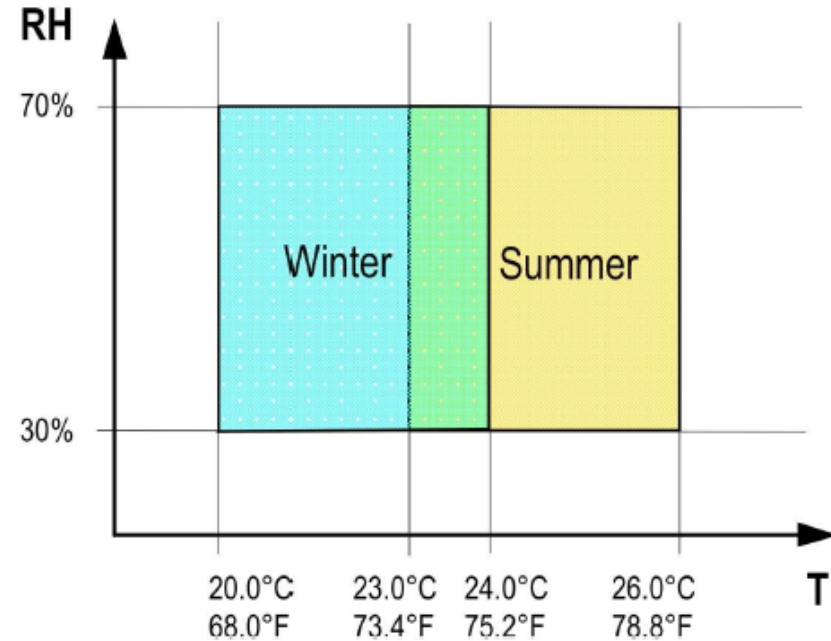
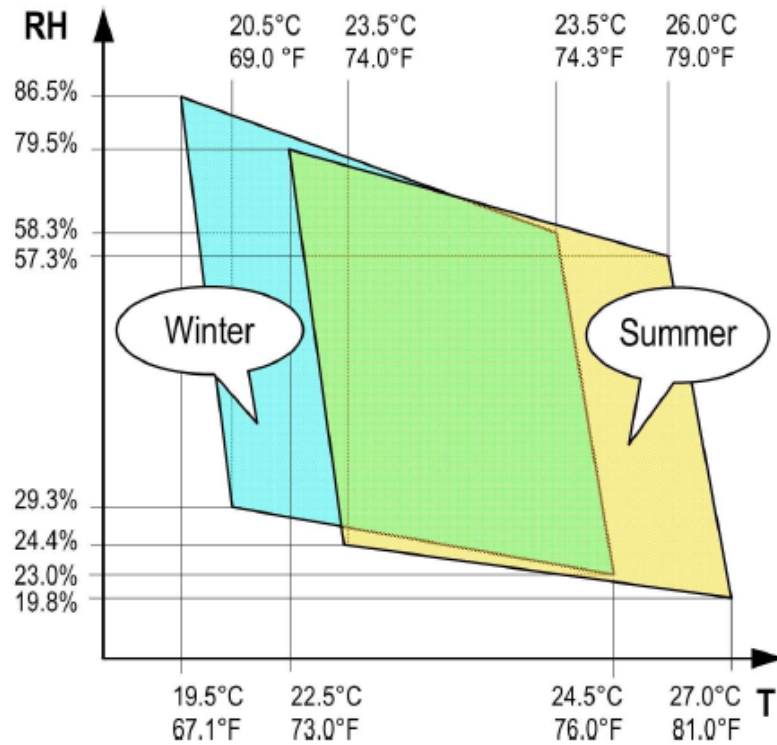




