**Phys-16B8** Describe how the oxygen Vacuum Insulated Evaporator works.

**Background**

Bulk oxygen supply may be stored using
- cylinder manifold system
- vacuum insulated evaporator (VIE)

VIE is more economic when requirements are high (> 300L/second or > 7 million L/year, i.e. large hospitals)

1L liquid oxygen in VIE evaporates to approx. 840L at normal temperature and pressure

**Components of VIE**

- large insulated container with double shell
  - inner shell = stainless steel
  - outer shell = carbon steel
  - space between shells = vacuum at 0.3 kPa and filled with insulating powder to minimise heat transfer
- valves
  - blow off valve – prevents excessively high pressures
  - pressure raising valve and vapouriser – prevents excessively low pressures
- pressure gauges
  - internal pressure gauge
  - differential pressure gauge – pressure difference between top and bottom → proportional to volume of liquid O₂
- system of remote alarms to indicate low contents and pressure
- heat exchanger – warms outgoing gas
- pressure regulators – reduce pressure of outgoing gas to distribution pipeline pressure (usu. ~ 400 kPa)
How VIE works

- VIE stores liquid oxygen
  - under pressure (1000 kPa)
  - at low temperature (–150°C)
- internal temp needs to be above boiling point (–183°C @ 1 atm) but below critical temp (–119°C) of O₂
- if internal temp exceeds critical temp → liquid O₂ boils → VIE explodes
- steady demand for O₂ → liquid O₂ vapourises → keeps content within VIE cool (due to latent heat of vapourisation)

Effects of fluctuations in ambient temp, pressure and oxygen demand

- low demand or high ambient temp → ↑VIE temp → ↑VIE pressure
  - when P ≥ 1500 kPa → blow off valve opens → vapourisation → cools residual content
- high demand or low ambient temp → ↓VIE temp → ↓VIE pressure
  - when P ≤ 1000 kPa → pressure raising valve opens → allows environmental heat to enter VIE → VIE temp and pressure rise

Advantages and Disadvantages

Advantages
- economic for high demand
- relatively less storage space required (for amount of O₂ stored)
- less frequent deliveries required
- less manual handling of frequent cylinder changes

Disadvantages
- potential for fires and explosions
- burns to staff from liquid oxygen
- contamination
- wastage through blowoff valve (esp. if low demand)
- wastage during delivery → considerable vapourisation (and wastage) required to cool delivery tube between tanker and VIE to below critical temp
Examiner’s Comments

A description was required, aided by a diagram where necessary. The VIE is filled with cold liquid oxygen, and stored in an insulated container under pressure at a temperature above its boiling point, but below its critical temperature. In addition to the insulation, a steady demand for oxygen keeps the liquid cool, due to the effect of latent heat of vapourisation.

A description of how a VIE functions with fluctuations in demand, temperature or pressure gained additional marks.