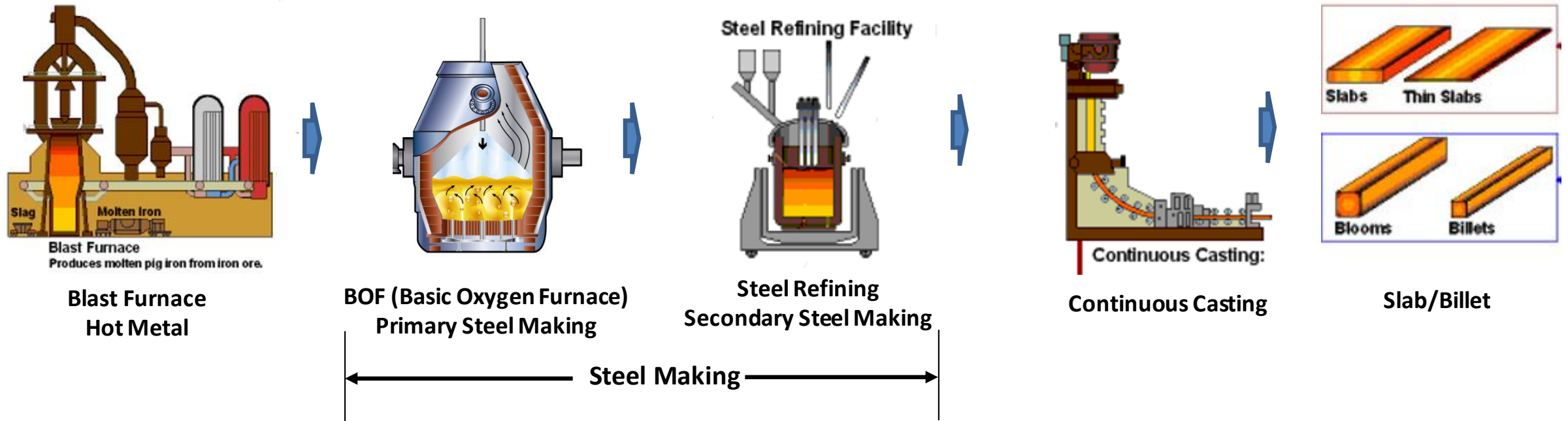




Steel Making

Presented By
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Head Steel Making & Through process
Product Technology Group

1	EAF Vs BOF Steel Making	slide: 3 – 4
2	Tats Steel Jamshedpur Steel Making Facilities	slide: 5
3	Primary Steel Making <ul style="list-style-type: none">○ Hot Metal De-Sulphurization○ Basic Oxygen Furnace (BOF)○ Online Purging	slide: 6
4	Secondary Steel Making <ul style="list-style-type: none">○ RH Degasser○ CASOB○ Ladle Furnace	slide: 7
5	Clean Steel Making & Various Steel Grades: Challenges	slide: 8 – 9



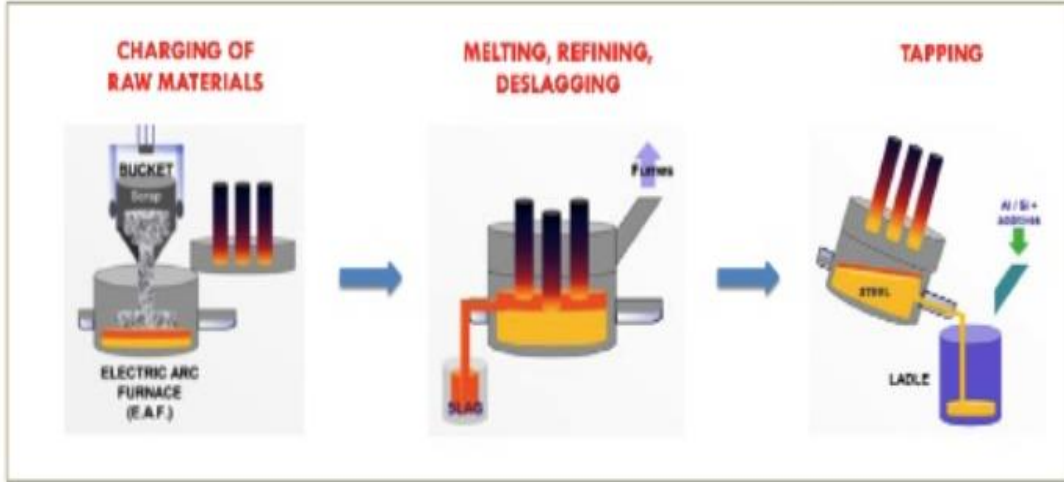
Primary Steel Making:

