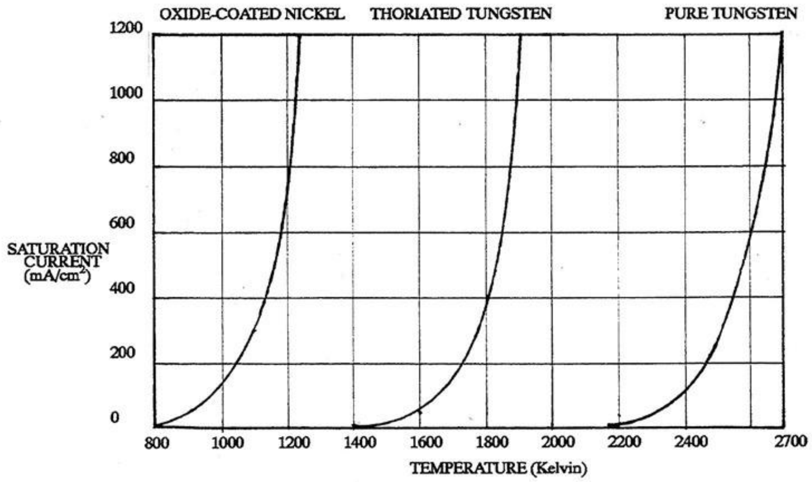


**Figure 8.4** Saturation current from three types of cathode.

The process entails heating the cathode to a temperature of between 1275K and 1475K for a time that may range from a few minutes up to an hour, depending upon the type of cathode and the temperature used. Periodically during this process, the cathode temperature is lowered to its operational level and the emission checked. Activation is completed when the required emission current has been achieved.

**Comparison of Cathodes.** Figure 8.4 shows how the saturation currents for the three types of cathode vary with temperature. The shapes of the three curves are almost identical, the only significant difference being their relative position along the temperature axis. Typical performance figures for the cathodes are given in Table 8.1 shown below.

| Type of Cathode | Operating Temp. (K) | Emission Density $mA/cm^2$ | Efficiency mA/W |
|---|---|---|---|
| Tungsten | 2500 | 250 | 3.5 |
| Thoriated Tungsten | 1875 | 1500 | 60 |
| Oxide-coated nickel (DH) | 1000<br>1200 | 100<br>1000 | 50<br>250 |
| Oxide-coated nickel (IH) | 1000 | 100 | 20 |

**Table 8.1** Properties of thermionic cathodes.

The data given for the emission density and emission efficiency are typical values and these are very temperature dependent; also, for the oxide-coated cathode, these values depend upon the composition of the oxide and the particle size.

As the electrons are emitted from the cathode and attracted towards the anode, they may strike gas molecules and dislodge electrons from their outer shell to give positive charged particles, which are then attracted towards the cathode. The velocity of these particles increases as the anode voltage is increased, and for high anode voltages, they will strike the cathode with considerable force. With the oxide-coated cathode it is necessary to restrict the anode voltage to less than about 2kV, as otherwise severe damage could be caused to the oxide coating. The thoriated tungsten cathode is more robust and the thorium layer is reasonably safe to anode voltages up to about 5kV. For voltages in excess of 5kV, it is necessary to use pure tungsten filaments.

The life of the tungsten filament is typically 1500 hours. Because of the high operating temperature, there is a constant evaporation of the tungsten and also a process of re-crystallisation, which results in brittleness. Both these factors are likely to cause fracture of the filament. Although the thoriated tungsten filament operates at a lower temperature, its life is also restricted to about 1500 hours because of evaporation of the thorium, which results in loss of emission. A further problem is that the filament is often very thin and hence liable to be fragile. Conversely the life of the oxide-coated cathode may be many thousands of hours because of its comparatively low operating temperature.