# AIR CONDITIONING



# Thermal Comfort



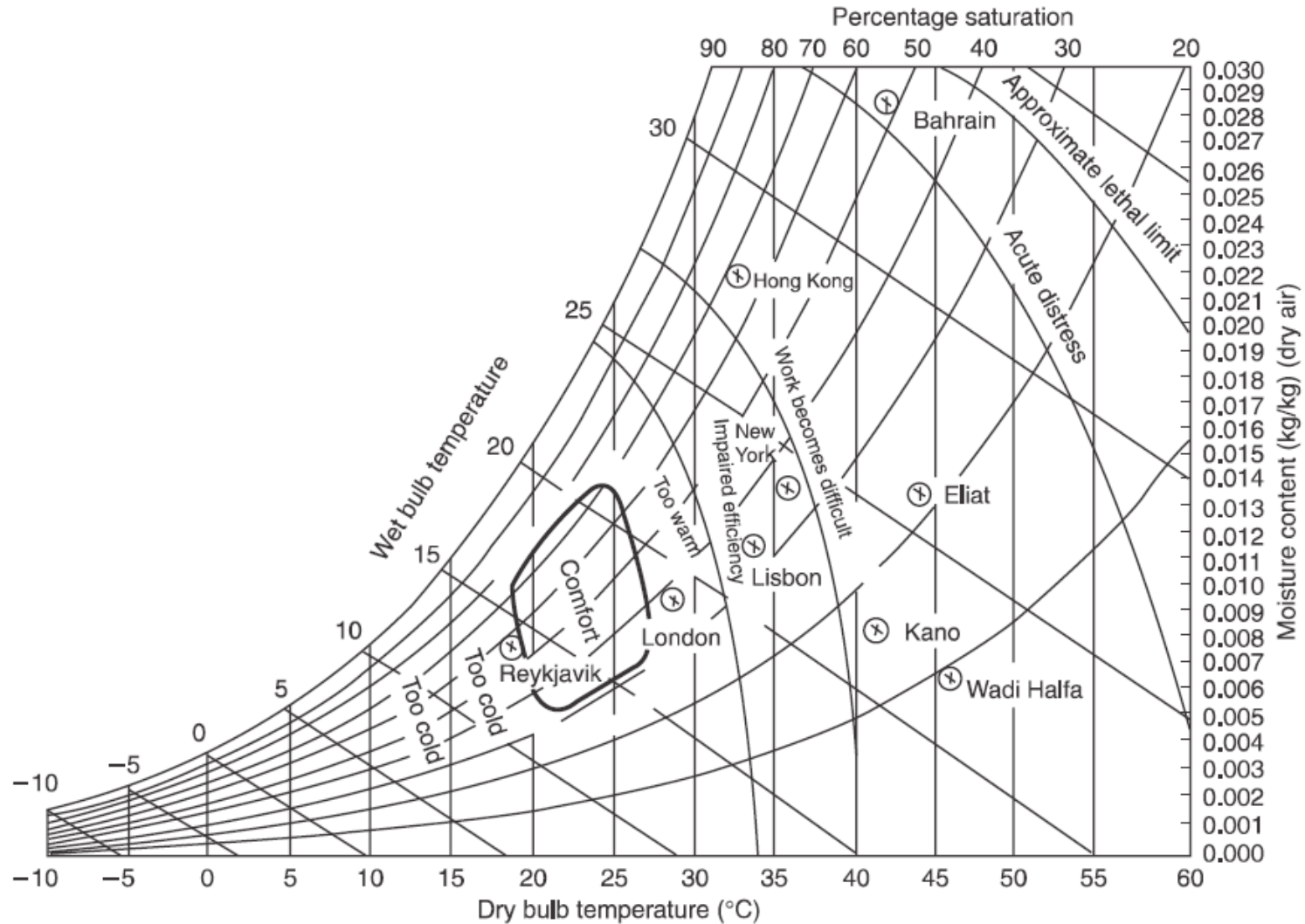
Comfort zone according to ISO 7730

Comfort zone according to ASHRAE 55-1992

- Thermal comfort is defined as that condition of mind which expresses satisfaction with the thermal environment.