- Carbon Removal
- Mn removal
- Silicon Removal
- Sulphur removal
- Phosphorous removal

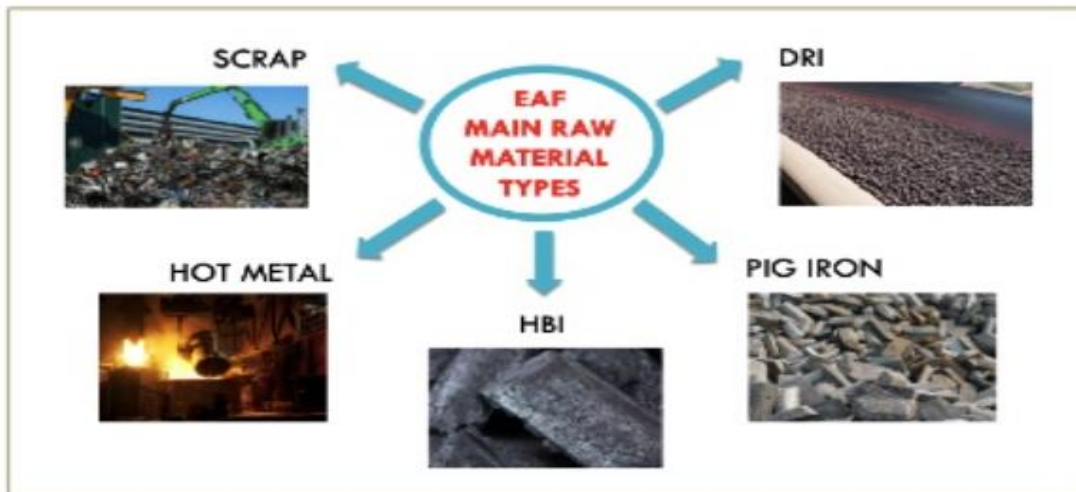
Secondary Steel Making:

- Steel refining
- Micro alloy addition
- Sulphur removal
- Ultra Low 'C' Steel making
- Inclusion Control
- Temperature Control

Processing Route for EAF Steel Making:



Raw Materials for EAF Steel Making



- EAF is generally used to make carbon steels and alloy steels primarily by recycling ferrous scraps
- Worldwide, scrap covers 75% of the raw material for EAF, while DRI & HBI covers 15% and balance 10% by hot metal
- Scrap: depends on grade of steel and sort of charge scrap available commercially in the market
 - Content of alloying elements
 - Content of harmful elements (S, P, Zn)
- DRI: Product of direct reduction of iron ore in the solid state
- HBI: Premium form of DRI that has been compacted at a temperature $>650^{\circ}\text{C}$

LD1 & Wire rod mill- Process Overview



LD1: Long Product

LD2 & Slab Caster - Process Overview



LD2 SC: Flat Product

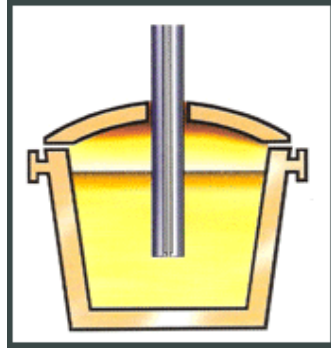
LD3 & Thin Slab Caster and Rolling (TSCR)- Process Overview



