# ELECTRIC ARC FURNACE

MET346E-Modeling and Simulation of Metallurgical & Materials Processes

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## OVERVIEW

- Electric arc furnace (EAF) is a furnace that uses electrical power to heat charged material.



## OVERVIEW

| | |
|---|---|
| Recycled Steel Scrap | Metallic scraps are used as raw material in the EAF |
| ↓ | |
| Electric Arc Furnace | In the EAF steel scrap is melted and converted into liquid crude steel |
| ↓ | |
| High Quality Steel | High Quality Steel is achieved after EAF Processes |



## OVERVIEW

- The main objective of Electric Arc Furnace is producing a crude steel bath to be further processed.
- After Electric Arc Furnace Processes, Secondary Steel Making takes place.
- The Power Input determines the production capacity of the EAF.

## BASIC EQUIPMENTS

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Plan View of EAF

- **Water-Cooled Elements:** They are used instead of ceramic insulation. These water cooled panels are positionedtop of the furnace so there will be no direct contact with the liquid steel.
- **Power Conduction Arms:** They transfer the power into the electrode graphites
- **Roof Suspension Beams:** They provide the movement for the roof.

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## BASIC EQUIPMENTS

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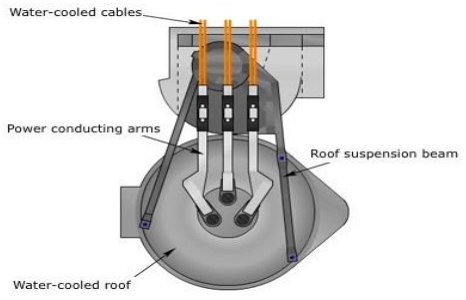


## BASIC EQUIPMENTS

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Section View through EAF

- **Molten Steel Chamber:** This chamber contains the molten metal without loss of heat.
- **Furnace Shell:** It is lined with ceramic bricks insulating the furnace from the liquid steel.
- **Graphite Electrode:** The electrical power is switched on and contact electrical power is transformed into heat as arcing takes place between the electrodes.
- **Rocker Tilt:** It provide a movement to shell through the teeming ladle.
- **Eccentric Bottom Tapping:** When the steel has obtained the correct composition and temperature, the furnace power is switched off and the furnace is tapped.

## BASIC EQUIPMENTS

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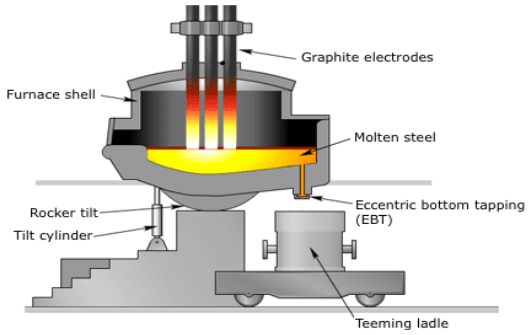
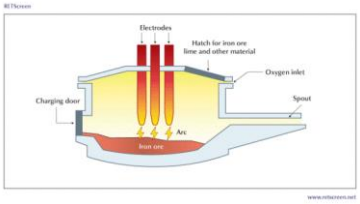


## MELTING




The melting period is the heart of EAF operations. The EAF has evolved into a highly efficient melting apparatus and modern designs are focused on maximizing the melting capacity of the EAF.

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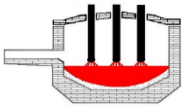
## MELTING

- Melting process starts at low voltage (short arc)between the electrodes and the scrap.
- The arc during this period is unstable.
- In order to improve the arc stability small pieces of the scrap are placed in the upper layer of the charge.
- The electrodes descend melting the charge and penetrating into the scrap forming bores.



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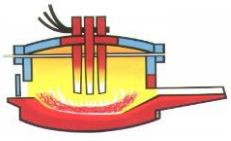
## MELTING

- The molten metal flows down to the furnace bottom.
- When the electrodes reach the liquid bath the arc becomes stable and the voltage may be increased (long arc).
- The electrodes are lifting together with the melt level. Most of scrap (85%) melt during this period.
- Temperature of the arc reaches 6300°F(3500°C).



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## ADDITIONS

- During tapping additives are added to the furnace.
- There is three reason for that;

1) To adjust the final steel compostion

2) To deoxidize the steel and forming oxides

3) Achieve a slag which is more effective

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## ADDITIONS

- A few of the alloying elements are oxidized and transferred to to slag phase
- These elements must be recovered
  - high value
  - environmentally unfriendly

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## ADDITIONS

- Oxygen enters the furnace from two main source

- Air drawn through the furnace

- Oxide raw materials

Eg. Molybdenum oxide

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## SLAGGING

- Electric arc furnace slag is produced during the manufacture of crude steel by the electric arc furnace (EAF) process.
- Slagging operations are carried out to remove impurities from the furnace.during the melting and refining operations some of the undesirable metarials within
the bath are oxidized and enter the slag phase.