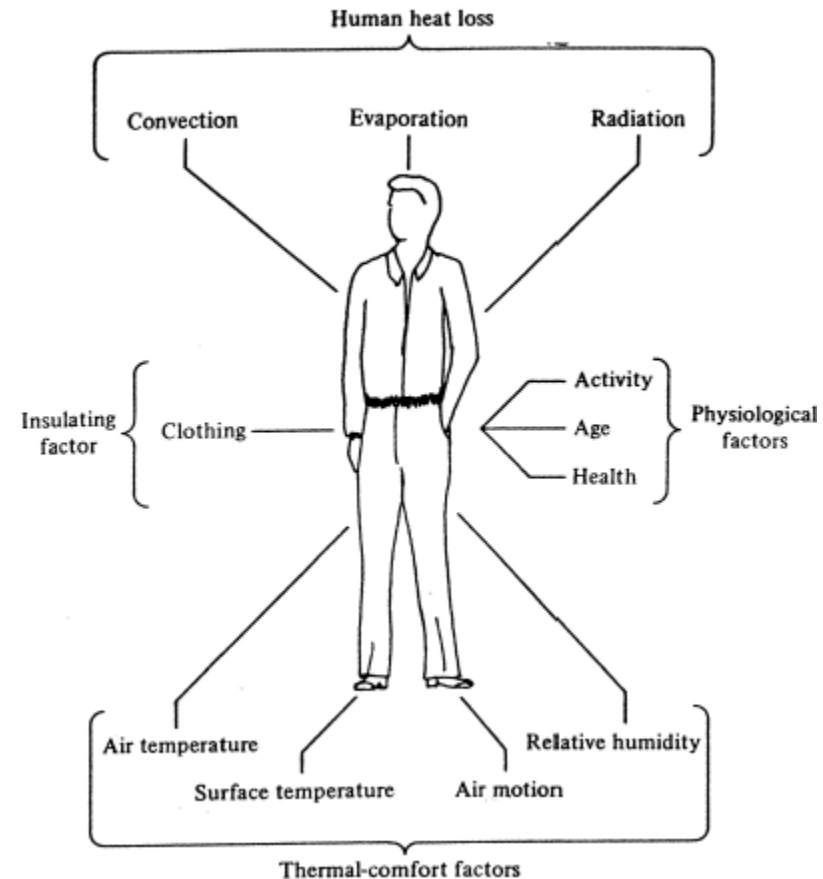


# Typical Climate Condition

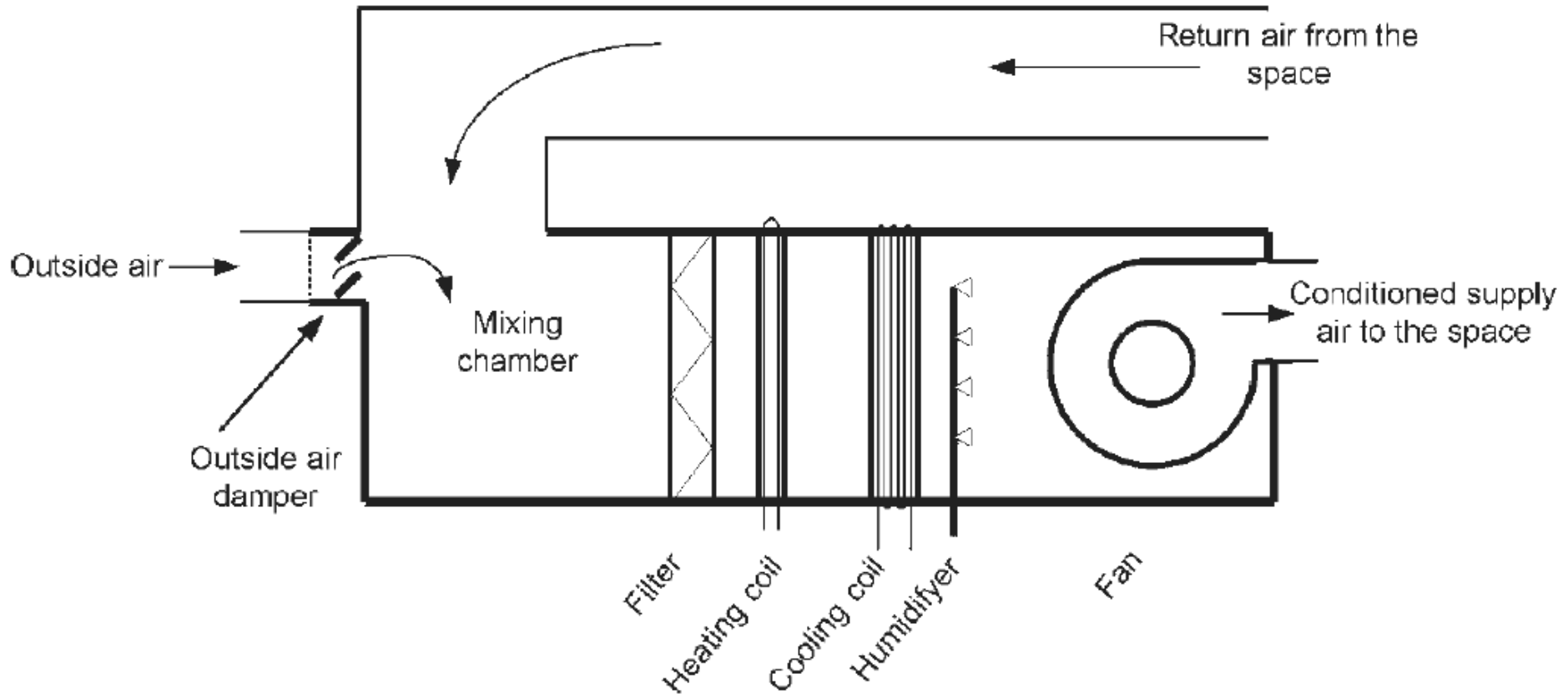


# Factors Affecting Thermal Comfort