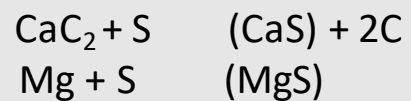
LD3 TSCR: Flat product

Primary Steel Making

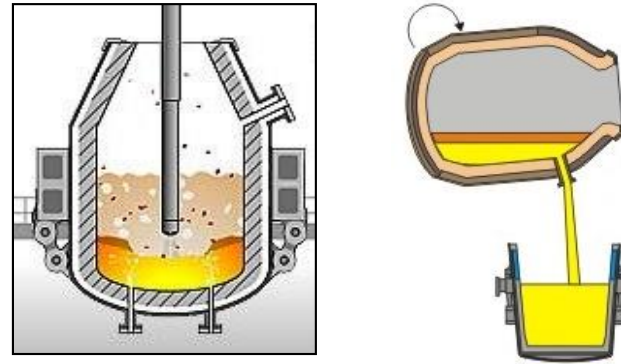
HM Desulphurization



- Pre-treatment of hot metal
- Requires bath agitation
- Removal of Sulphur from Hot metal
- DeS by injecting CaC_2 & Mg:
- Additions:

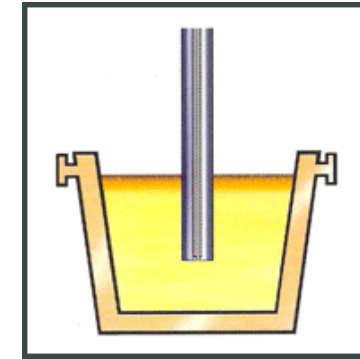


Basic Oxygen Furnace



- Oxygen blowing
- Removal of C, Si & P
- Tapping: Ferro alloy additions to achieve design chemistry for strength and properties
- Additions:
CPC/GPC
Mn met/HCFeMn/MCFeMn
Al/FeSi: for deoxidation

Online Purging



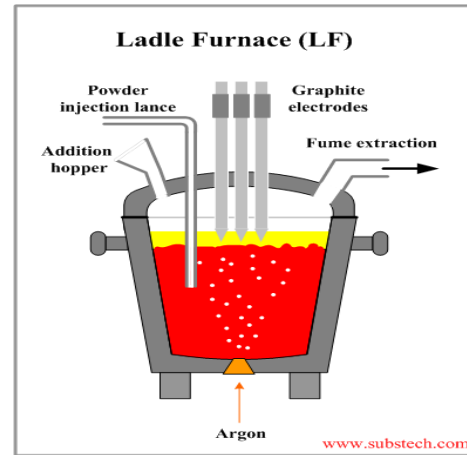
- Homogenization of steel with respect to chemistry as per additions
- Argon (inert) gas is used for homogenization
- Alloying as per requirement
- Oxygen and Temperature measurement before sending to Caster (for Direct heats) and Secondary Steel Processing Unit (RH/LF/CASOB)

RH Degasser



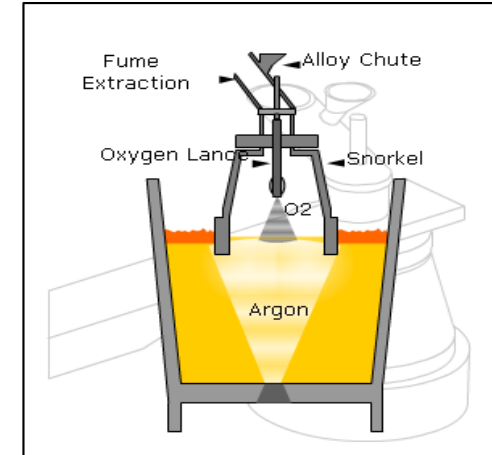
- Vacuum Degassing (≤ 1 mbar) to make Ultra low carbon steel
- Argon injection to lift the steel
- Flootation and removal of inclusion
- Micro-alloy addition
- Oxygen blowing for temperature rise
- MFB: heating of vessel/O₂ blow

Ladle Furnace



- Electrode for arcing to raise temperature
- Desulphurization of steel by slag making
- Flootation and removal of inclusion
- Ca treatment: inclusion modification
- Homogenization of steel with respect to composition by Ar purging

CASOB



- For heating, Al to O₂ ratio as per stoichiometric calculation
- Allows alloy additions to be made under an inert argon environment
- Slag Killing for reducing (Fe+MnO)
- Ripple purging: inclusion floatation
- Ca treatment for inclusion modification

Clean Steel Practice at BOF

Desulphurization of Hot Metal:

- Initial & Final raking to ensure no S reversal from slag
- Low Re-blow: To avoid N pick up
- Dart Use: Ensure no slag carry over
- IR Camera: Slag detection during tapping to avoid slag carry over
- No pooled iron: For S control, clean scrap is used
- Bottom purging with Inert gas (Ar) for homogenization

