SECONDARY STEEL MAKINING

Modeling and Simulation of Metallurgical & Materials Processes – MET346E

Cüneyt ARSLAN

07.04.2015

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Secondary Steel Making

- What is Secondary Steel Making ?
- Stirring
- Ladle Arc Furnace
- Ladle Injection
- Degassing
- CAS – OB
- Simulation

What is Secondary Steel Making?

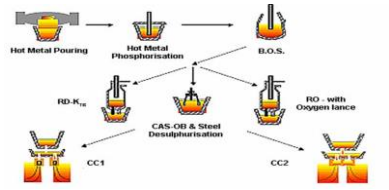
Secondary steelmaking is commonly performed in ladles and usually referred to as ladle metallurgy.

What is Secondary Steel Making?

Some of the operations made in ladles involve

- de-oxidation (or "killing"),
- vacuum degassing,
- alloy addition,
- inclusion removal,
- inclusion chemistry modification,
- de-sulphurisation and
- homogenisation .

What is Secondary Steel Making?



*http://news.alibaba.com/article/detail/metalworking/100187856-1-metals-knowledge%253A-clean-steel%253A-part.html

What is Secondary Steel Making?

- It is popular to perform ladle metallurgical operations in gas stirred ladles with electric arc heating in the lid of the furnace nowadays.

*http://www.siemens.com/press/en/pressrelease/?press=/en/pressrelease/2010/industry_solutions/is201008537.htm&content[]=IS&content[]=SD&content[]=MT&content[]=PDMT

- Increasingly today, steels after they have been poured from the furnace go through the stage of secondary steelmaking before the steel is cast (both BOF and EAF).

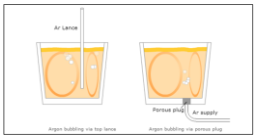
*http://www.ciuc.com.cn/showproduct_en.asp?id=258&mid1=87&pid=0&cid=0&tid=87

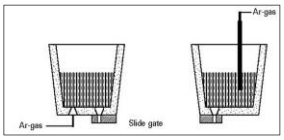
Stirring

- Molten steel can be stirred by Argon bubbling or electromagnetically (EMS) during secondary steelmaking.
- Argon is used for stirring because argon is a noble gas that will not react with hot steel.
- This ensures that the composition of the metal is uniform.
- The principal purpose is to homogenize the steel with respect to both composition and temperature.

Stirring

- Stirring helps to even out the temperature throughout the liquid metal which is about 1600 °C.
- Stirring also accelerate the removal of inclusions in the steel





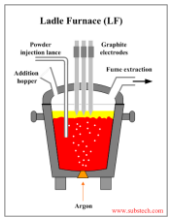
Ladle Arc Furnace

- It is used to heat the steel.
- Argon is applied for homogenization.
- Heating up the temperature 3°C per minute.
- The furnace is used as a bridge with BOF and continuous casting machine.

Ladle Arc Furnace

Components of Ladle Arc Furnace:

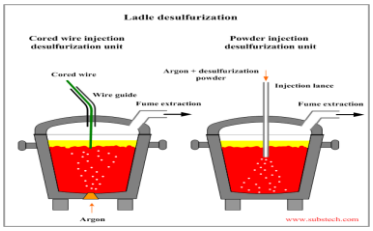
- Electrodes are used to heat scraps.
- Addition hopper is used to add alloying elements or slag components.
- Cooling parts.
- Extraction of fume.



Ladle Injection

- Injection methods effectively reduce Sulphur content.
- In this method, a strong desulphurizing reagent in the form of fine powder is injected(through a lance) in the refined steel bath along with an inert gas(Argon) as carrier.

Ladle Injection



Ladle Injection

Benefits of Using it :

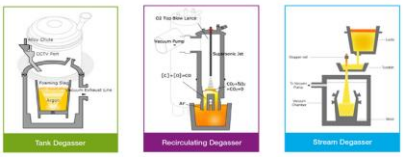
- Sulphur removal (Desulfurization)
- Temperature and chemical homogenizing
- Toughness and elongation of the Steel.
- Non-metallic inclusions removal

Degassing

- Vacuum treatment (generally called vacuum degassing) is a commonly used steelmaking process, used for removing dissolved gases (e.g. hydrogen) from the steel.

