



## SECONDARY STEEL MAKING



PROCESS METALLURGY

CÜNEYT ARSLAN

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Ali ALTUN	060110292
Bilal DEMİR	060100281
Doğan ARSLAN	060130301
Gamze H. TERZİ	060120420
Gürsey AKDAŞ	060100349
Maimadiluseyn MAMADZADA	060100912
Reha SAVASERİ	060120525
Selin BULUT	060110327
Semih GÜRSOY	060110317
Tolga EKER	060100326

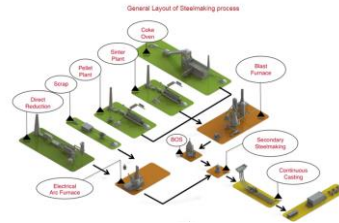
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## What is the secondary steelmaking?



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## GENERAL OVERVIEW



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

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## 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

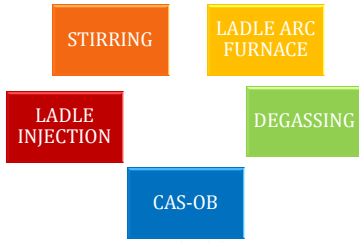
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## SECONDARY STEELMAKING



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## 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**

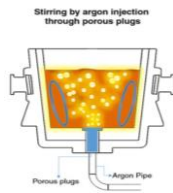
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## TOP LANCE INJECTION OF ARGON



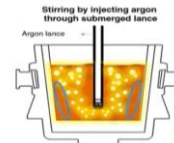
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## BASAL INJECTION OF ARGON



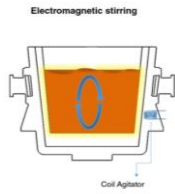
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### ELECTROMAGNETIC STIRRING (EMS)



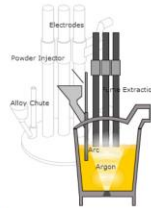
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### LADLE ARC FURNACE



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

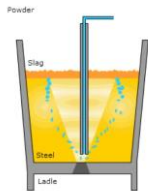
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### LADLE INJECTION



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

Why it is necessary?

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### DEGASSING



#### 1. Tank Degasser

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



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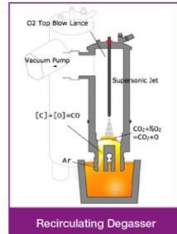


## DEGASSING



### • 2. Recirculating Degasser :

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



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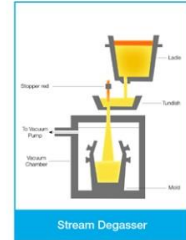


## DEGASSING



### • 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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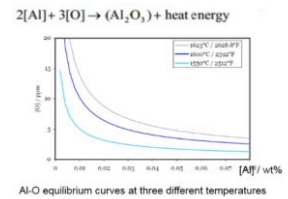
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## SCIENTIFIC BACKGROUND



### • Deoxidation



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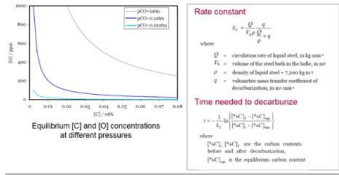
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## SCIENTIFIC BACKGROUND



- Decarburization



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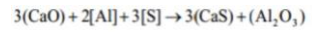
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## SCIENTIFIC BACKGROUND



- Desulfurization



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## SIMULATION



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## SIMULATION



Main Addition	Element	Weight%	Unit
Aluminum	Al	0.02	wt%
High Phosphorus	P	0.02	wt%
Low Phosphorus	P	0.005	wt%
High Phosphorus High Carbon	C	0.02	wt%
Low Phosphorus	C	0.005	wt%
High Carbon Low Phosphorus	C	0.02	wt%
High Phosphorus Low Carbon	C	0.005	wt%
High Phosphorus	P	0.02	wt%
Low Phosphorus	P	0.005	wt%
High Phosphorus	P	0.02	wt%
Low Phosphorus	P	0.005	wt%
High Phosphorus	P	0.02	wt%
Low Phosphorus	P	0.005	wt%
High Phosphorus	P	0.02	wt%
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High Phosphorus	P	0.02	wt%
Low Phosphorus	P	0.005	wt%

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## SIMULATION



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## SIMULATION



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## SIMULATION



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Results

Summary of Results

User Level	University Student	Steel Grade	General purpose construction beam steel	Time	01h 20M	Target	01h 14M +/- 5M
Temperature	1540°C				1530-1540°C		
Inclusions	Very low				Moderate		
Caster	Bloom Caster				Bloom Caster		
Total Cost	23,861						

Event Log

Composition

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## SIMULATION



### RESULTS :

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Results

Summary of Results

User Level	University Student	Steel Grade	General purpose construction beam steel	Time	01h 24M <th>Target</th> <th>01h 20M +/- 5M</th>	Target	01h 20M +/- 5M
Temperature	1540°C				1530-1540°C		
Inclusions	Very low				Moderate		
Caster	Bloom Caster				Bloom Caster		
Total Cost	23,871						

Event Log

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## SIMULATION



	Tap	Ann	Min	Max
C	0.1516	0.1450	0.1300	0.1600
Si	0.2991	0.2000	0.1500	0.2500
Mn	1.4217	1.4500	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	0.0091	-	-	0.0095
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

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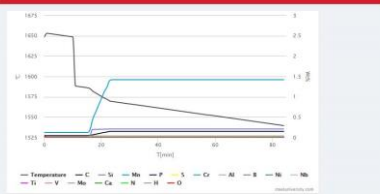
## SIMULATION



Results

Summary of Results

Composition



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## REFERENCES



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