Definition of Metallurgy

Metallurgy is the Science and art of extracting metals from their ores, refining them, and creating alloys with desired properties. it involves the Study of the physical and chemical properties of Metals and their alloys.

Definition of Metal and Alloys

- Metal : A Substance that is typically hard, shiny, malleable, ductile, and good conductor of heat and electricity.
  Ex: Iron, aluminum, and copper

- Alloy

A mixture of two or more elements, where at least one is a metal. Alloys have improved properties compared to their base metals. Examples :- include steel (iron + carbon) and bronze (copper + tin).

Properties of Metals and Alloys

i. Properties of Metals

- High melting and boiling points.
- Good conductors of heat and electricity.
- Malleable and ductile
- Lustrous (shiny Surface).
- Reactive with Oxygen, acids, and Water
- tends to lose eletron to form positive ions.

ii. properties of Alloys

- Improved strength and hardness
- Enhanced resistance to corrosion and Wear.
- Tailored electrical and thermal conductivity
- Lower melting points (in Some cases).

अनुकूल

Division of Metallurgy

1. Extractive Metallurgy :

- Deals with the extraction of Metals from their ores.
- Indudes processes like roasting, Smelting, and electrolysis

2. physical Metallurgy

- focuses on the physical properties and structure of Metals and alloys.
- Helps in designing materials with desired characteristics.

3. Mechanical Metallurgy

- Studies the behaviour of Metals under Mechanical forces.
- Includes testing for strength, ductility and hardness.

4. Chemical Metallurgy.

- Concerned with the chemical behivior of Metals.
- Involves refining, corrosion resistances, and chemical treatments.

5. process Metallurgy:

- Focuses on the techniques and processes to manufacture metals and alloys for Industrial use.

Mineral Dressing Operations

Mineral dressing, also known as mineral processing or ore dressing, is the process of separating commercially valuable minerals from ore.
The operations involved in mineral dressing include:

1. Comminution: Breaking down the ore into smaller particles to release the minerals.
2. Sizing (screening): Separating particles by size to separate minerals.
3. Concentration: Separating minerals from waste rock using physical or chemical properties.
4. Dewatering: Removing excess water from the mineral concentrate.

Crushing and Grinding

Crushing and grinding are two essential operations in mineral dressing that work together to break down the ore into smaller particles.

Crushing

Crushing is the process of reducing the size of the ore particles using mechanical force.
The primary objective of crushing is to:

1. Reduce the size of the Ore particles to increase the surface area.

2. Release the minerals from the ore matrix.

Types of Crushers:

i. Jaw Crushers
ii. Gyratory Crushers
iii. Cone Crushers
iv. Impact Crushers

Grinding

Grinding is the process of Reducing the size of the ore particles using abrasion and impact. (घर्षण और प्रभाव)
The primary objective of grinding is to:

1. further reduce the size of the ore particles.

2. Increase the surface area of the minerals.

Types of grinding mills:

1. Ball mills
2. Rod ,,
3. Autogenous mills
4. Semi-autogenous mills

Combination of Crushing and Grinding

The combination of crushing and grinding is essential in mineral dressing to:

1. Release the minerals from the ore matrix.
2. Increase the surface area of the minerals
3. Improve the sepration of minrals from the waste rock.

By combining crushing and grinding, mineral dressers can achieve the desired particle size and liberation of the minerals, which is critical for efficient separation and concentration of minerals.

Concentration

Concentration refers to the process of Separating valuable minerals from the gangue (unwanted material) in an ore. Different methods are used based on the physical or chemical properties of the materials involved.
Below are the principles and methods of Magnetic Seperation, Gravity Concentration, and pneumatic classification.

1. Magnetic Separation

Magnetic Separation is based on the differences in magnetic properties of minerals. Magnetic materials are attracted by a magnet, whereas non-magnetic materials remains unaffected.

Process :-

i. The ore is crushed and passed through a magnetic Separator.

ii. Magnetic materials are attracted to the magnetic roller or drum, Separating them from the non-magnetic gangue.

2. Gravity Concentration process

Gravity concentration works on the principle of the difference in specific gravities of minerals and gangue. Heavier particles settle faster than lighter ones under the influence of gravity or water flow.

process :-

i. The Crushed ore is washed in a Stream of water or shaken on a table.

ii. Heavy minerals (concentrate) settle at the bottom, while lighter gangue flows away with the water.