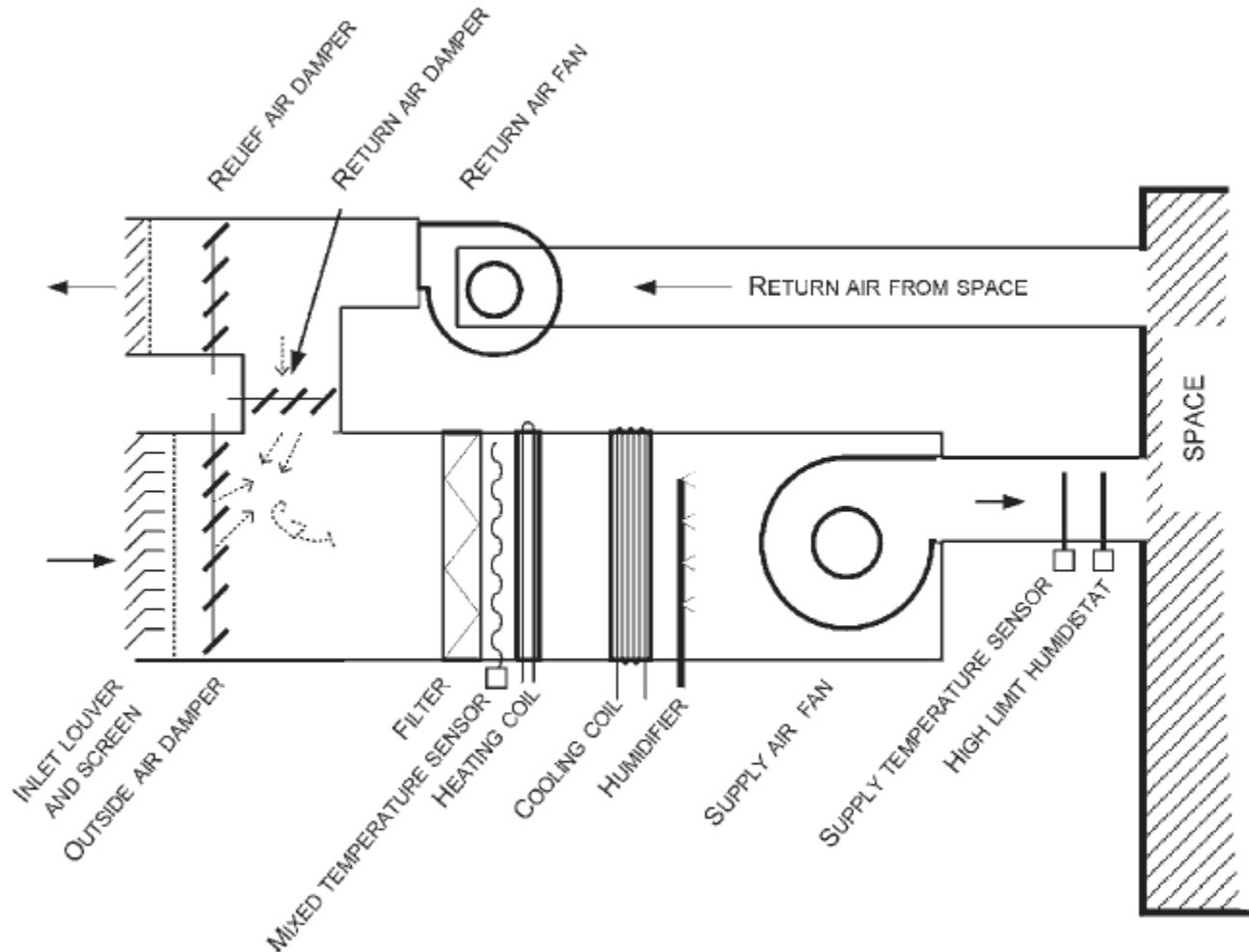
1. Activity level
2. Clothing
3. Expectation
4. Air temperature
5. Radiant temperature
6. Humidity
7. Air speed