Degassing

- Types of Degassing:



Used mainly to remove hydrogen content. Molten steel is poured into another vessel which is under vacuum. Degassing occurs during the fall of molten stream

Degassing

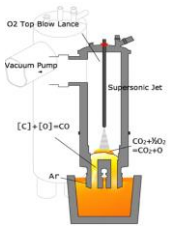
1. Tank Degasser :

- The tank degasser is used to remove goseous elements and sulfur from the steel.
- The removal of sulfur is achieved through slag-metal reactions, which are promoted by strong argon 'flushing'(bubbling) with in the vacuum envelope.

Degassing

2. Recirculating Degasser :

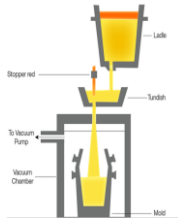
- The recirculation (RH) degasser is used for the **removal** of **Carbon** and **other impurity elements.**
- It comprises a pair of 'snorkels' which are lowered into the liquid steel. The pressure is the vessel is reduced to about 1-3 torr(1 torr=1 mmHg)
- Argon is injected through tuyeres in one of the snorkels, forcing the steel up into the unit and out again through the other snorkel.
- In some units, oxygen is injected through a lance in order to assist decarburization.



Degassing

3. Stream Degasser :

- In stream degassing, molten steel is poured into another vessel which is under vacuum. Sudden exposure of molten stream in vacuum leads to very rapid degassing due to increased surface area created by breakup of stream into droplets.
- This process heps the hydrogen dissolved in steel, to be evacuated by the vacuum pump.
- The major amount of degassing occurs during the fall of molten stream. Height of the pouring stream is an important design parameter.



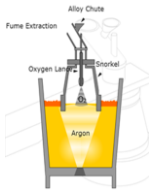
CAS-OB (Composition Adjustment by Sealed Argon Bubbling - Oxygen Blowing)

The CAS-OB (Composition Adjustment by Sealed Argon Bubbling - Oxygen Blowing) allows alloy additions to be made under an inert argon environment.

The unit is lowered onto the liquid steel over an 'eye' in the slag formed by argon bubbling.

In particular, it allows the simultaneous addition of Al and O_2 gas blown through a top lance. These react to form Al_2O_3 plus considerable exothermic heat energy - the steel temperature can be raised by up to 10°C per minute.

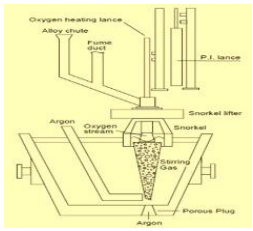
The CAS-OB is therefore used for CHEMICAL REHEATING. Note however that the Al_2O_3 must subsequently be removed.



http://steelx.org/content/html/eng/default.asp?catid=26&pageid=1027690347

CAS - OB

Schematic diagram of CAS-OB installation



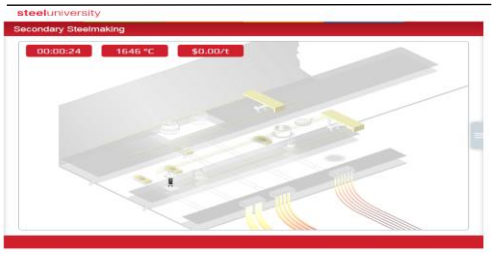
http://npalgroup.com/wp-content/uploads/2013/10/CAS-OB-process.jpg

CAS – OB

Important Points

- In CAS-OB process, opening of bottom bubbling plug is important to secure open eye. To avoid the risk of failure of bubbling plug opening, bell position changing system is adopted. With this bell position can be switched to good bubbling area.
- Total oxygen content of CAS-OB process is normally similar to bubbling process and ladle furnace but it is slightly inferior to that of RH process.

Simulation



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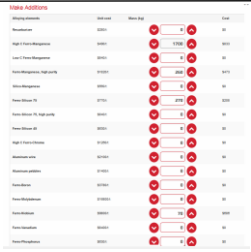

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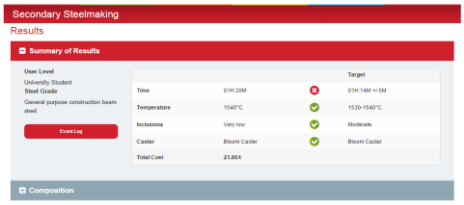

Simulation

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

Results

References

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4- Turkdogan, ET, Fundamentals of Steelmaking, The Institute of Materials, 1 86125 004

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7- http://steelx.org/content/html/eng/default.asp?catid=26&pageid=1027690347, retrived from 05.04.201

8- http://ispatguru.com/wp-content/uploads/2013/10/CAS-OB-process.jpg, retrived from 05.04.2015