SECONDARY STEEL MAKING

What is the secondary steelmaking?

GENERAL OVERVIEW

REATIONS TAKES PLACE IN SECONDARY STEELMAKING

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

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

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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
LADLE ARC FURNACE

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

LADLE INJECTION

- The aim of powder injection in ladle furnace is to reduce sulfur 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 reactions and favored by the argon bubble 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.

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

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

- Allows:
  - Alloy additions
  - The simultaneous addition
  - Used for chemical reheating

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**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

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

SCIENTIFIC BACKGROUND

• Desulfurization

SIMULATION

SIMULATION
RESULTS:
SIMULATION

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<th>Max</th>
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REFERENCES

1. Turkdogan, ET, Fundamentals of Steelmaking, The Institute of Materials, 186125 004
2. ISIE, The Making, Shaping and Treating of Steel - Steelmaking and Refining Volume, The ASIE, Steel Foundation, 0-930767-02-0
3. AISE, The Making, Shaping and Treating of Steel - Steelmaking and Refining Volume, The ASIE Steel Foundation, 0-930767-02-0
4. Turkdogan, ET, Fundamentals of Steelmaking, The Institute of Materials, 186125 004
6. www.steeluniversity.org