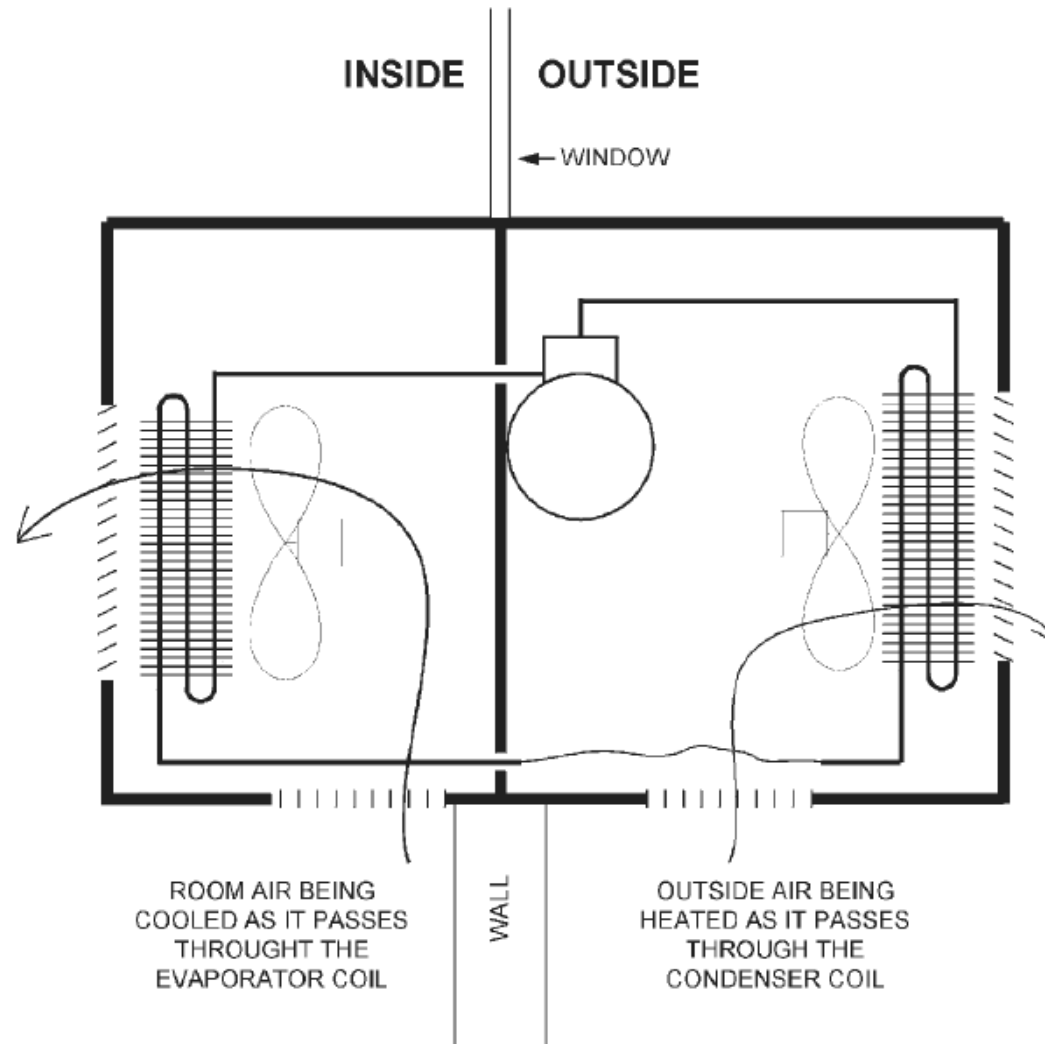
# Basic Air Conditioning System



# Air Handling Unit