3. Pneumatic classifier

pneumatic classification uses air as the medium to Separate particles based on Size, Shape, and density. Fine and lighter particles are carried away by the air, while heaviour particles settle.

process :

i. The ore is fed in to a chamber where a Streany of air blow through.

ii. particles are classified as:

- fine & light :- Carried out the air flow
- Coarse and heavy

processes:-

- The ores are fed into a chamber where a steam of air blows through.
- particles are classified as:
  - fine and light: Carried away with the airflow.
  - Coarse and heavy: Drop to the bottom due to gravity.

#. Define Sample and Sampling

Sample

In metallurgy, a Sample is a small portion of material (such as ore, metal or alloy) taken from a larger batch to test its properties, composition, or quality. It represents the characteristics of the whole batch or lot.

Ex:- A small piece of metal cut from a steel billet for chemical composition analysis.

Sampling

Sampling in metallurgy is the process of collecting and preparing a sample from a larger material batch. It ensures that the sample is representative of the entire material, enabling accurate analysis and decision-making.

Raw Materials for Iron Making

Iron Ores :-

Raw Materials

The raw material required for the production of one tons of hot metal that the required quantity are Iron Ore, coke, flux.

OLD DATA

IRON Ore :- 1.7 — 1.8 ton — 1700 - 1800 kg
Coke :- 700 - 800 kg
flux :- 400 - 500 kg

Total - 3 ton.

Iron Ores

(1) Haematite — It is also called as Raddish Ore. The maximum theoritical iron contain 70% and oxygen 30%. for pure fe_2O_3 in actual deposit iron content varies 50 - 65%. In Specific gravity is about 4.9 - 5.2. if is non - magnetic in nature and is more reducible compare to other material.

2. Magnetite :- It is called as black ore. The maximum theoritical iron contain 72% and oxygen 28% for pure Fe_3O_4 in actual deposit iron content varies 50-70%. In Specific gravity is about 4.9 - 5.2 if is magnetic in nature so if can be easily seprated from the gangue confituent. by magnetic Separation. The main disadvantage of ore is that it has very poor reductibility hence magnetic ore required to be agglomerated by Sintering or ore lump pelletizing because charging into blast furnace due to the high temprature firing Fe_3O_4 gets converted into Fe_2O_3 and hence the poor reducibility of magnetic ore is taken care of it.

3. Siderite :- It is known as Spathik iron ore, it contain 48% Fe and 42.76% oxygen, 10.3% carbon for pure $FeCO_3$ in actual deposit iron content varies in Specific gravity. is about 4.9 - 5.2 if is.

It requires calcination before charged in furnace.

$$FeCO_3 \longrightarrow FeO + CO_2$$

4. Limonite (Hydroxide Ore) :- $FeO(OH) \cdot NH_2O$
it is called as brownish yellow.

→ $FeO(OH) \cdot NH_2O$

5. pyrite (FeS_2)

6. Goethite ($FeO(OH)$)

7. ILLimenite ($FeO \cdot TiO_2$)

Classification of ore according to their colour.

- Red – Haematite
- Black – Magnetite
- Brown – Limonite
- Grey – Carbonate.

- Oxide – Haematite, Magnetite
- Hydroxide – Limonite, Goethite
- Carbonate – Siderite.
- Sulphide – pyrite.

ACCORDING TO IMPURITIES

- Siliciws :- Silica
- Aluminous :- Al_2O_3
- Argillaceous :- Clay Matal.
- Calcariow : CaO
- Bitominus : Coal Matter
- Titaniforous : TiO_2

- Reserves of iron ore in world (2020)

	Deposite of Ore in world		production of Ore in world
1.	AUSTRALIA	1.	AUSTRILIA
2.	BRAZIL	2.	BRASIL
3.	RUSSIA	3.	CHINA
4.	CHINA	4.	INDIA
5.	INDIA	5.	RUSSIA.

	Reserves of Iron Ore in India		Reserves of iron Ore in INDIA.
1.	ODISHA	1.	NOUMUNDI (odisha Border)
2.	JHARKHAND	2.	KIRIBURU (Singhbhum - Simdega)
3.	KARNATAKA	3.	MANOHARPUR (W. Singhbhum)
4.	CHATTISGARH	4.	JHIKPANI
5.	GUJRAT	5.	