Clean Steel Practice at RH/LF

Ladle Furnace:

- Slag refining practice
- Flotation and removal of inclusion by metal stirring, ripple purging etc.
- Ca Treatment: Inclusion modification
- Micro alloying and finer adjustment of composition

RH Degasser:

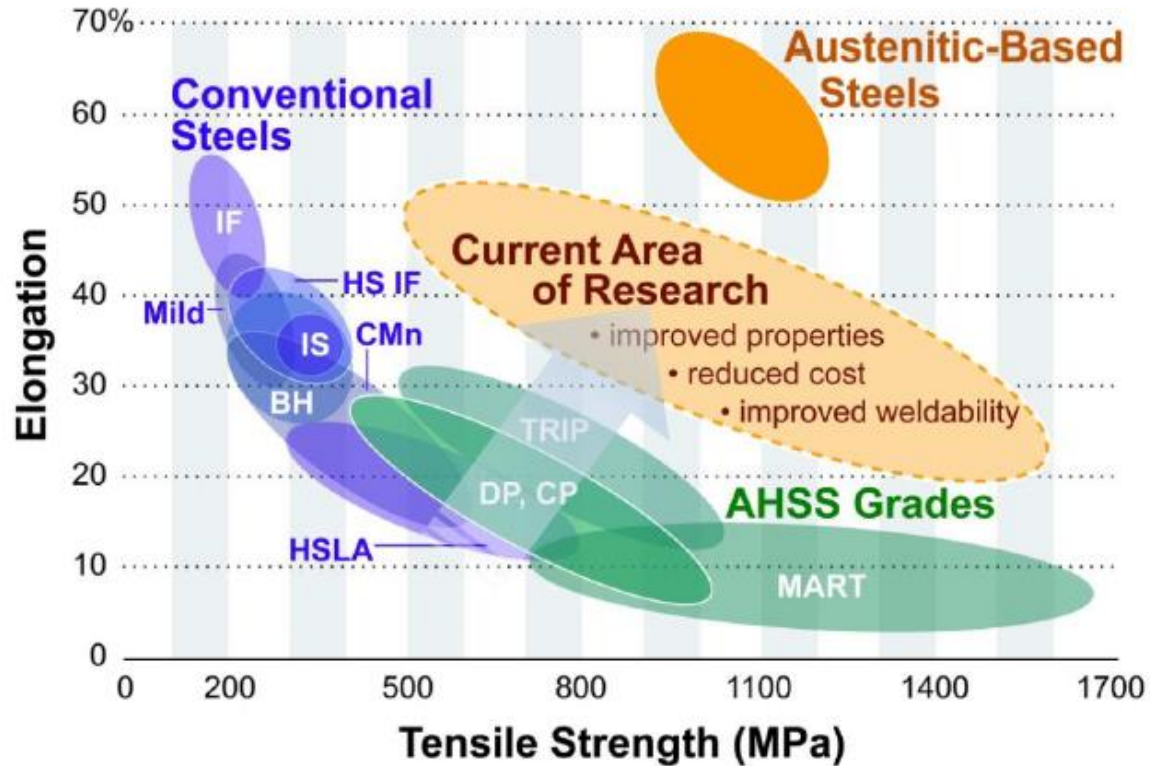
- Ultra Low 'C' steels
- Inclusion floatation by process control e.g. bottom purging, sequence of alloying, float time etc.

Clean Steel Practice at Caster

Caster:

- Vertical mould for Improved floatation of Inclusions and gas Bubbles
- Flow Control mold to optimize quality and speed of caster
- Ladle slag detection
- N₂ Control: Shroud, SEN & Tundish Covering
- Tundish furniture (dams/weirs) for flow direction and turbulence reduction
- Basic flux: to capture inclusion

Research on Automotive Steel Sheet



* DP (Dual Phase), TRIP (Transformation Induced Plasticity),
 XF (eXtra Formable) steel, TWIP (TWinning Induced Plasticity),
 CP (Complex Phase), Mart (Martensitic) Steel, FB (Ferrite and Bainite)

- Demand is increasing for high strength and highly formable and weldable steel at lower cost
- Such steels require very high level of alloying and special casting conditions which are a big challenge Steelmaking & Casting operations respectively

Thank You