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EXTRACTION OF IRON

⇒ **Raw materials**; Ore (Haematite), Limestone, Coke.

⇒ **Process of production;**

The raw materials, ie haematite, limestone and coke are fed into a blast furnace. (V)

Bottom part of furnace

Stage 1; Oxidation of Coke. (oxidises)

Hot air from the bottom reacts with Coke forming Carbon dioxide gas

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$$

middle part of furnace

Stage 2; Reduction of Carbon dioxide

Carbon dioxide reacts with excess coke forming Carbon monoxide

$$C_{(s)} + CO_{2(g)} \longrightarrow 2CO_{(g)}$$

(Cp)

Stage 3; Reduction of Iron(III) oxide (Haematite)

(Cd) Carbon monoxide reduces haematite to molten iron and carbon dioxide

$$3CO_{(g)} + Fe_2O_{3(s)} \longrightarrow 2Fe_{(l)} + 3CO_{2(g)}$$

Role of Limestone

Calcium Carbonate decomposes to Calcium oxide and Carbon dioxide. The Calcium oxide reacts with Silicon dioxide and aluminium oxide impurities forming Calcium silicate and Calcium aluminate that are tapped off.

(Pr) **Purification;** Pure Iron (Wrought iron) is obtained by passing air through molten iron to remove non-metal impurities.

⇒ **Side effects + Mitigation**

- Poisonous fumes — Proper use of PPE
- ~~Excessive~~ noise from the plant — PPE
- Too much heat from furnance to workers
- Chemical spills. eg molten slag.

⇒ **Social benefits.**

EXTRACTION OF ZINC

⇒ **Raw materials;** Ore (zinc blende), Coke

⇒ **Process of production;**

Concentration of the ore by froth flotation.

The ore is crushed into powder and mixed with water containing a frothing agent such as palm oil in a tank/container.

Compressed air is blown through the mixture to aggitate it, making air bubbles rise to the surface with froth. The impurities sink at the bottom since they are wetted by water and ore float on surface since they are wetted by oil.

The froth is skimmed off, and dilute sulphuric acid is added to it to break the froth. It is filtered off and dried.

Roasting

The dried ore is roasted to obtain zinc oxide and sulphur dioxide

$$2ZnS_{(s)} + 3O_{2(g)} \rightarrow 2ZnO_{(s)} + 2SO_{2(g)}$$

Reduction; Zinc oxide is reduced by heating with coke in a blast furnace, to form zinc vapour.

$$ZnO_{(s)} + C_{(s)} \rightarrow Zn_{(g)} + CO_{(g)}$$

The zinc vapour distils off from the furnance, cooled by a spray of molten lead

Purification; This is by Redistillation.

⇒ **Side effects and Mitigation** — Proper use of PPE

- Poisonous fumes that are toxic to man leading to death.
- Excessive heat and noise from rotating cylinders — Proper use of PPE

⇒ **Social benefits**

- Employment opportunity to the residents hence improving their standard of living.
- Source of government revenue to improve infrastructure in the region.

Product formed is used in manufacture of alloys such as Brass that are ornaments

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EXTRACTION OF COPPER.

⇒ **Raw materials**; Ore (copper pyrites)
Silicon dioxide

⇒ **Production process**;

① Concentrating the ore by froth flotation.
The ore is crushed and mixed with water containing a frothing agent such as palm oil in a container. Air is blown in the mixture to aggitate as ore particles go to the surface with oil while impurities sink down with water. The froth is skimmed off and dilute sulphuric acid is added to break the froth. The froth is filtered off and dried

② Roasting.
The dried ore is roasted in air in a blast furnace ✓ to form Copper(I) sulphide, Iron(II) oxide and sulphur dioxide (Cp)

$$2CuFeS_2(s) + O_2(g) \longrightarrow Cu_2S(s) + 2FeO(s) + 3SO_2(g)$$

③ Smelting
Silicon dioxide is added
The above resultant mixture is roasted in absence of air all in a furnace to remove Iron(II) oxide

④ Reduction;
The copper(I) sulphide is heated (cd) in controlled amount of air to form impure copper.

Purification; (Pr) Impure copper is purified by electrolysis using impure copper as anode and pure copper as cathode using acidified Copper(II) sulphate solution electrolyte

⇒ **Side effects and Mitigation**
- Toxic fumes from production process can lead to suffocation and death — Proper control of waste gases, use of PPEs
- Sulphur dioxide produced as a by-product reacts with water forming acidic rains that affect walls of houses

⇒ **Social benefit**
- Employment opportunity — salary — Improved standards of

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EXTRACTION OF SODIUM

⇒ **Raw materials**; - Sodium chloride (Rock salt)
- Calcium chloride.

⇒ **Production process.**

Sodium is extracted by electrolysis of molten sodium chloride using Iron as cathode and graphite as anode in a DOWN'S CELL (V)

(Cp) During the process, Calcium chloride is added to Sodium chloride to lower its melting point from 800°C to 600°C

At the Cathode; $Na^+_{(l)} + e \longrightarrow Na_{(l)}$ (Cd)

(Pr) The sodium ~~is~~ discharge is tapped off and collected into iron storage tanks containing dry nitrogen.

⇒ **Side effects and mitigation**

- Poisonous fumes that if inherited may cause death (Chlorine by-products) — Proper use of PPE
- Burns caused ~~with~~ by contact with hot surfaces on ~~furnace~~ Down cell. — Proper use of PPE

⇒ **Social benefits**

- Employment opportunities to residents hence improving their standards of living.
- Source of revenue to government hence improving infrastr...
- Sodium produced is a coolant in nuclear weapons.

Add more points

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EXTRACTION OF ALUMINIUM.

Raw materials; Ore (Bauxite), sodium hydroxide

Process of production;

Concentrating the ore

Bauxite is ground to powder and heated to convert any Iron(II) oxide impurity present to Iron(III) oxide and also to remove water of crystallisation.

The powder is then boiled with hot concentrated sodium hydroxide solution, that dissolves the amphoteric aluminium oxide and acidic silicon dioxide in the ore forming sodium aluminate and sodium silicate respectively in a conte

(Cp) $Al_2O_{3(s)} + 2NaOH_{(aq)} \longrightarrow 2NaAlO_{2(aq)} + H_2O_{(l)}$

$SiO_{2(s)} + 2NaOH_{(aq)} \longrightarrow Na_2SiO_{3(aq)} + H_2O_{(l)}$

- The undissolved basic Iron(III) oxide and titanium(IV) oxide are filtered off
- Carbon dioxide is bubbled through the filtrate to precipitate aluminium hydro leaving silicate ions in the solution.

(Cd) - Aluminium hydroxide is washed, dried and heated strongly to produce aluminium oxide.

Electrolysis of aluminium oxide

Aluminium oxide is dissolved in molten cryolite to lower its melting point to 800°C. Electrolysis of molten aluminium oxide occurs using graphite electrodes in an Iron bath lined with graphite

(Pr)

At cathode; $Al^{3+}_{(l)} + 3e \longrightarrow Al_{(l)}$ At Anode $2O^{2-}_{(l)} \longrightarrow O_{2(g)} + 4e$

Side effects and mitigation

- Pollution from poisonous fumes — Proper use of PPEs
- Burns caused by contact with hot surfaces of chemical spills — Proper use of PPE

Social benefits.

- Employment opportunities to residents hence improved standards of living
- Source of revenue to government hence improved infrastructures