

# Metals and Nonmetals Overview



## Comparison Table: Calcination vs. Smelting

Feature	Calcination	Smelting
<b>Definition</b>	Thermal decomposition of a substance in the absence or limited supply of air.	Extraction of metal from its ore by heating and reducing in the presence of a reducing agent.
<b>Primary Purpose</b>	To remove volatile substances, decompose carbonates, and bring about phase transitions.	To extract pure metal from its ore by reducing metal oxides.
<b>Process</b>	- Ore is heated in the absence or limited supply of air.   - No reduction agent is used.	- Ore is heated in the presence of a reducing agent (e.g., carbon).   - Flux is used to remove impurities.
<b>Key Reactions</b>	- Decomposition of carbonates: $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$   - Removal of water from hydrated ores: $\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O} \rightarrow \text{Fe}_2\text{O}_3 + 3\text{H}_2\text{O}$	- Reduction of oxides: $\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO}$   - Formation of slag: $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$
<b>Materials Treated</b>	- Carbonate ores   - Hydrated ores   - Other materials requiring thermal decomposition	- Metal oxides   - Sulfide ores (after roasting)
<b>Temperature</b>	High temperature but below the melting point of the ore.	High temperature, often close to or above the melting point of the metal.
<b>Air/Oxygen Supply</b>	Limited or no supply of air/oxygen.	Usually in the presence of air/oxygen and a reducing agent.
<b>Reducing Agent</b>	Not used in calcination.	Used (e.g., carbon, carbon monoxide).
<b>Flux Usage</b>	Generally not used.	Used to form slag and remove impurities.
<b>Examples</b>	- <b>Calcination of Limestone:</b> $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$   - <b>Calcination of Bauxite:</b> $\text{Al}(\text{OH})_3 \rightarrow \text{Al}_2\text{O}_3 + 3\text{H}_2\text{O}$	- <b>Iron Extraction:</b> $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$   - <b>Copper Extraction:</b> $2\text{CuFeS}_2 + \text{O}_2 \rightarrow \text{Cu}_2\text{S} + 2\text{FeS} + \text{SO}_2$
<b>Applications</b>	- Production of lime from limestone.   - Preparation of anhydrous substances.   - Phase transitions in materials.	- Extraction of metals like iron, copper, lead, and zinc.   - Industrial metal production.
<b>Environmental Impact</b>	Relatively lower as it does not involve reducing agents that produce large amounts of gases.	Higher due to the production of gases like CO and CO <sub>2</sub> and potential air pollution.

## Summary

Both calcination and smelting are essential processes in metallurgy, but they serve different purposes and involve different procedures. Calcination is primarily used for decomposing carbonates and removing water from hydrated ores, while smelting is used for extracting pure metals from their ores by reducing metal oxides. The choice between these methods depends on the type of ore and the desired outcome.