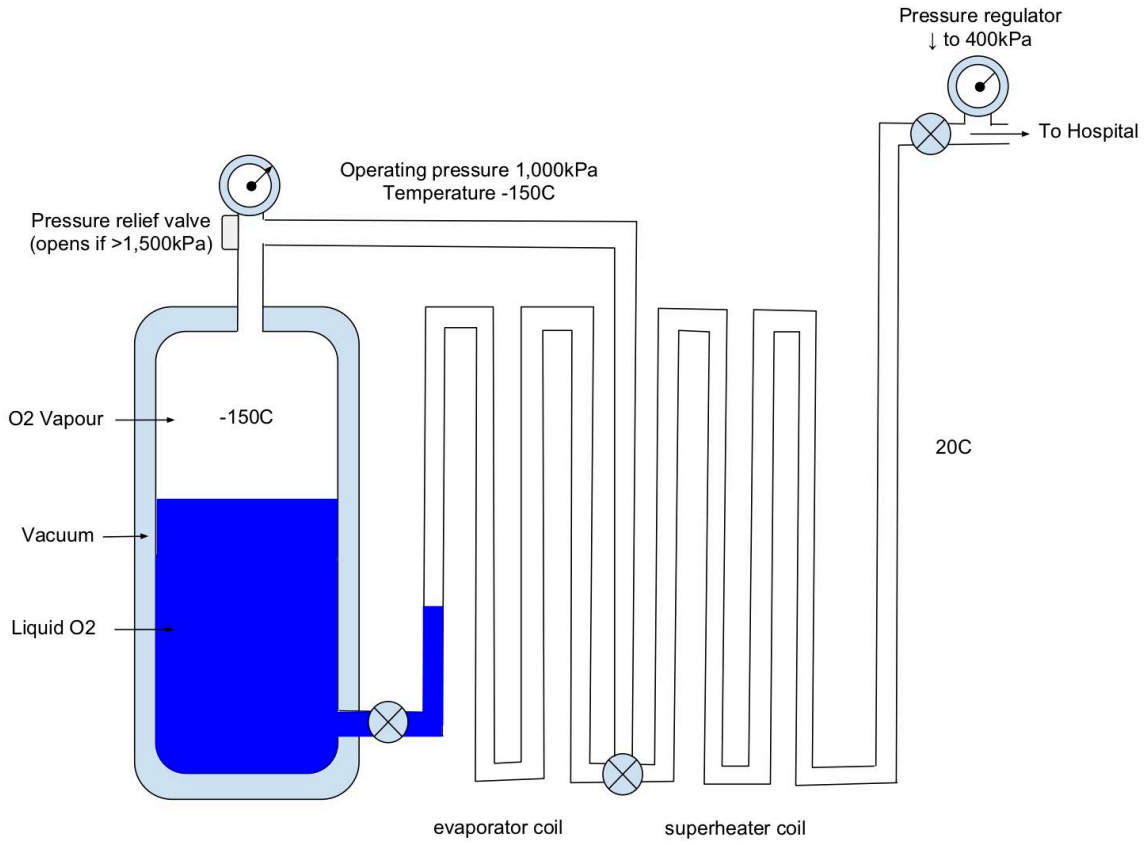
2016B08 Pass Rate: 47%

Describe how the oxygen Vacuum Insulated Evaporator works.

- At most hospitals, the main storage system for oxygen is a vacuum insulated evaporator (VIE)
- VIEs are a storage system for liquid oxygen
- Critical temperature of O2 is -119C, hence O2 must be stored below this temperature to maintain a liquid state
- VIEs maintain an internal temperature of -150 to -180C
- They are NOT actively cooled, instead rely on insulation and evaporation to maintain the low temperature
    - The small amount of heat energy that enters the VIE → evaporation of liquid O2 → uses the **latent heat of vaporization** → ↓ temperature in chamber → maintain cool temperature



Components & Operation

- Vacuum insulated chamber
    - Double wall separated by a vacuum
    - Inner wall stainless steel
    - Outer wall carbon steel
    - Vacuum insulation minimises conduction and convection of heat into the chamber
- Pressure relief valve (active in **low O_2 use scenarios**)
    - Pressure in VIE is approximately 1,000kPa (the SVP of O2 at -150C)
    - If the rate of formation of gaseous O2 from evaporation > rate of O2 output to hospital pipelines → ↑ pressure build up in chamber → potential explosion risk
    - To prevent this, the pressure relief valve will vent excess O2 into the atmosphere is pressure > 1,500kPa
- Evaporator coil (active in **high O_2 use scenarios**)
    - If O2 demand is high, rapid vaporization of O2 → ↓ temperature in chamber → ↓ SVP of O2 → ↓ gaseous O2 supply→ potential for inadequate O2 flow to hospital
    - To prevent this from occurring, if a drop in chamber pressure is detected → electronically controlled valve is opened → allows liquid O2 to enter the evaporator coil
    - This is a large surface area coil of pipes that is exposed to ambient temperature → rapid vaporization of O2 to supplement the gaseous O2 supply
- Superheater coil
    - Gaseous O2 exiting directly from the chamber or from the evaporator coil is extremely cold (close to -160C) and needs to be warmed up to ambient temperature before entering the hospital pipeline
    - To achieve this, the gas exiting directly from the chamber and from the evaporator coil both pass through a second superheater coil
- Pressure Regulator
    - Before entering the hospital pipeline, the gas passes through a pressure regulator that reduces the pressure to 400kPa

Measuring O2 Content of VIE

- There are 2 methods of measuring the remaining O2 content:
- The VIE rests on a weighing tripod
    - VIE pivots on 2 legs while the 3rd leg rest on a weighing scale
    - The VIE's known tare (empty) weight is subtracted from the measured total weight to give the weight of the contained O_2
- Alternatively, by knowing
    - The difference between the vapour pressure at the top of the VIE and the pressure at the bottom of the liquid O_2 → can calculate the height of the liquid column within the chamber
    - The cross-sectional area of the VIE
    - Knowing these, one can calculate the volume of liquid O_2 contained

Advantages

- Efficient storage of volume
    - Liquid O_2 occupies 860 times less volume than gaseous O_2 at 20C
- Storage at lower pressure
    - Liquid O_2 is stored at 1,000kPa vs gas cylinder storage at 14,000kPa (which poses a much greater explosion risk)
- Cheaper to deliver and store O_2 in liquid form

Disadvantages

- Higher initial equipment setup cost compared to cylinder manifold
- If O_2 demand is not continuous, may vent and waste a significant amount of O_2
- VIE must be external to and away from hospital due to potential explosion/fire risk