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## SLAGGING

- In this process steel scrap with additions of fluxes (e.g., lime[stone] and/or dolomite) are heated to a liquid state by means of an electric current. During the melting process the fluxes combine with non-metallic scrap components and steel incompatible elements to form the liquid slag.
- As the slag has a lower density than steel, it floats on top of the molten bath of steel. The liquid slag is tapped at temperatures around 1600 °C and allowed to slowly air-cool forming crystalline slag.

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## SLAGGING

- Depending on the intended steel quality (carbon steel or stainless/high alloy steel), two different slag types can be generated:
- **EAF C**: Electric arc furnace slag from **c**arbon steel production.
- **EAF S**: Electric arc furnace slag from **s**tainless steel production.

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## SLAGGING

- For the carbon steel production non-alloyed steel scrap is used as input material. In contrast, for the stainless/high alloy steel production low- or high alloyed steel scrap is used and other metals (alloys) are optionally added along with the fluxes to give the crude steel the required chemical composition.
- Electric arc furnace (EAF) slag is a strong, dense, none porous aggregate that is cubical in shape, has good resistance to polishing and has an excellent affinity to bitumen. This makes it an ideal aggregate for asphalt surface materials and road surface treatments as it produces materials that are resistant to deformation (rutting), safe and durable.

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## SLAGGING

| Component | Source | Composition Range |
|---|---|---|
| CaO | Charged | 40 - 60 % |
| SiO2 | Oxidation product | 5 - 15 % |
| FeO | Oxidation product | 10 - 30 % |
| MgO | Charged as dolomite | 3 - 8 % |
| CaF2 | Charged - slag fluidizer | |
| MnO | Oxidation product | 2 - 5% |
| S | Absorbed from steel | |
| P | Oxidation product | |

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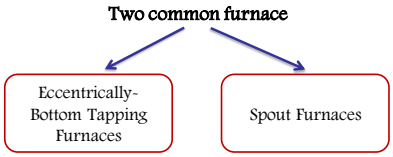
## TAPPING

Tapping of the furnace is initiated by the operator when the processing

In the furnace is **finalized** and the **target temperature** has been **reached**.

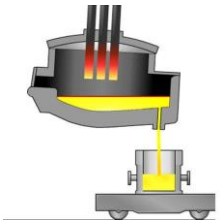
Tapping should be performed as **fast** as possible in order to **save time**.



## TAPPING

### Eccentrically-Bottom Tapping furnaces

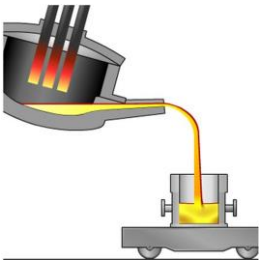
- They have a taphole positioned off-center in the base of the furnace.
- Such a configuration enables slag-free tapping.
- In this cases a «hot heel» is retained in the furnace between the heats.



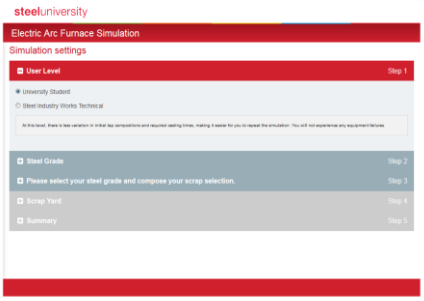
## TAPPING

### Spout Furnaces

- They are used for some **steel grades.**
- Tapping via a spout causes the slag to be carried over to the ladle, where it is thoroughly **mixed** with **steel.**
- In these cases all the metal **is poured out,**without any hot heel remaining in the furnace.



## SIMULATION



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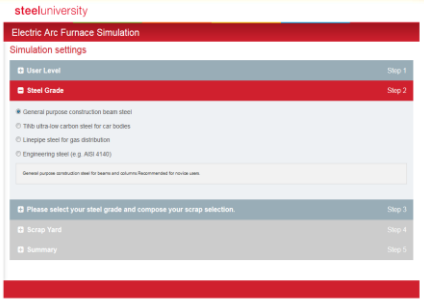

