

DEMONSTRATION 6.13

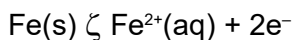
RUSTING AND CATHODIC PROTECTION

An iron nail is placed in an agar solution and within an hour the areas around the head and tip of the nail have turned blue, while the area around the body of the nail has turned pink. Another nail wrapped with a magnesium strip is placed in the agar but shows no colour change to blue.

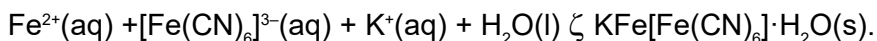
- EQUIPMENT**
- 2 iron nails
 - 2 petri dishes
 - 1 strip of magnesium
- REAGENTS**
- potassium hexacyanoferrate(III), $K_3[Fe(CN)_6]$ (1.65 g) , (0.1M)
 - phenolphthalein indicator (2 mL)
 - potassium nitrate, KNO_3 (5 g)
 - agar (1 g)
- PROCEDURE**
- Prepare a 0.1 M potassium hexacyanoferrate(III) solution by dissolving 1.65 g in 10mL.
 - Prepare the agar gel by making a mixture of 50 mL distilled water, 5 g potassium nitrate, 1 g agar, 10 mL of 0.1 M potassium hexacyanoferrate(III) and 10 drops phenolphthalein indicator.
 - Place this mixture on a steam bath until the agar dissolves (usually about 20 minutes).
 - Place some agar gel into two petri dishes.
 - In one dish place an iron nail, into the other dish place a nail with magnesium strip wrapped around it.

RESULTS

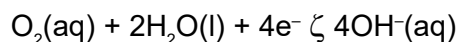
The unprotected nail, acting as both anode and cathode, will show regions of blue and pink coloration. Iron is oxidised to Fe^{2+} , which then reacts with potassium hexacyanoferrate(III) ion to give the dark blue precipitate known as *Turnbull's blue*. These blue regions appear around the head and tip of the nail. Oxidation occurs at these areas because the strained metal is more anodic (more active) than the body of the nail.



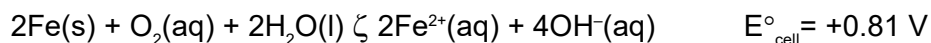
The Fe^{2+} reacts with $K_3[Fe(CN)_6]$ to produce the blue precipitate



The electrons released at the two ends of the nail migrate to the body of the nail where they are used to reduce dissolved oxygen in the gel to $OH^{-}(aq)$. The increased concentration of $OH^{-}(aq)$ causes the phenolphthalein to turn magenta.



The overall redox reaction is



The nail protected with magnesium, on which the magnesium functions as the cathode, shows no blue or black regions indicating that no corrosion of the iron nail has taken place. Here magnesium is oxidised in preference to the iron. The electrons released in the oxidation of the magnesium are again used to reduce oxygen to hydroxide which turns the phenolphthalein magenta.



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