SECONDARY STEEL MAKING

PROCESS METALLURGY

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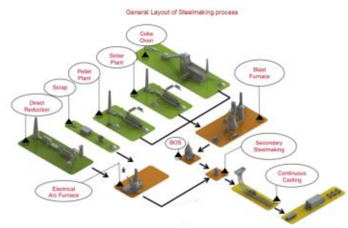
What is the secondary steelmaking?



GENERAL OVERVIEW

- Secondary steelmaking is a step between steel production and primary processes.

REACTIONS TAKES PLACE IN SECONDARY STEELMAKING

1. de-oxidation ,
2. vacuum degassing,
3. alloy addition,
4. inclusion removal,
5. inclusion chemistry modification,
6. de-sulphurisation
7. homogenisation

SECONDARY STEELMAKING

- STIRRING
- LADLE ARC FURNACE
- LADLE INJECTION
- DEGASSING
- CAS-OB

STIRRING

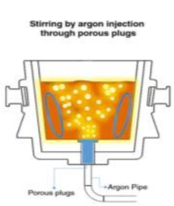
Ladle stirring is an essential operation during secondary steelmaking in order to:

- homogenize bath **composition**;
- homogenize bath **temperature**;
- facilitate **slag-metal interactions** essential for processes such as desulfurization;
- accelerate the **removal of inclusions** in the steel

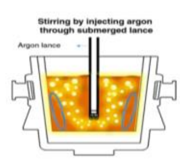
In practice, stirring is achieved by:

- **Argon bubbling** through the liquid steel, either via a submerged lance, or by porous plugs in the bottom of the ladle;
- **Electromagnetic Stirring** - EMS

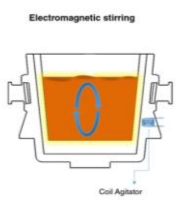
TOP LANCE INJECTION OF ARGON



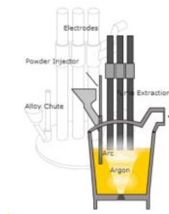
BASAL INJECTION OF ARGON



ELECTROMAGNETIC STIRRING (EMS)

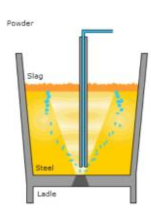


LADLE ARC FURNACE



- Purpose of ladle arc furnace is heat to steel
- Elelectrods
- Alloy Chute
- Cooling parts
- Fume extraction

LADLE INJECTION



- The aim of powder injection in ladle furnace is to reduce sulphur content in molten steel

Why it is necessary?

DEGASSING

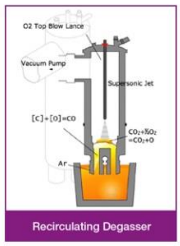
1. Tank Degasser

- Used mainly to remove sulfur and other impurities
- This is achieved through slag – metal reacitons and favored by the argon bubbling in a vacuum chamber

DEGASSING

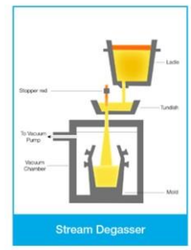
- **2. Recirculating Degasser :**

- Used mostly to assist decarburization.
- Argon is injected through one and forces the steel to circulate out through the other snorkel.

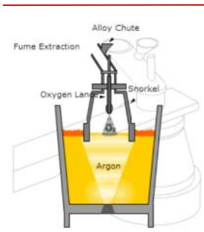


DEGASSING

- **3. Stream Degasser :**
  - Used mainly to remove hydrogen content
  - Molten steel is poured into another vessel which is under vacuum
  - Degasssing occur during the fall of molten stream



CAS-OB (Composition Adjustment by Sealed Argon Bubbling - Oxygen Blowing)



Allows

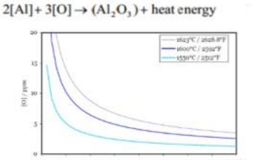
- Alloy additions
- The simultaneous addition

❖Used for chemical reheating

SCIENTIFIC BACKGROUND

- Deoxidation

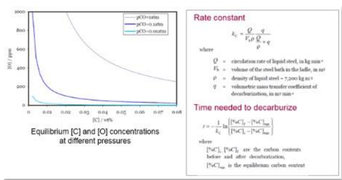
$$2[Al] + 3[O] \rightarrow (Al_2O_3) + \text{heat energy}$$



Al-O equilibrium curves at three different temperatures

SCIENTIFIC BACKGROUND

- Decarburization



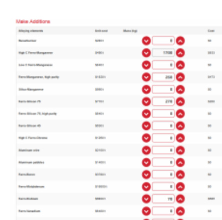
SCIENTIFIC BACKGROUND

- Desulfurization

$$3(CaO) + 2[Al] + 3[S] \rightarrow 3(CaS) + (Al_2O_3)$$

SIMULATION

SIMULATION



SIMULATION

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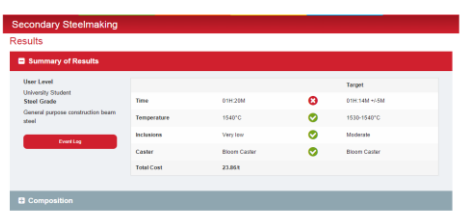


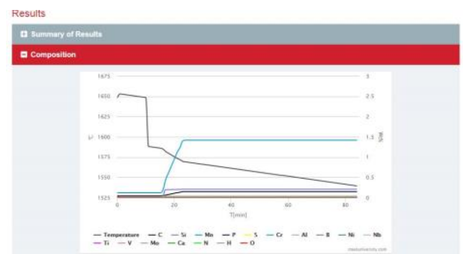
SIMULATION

RESULTS :

SIMULATION

	Tap	Aim		Min	Max
C	0.1516	0.1450	✓	0.1300	0.1600
Si	0.2091	0.2000	✓	0.1500	0.2500
Mn	1.4217	1.4000	✓	1.3000	1.5000
P	0.0222	-	✓	-	0.0250
S	0.0147	-	✓	-	0.0200
Cr	0.0099	-	✓	-	0.1000
Al	0.0283	0.0350	✓	0.0250	0.0450
B	0.0001	-	✓	-	0.0005
Ni	0.0097	-	✓	-	0.1500
Nb	0.0427	0.0420	✓	0.0350	0.0500
Ti	0.0012	-	✓	-	0.0100
V	0.0000	-	✓	-	0.0100
Mo	0.0020	-	✓	-	0.0400

SIMULATION



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