Q. What are the main iron ore deposited in India?
Ans:- Main Iron Ore deposits are in Singhbhum district Mayurbhong, kiriburu, Meghtaburu etc.

Coke Making

1. Coal :- It is a Combustibe black ork or dark brown mineral formed by slow decomposition of vegitation mater like plant, animan under high temprature.

It is the result of the biological and geological factors acting in Sequence on accumulated vegitation of plant life in given area.

Trick ↓
एविलिपि
ए - एंथ्रासाइट - 95%
वि - बिटुमि नस - 80-85%
लि - लिग्नाइट - 50-65%
पि - पिट - ↓40%

- Stages of Coal formation

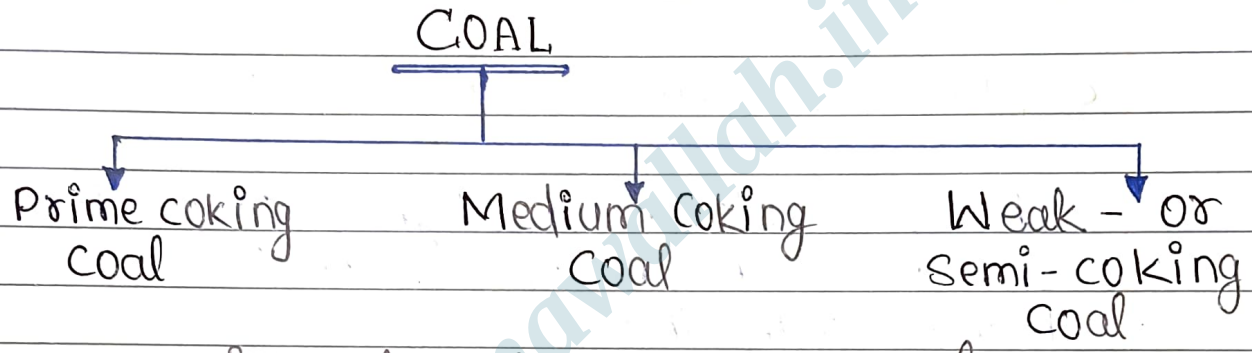
Types OF COAL		PERCENTAGE OF C
P	PEAT	Less than 40%
L	LIGNITE	50 - 65%
B	BITUMINOUS	80 - 85%
A	ANTHRACITE	95%

Coking Coal :- produce metallurgical coke on Carbonization used in B.F

NON - Coking Coal :- Does Not produce Metallurgical coke on Carbonization used in power plant.

METALLURGICAL COKE:- FOR Metallurgical purpose only good, porus, hard and compact coke are considered which can be obtained from coking coal.

- According to Indian category of Coal.



- Properties of prime coking coal.

i. Volatile mater ⟶ 25 - 30%
ii. fixed Carbon ⟶ 88 - 90%
iii. Hydrogen ⟶ 4.9 - 5.2%
iv. Caking Index ⟶ 20 - 27%
v. Swelling Index ⟶ >3 (greter than three)
vi. Calorific Value ⟶ 8500 kcal/kg.
vii. Ro Value ⟶ 1.1 - 1.4.

ii. Medium Coking Coal:- Coal which are slightly inferior to prime coking coals in their coking properties and which needs (10-30%) prime coals to be used for production of satisfactory metallurgical coke are called coke.

- property of Medium Coking Coal.

i. Volatile mater. → 32 - 35%
ii. fixed carbon → 86 - 88%
iii. Hydrogen gas → 5.1 - 5.4%
iv. Calorific Value → 8500 - 8700 kcal/kg.
v. Ro Value → 0.85 - 0.95
vi. Swelling Index → Around 2.

- Weak or Semi-Coking Coal :-

These coake needs higher proportion of suitable machining coals to be blend with them to produce satisfactory metallurgical coke are called as weak or semi-coking coal.

- properties of Weak or Semi-coking coal.

i. Volatile mater → 33 - 34%
ii. fixed carbon → 83 - 85%
iii. Hydrogen gas → 5.4 - 5.8%
iv. Calorific Value → 8200 - 8500 kcal/kg.
v. Reflectance (Ro) value → 0.75 - 0.85

FLUX

FLUX refers to a Substance that is added to a Metal or an ore in order to promote a chemical Reaction. Remove impurites or improve the physical properties of the Metal.

Flux can be categorised into two main types: acidic and basic.