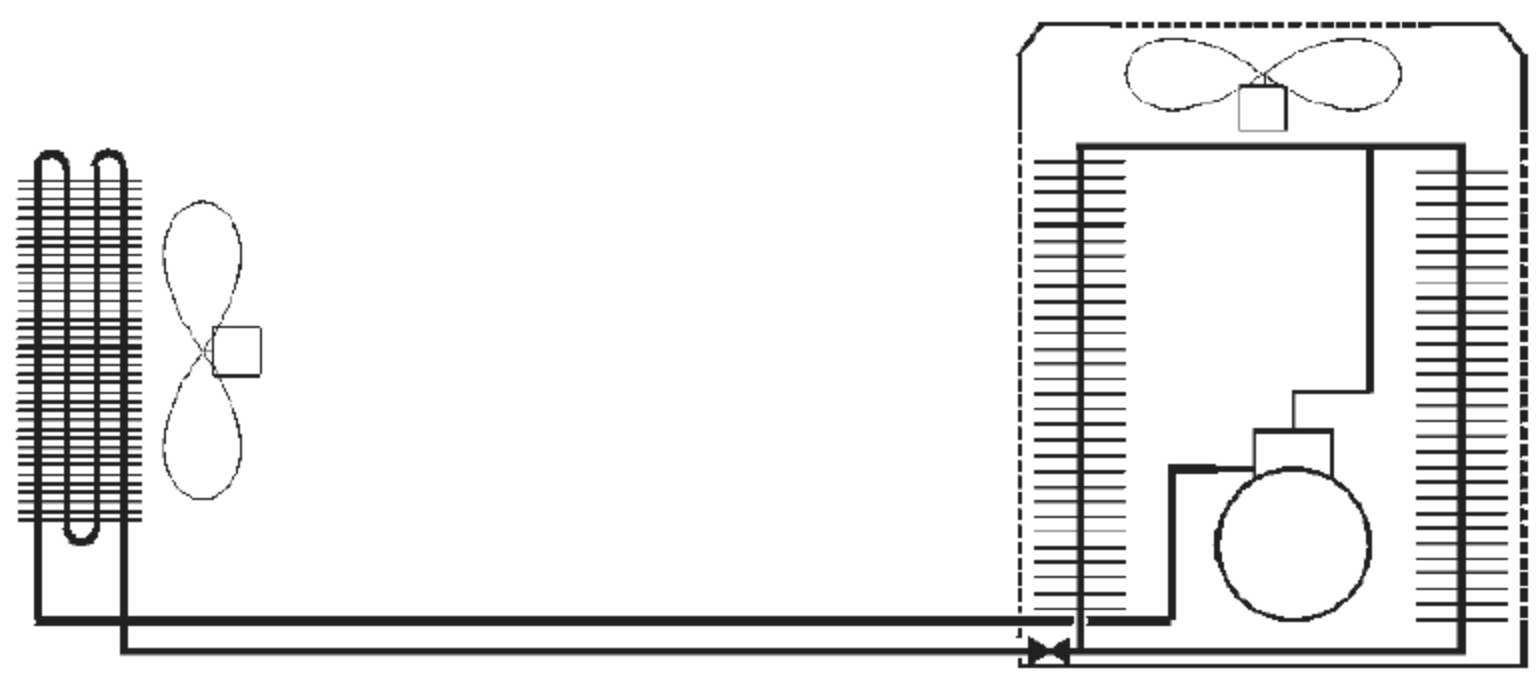
# Window Type Air Conditioner



# Split System

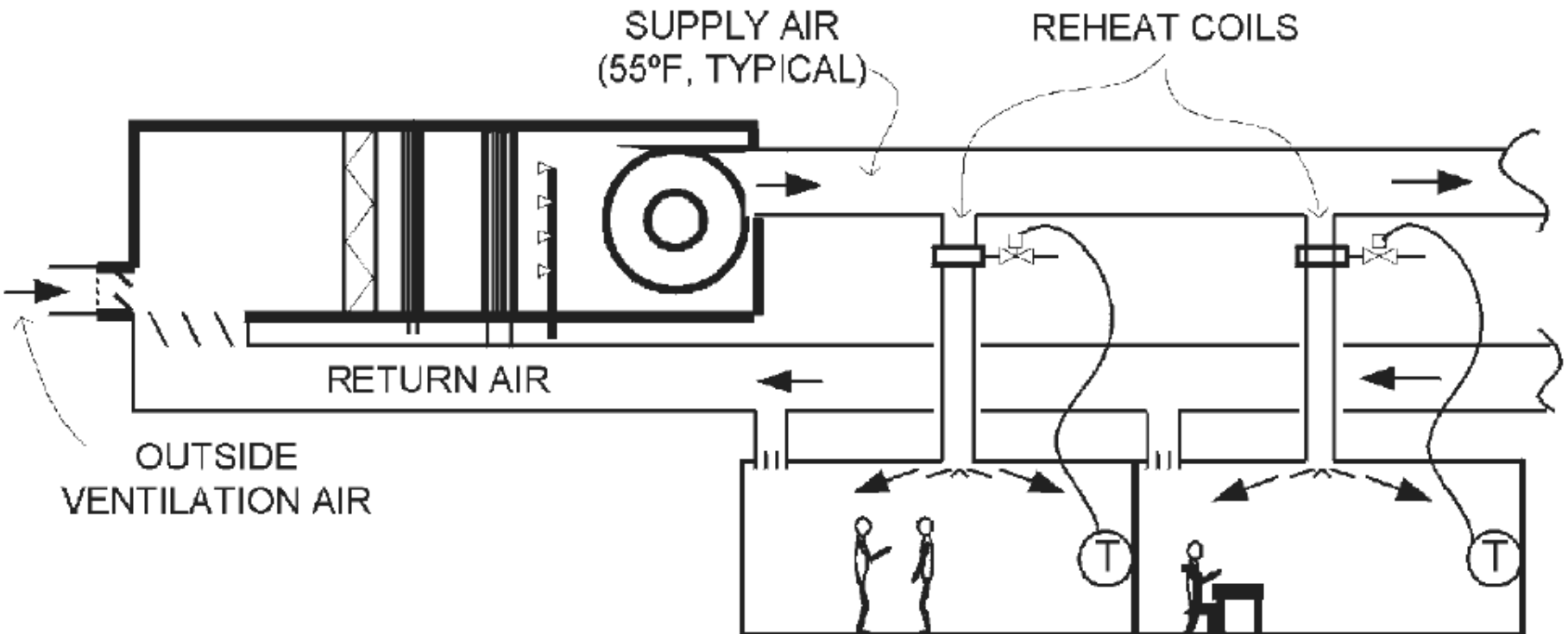