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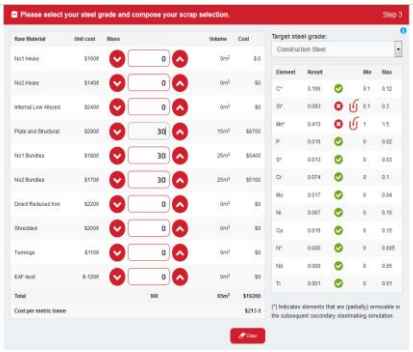


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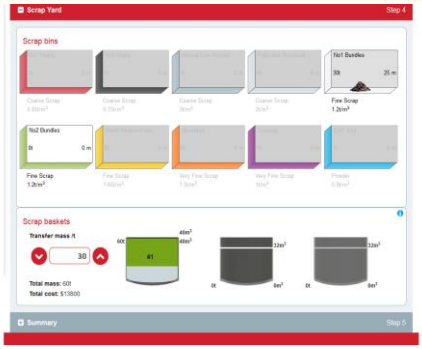
## SIMULATION

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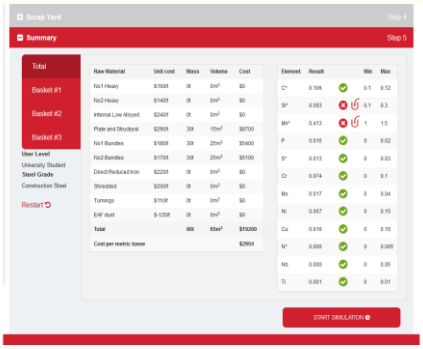


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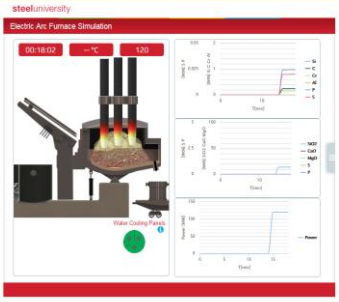


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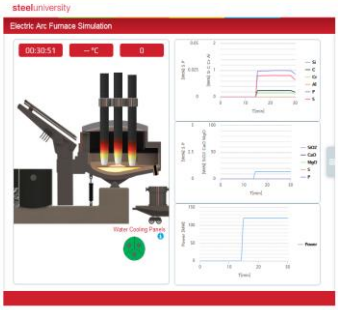


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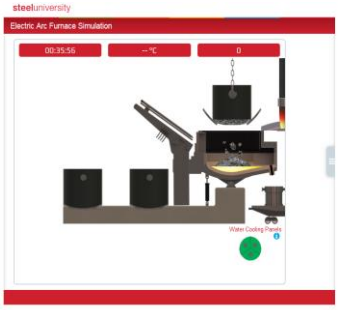


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## SIMULATION


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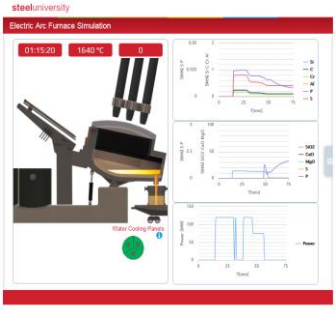
## SIMULATION

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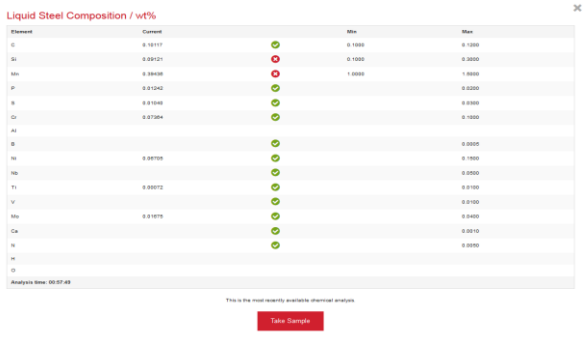


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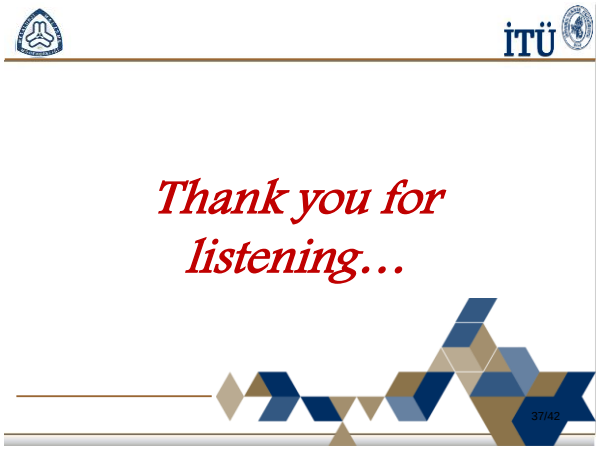
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Thank you for listening…
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