Acidic flux- (Silica(SiO_2)

- it helps to remove impurities from the iron ore, improving its quality and reducing the amount of waste generated during the process.
- It also helps to reduce energy consumption by lowering the melting point of the Impurities.

Basic Flux

Limestone and dolomite are the Basic flux. These are added to the furnace along with Iron Ore and fuel, and they Reacts with Impurites in the Ore to form slag.

1. Limestone

Limestone is the most common used basic flux in the ferrous extraction process. It is a Sedimentary rock composed mainly of Calcium carbonate ($CaCO_3$). When Heated, limestone decomposes to form calcium oxide (CaO), which reacts with acidic impurites In the iron ore to form Slag.

2. Dolomite

Dolomite is a double carbonate of Calcium and magnecium ($CaMg(CO_3)_2$). It is also used as a basic flux in the ferrous extraction process. When heated dolomite decomposes To form calcium oxide (CaO) and magnesium oxide (MgO), both of which are efficitive at Netralizing acidic impwrities in the Iron Ore.

(RMHS)

Raw material storage and handling System.

The raw Material storage and handling System is a critical component, ensuring a continuous and efficient Supply of the required materials to the iron-making process.
This System is desined to Store, transport, and manage the raw materials Such as iron ore, coke, and flux (limestone or dolomite).

Key points to Remember:-

i. The System keeps materials Safe, dry, and ready to use.

ii. it makes Sure the right amounts are Sent to the furnace.

iii. Dust Control and Safety measures are used to protect workers and the environment.

iv. Automation (using Machines) Makes the System Faster more efficient.

(Automation, Handling System में आता है, जिससे वजह से आसानी से काम कर सकते है)

Comminution :-

Def:-

- Comminution refers Specially to the process of reducing the size of ore in to Smaller particles through Crushing and grinding.

pur:-

- it prepares the ore for further processing by making it easier to extract the desire Mineral.

Ex:- Using Jaw crusher, cone crusher, or ball mill.

Beneficiation:-

Beneficiation is a broader process that includes communition as one step. it involves various techniques to improve the quality of the Ore by removing impurities (like - Silica, alumina, etc).
Ex:- Magnetic Separation, F. floatation, g. Separation.

Key differences.

- Comminution focuses only on Size reduction, while benificiation aims to improve the Overall quality of the ore.

- Communition ~~foe~~ is a part of benificiation include communition and other Steps like concentration, dewatering and tailings disposals

• Agglomeration.

Agglomeration is the process of conversion of iron ore fines (powder) in the suitable size for the B.F used feed for proper, smooth and efficient running of BF.

The process agglomeration can be classified as follows:-

i. Brequeting.
ii. Nodulising.
iii. Sinter
iv. pelleting.
v. Vaccume extrusion.

Noduliging:-

Noduliging is the process of Sintering. It does not need a binder agent. The Iron ore concentrate is mixed with carbon, and fed in to a rotary kiln, where the material is turbled at high temprature to form modules.

- Sintering :- Sintering is the process of agglomeration of iron ore fines (powder) of size (-10 mm to 100 mesh) in to a lumpy porous by the heat regnerating with in the mass itself in the pre-Sence of coke breeze.

principele of Sintering.

Iron Ore Sintering is carried out by putting green mix after miking and moduliging in up drum over up traveling grate inform of permeable bed.

The Top layer of Sinter bed is heated to the Sintering temprature 1200°c – 1300°c by a gas or oil burner ignition hood after that the air is drawn downward through the grate with the help of exhaust blower connected from underneath to grate.

The narrow combustion zone develop initially at the top layer travels through the bed layer by layer to the Sintering level.

The cold blast drawn through the bed cools the already Sintered layer and thereby gets itself heated.

The heat Content in the blast furnace is utilized in drying and preheating heating the lower layer in the bed. In Advance of Combustion therefore each layer gets driect and preheated by the heat transfer from the upper combaston zone much of the heat is the gasses is observe by the lower portion of the bed. In the combution zone bonding takes place between the grains and a Strong and porous mass is formed. The process is over when the combustion has reached the lowest Layer of the bed at the discharge end the fully Sintered cake is then broken, screened and cooled to the produce desired fraction.

The under Size is recycled the over Size is fully cooled and send to the blast furnace the Process described above is known as down draft Sintering.

Since the air blast is drawn through the Sinter bed downward.