INSIDE

OUTSIDE

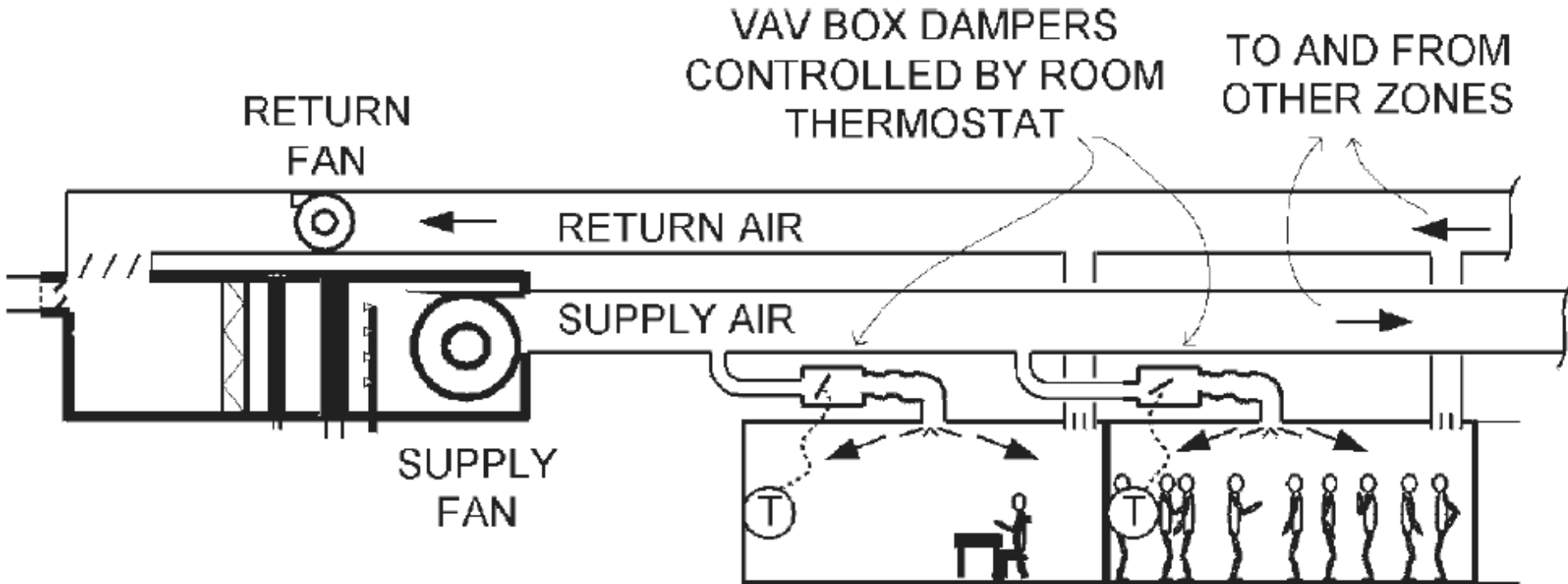


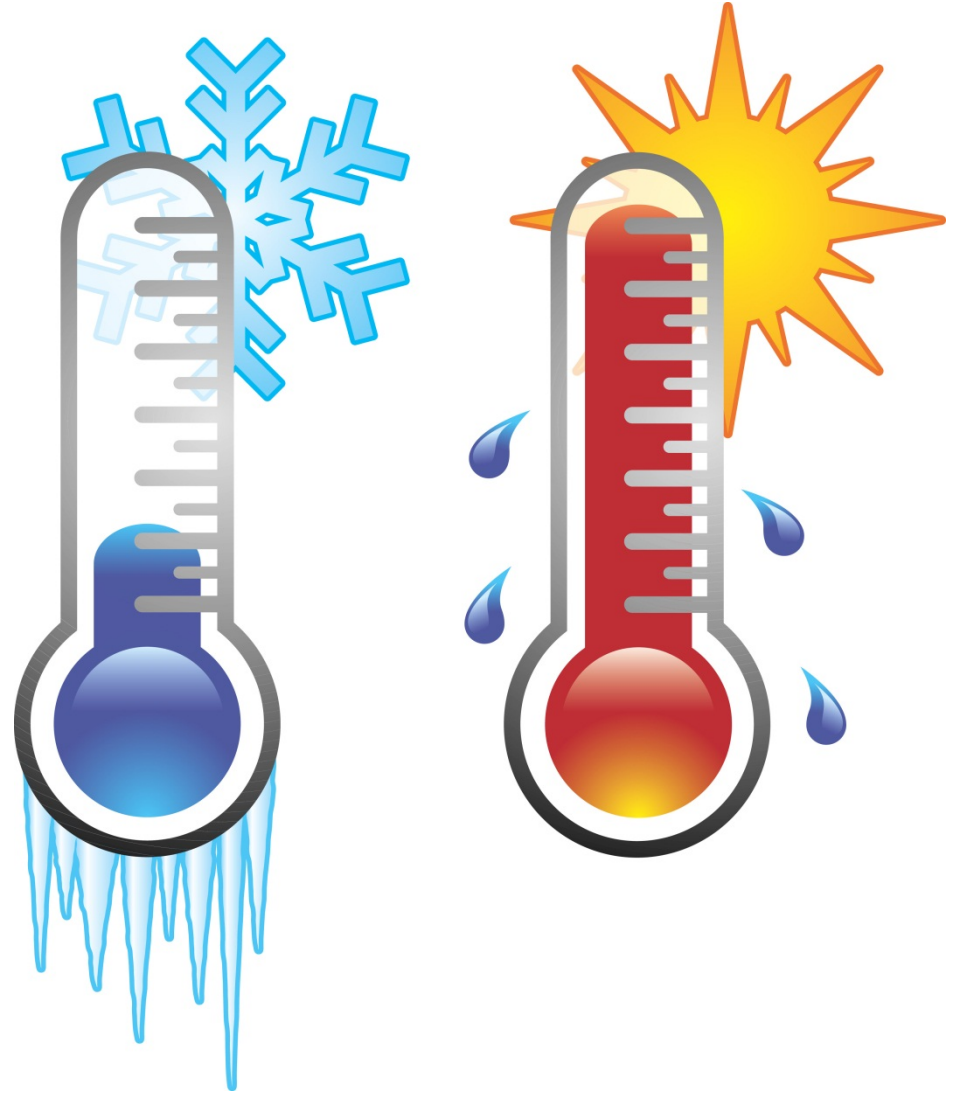


# All Air System with Reheat



# All Air System with Variable Air Volume





**THANK YOU**

