Metallurgy

LF-EMS
Reducing cost and improving quality
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The first stirrer for Electric Arc Furnaces (EAF) was delivered in 1947 and since then some 150 units have been supplied worldwide. ABB’s experience of EAF stirrers was further extended in the 1960s to ladle applications. The world’s first ladle furnace (with electromagnetic stirrer, LF-EMS) was commissioned at SKF Steel (now Ovako Steel), Sweden, in 1965. And today more than 142 units have been supplied.
– Clean steel…
– Improved yield…
– Reliable stirring…
– Reproducible quality…

…are four of the things ABB electromagnetic stirring will achieve for you.

Product features

Flexibility
The travelling magnetic field induced by the coil and the induced current in the liquid melt form the stirring force. Both the direction and the amplitude of the stirring force are easily controlled.

Reliability
Electromagnetic stirring will function even if there are sculls in the ladle, which will block the gas plug.

Safety
There is no physical contact between the stirrer and the ladle wall, i.e. no weak point as is the case with gas stirring.

Local service
ABB provides local service worldwide.

Unique process know-how
– Advanced computation techniques for magnetic fields and steel fluid flows.
– World-leading competence in coil design.
– Optimized design for maximum performance and minimum power consumption.
– Operational know-how of electromagnetically stirred ladle furnaces.
ABB has developed a complete set of stirrers for ladle furnace, covering a wide range of ladle furnace sizes from 10 up to 330 tonnes. Induction stirring in the ladle furnace gives efficient mixing of the entire melt whilst maintaining an unbroken protective slag layer.

Stirring can be customized to match the needs of different LF process steps, as de-sludging, heating, homogenization, alloy addition, melting of alloys, de-sulphurization, wire feeding and inclusion removal. Operation is characterized by low stirring cost, reliable and safe operation, optimum conditions for reproducible production of high quality steel and precise logistics.

Installation system
The main installation components for LF-EMS system include an electromagnetic stirrer, a frequency converter, a transformer and a cooling water station, as shown in Figure 1. The ladle shell directly facing the stirrer must be made of non-magnetic stainless steel so that the magnetic field from the stirrer can penetrate into the melt. As the LF-EMS has no physical contact with the melt and contains no moving parts, the need for maintenance is very low.
Flexible and reliable operation
The direction of the induction stirring, up or down, and the stirring power, can be easily and precisely changed. For instance can an unbroken slag layer be kept over the steel during the LF treatment but also that it is possible to open up a slag free steel surface (open eye) for the time it takes to add alloys directly into the steel bath, without risking that the alloys get stuck in the slag.

The turbulent energy in electromagnetic stirred ladle is more homogeneous distributed than the gas stirred ladle. With induction stirring it is possible to achieve a melt flow rate of around 0.5~2.0 m/s.

The schematic flow pattern in the ladle furnace by GAS stirring, EM stirring and EMGAS stirring are presented in Figure 2.

In metallurgical processing, the technology for stirring and braking the melt is important to ensure a higher quality and productivity. The resulting benefits in terms of reproducible quality and profitable production have been repeatedly demonstrated, often with payback times of less than a year.

As the leading company in this area, ABB can provide advanced solutions for stirrers and brakes, but can also assist our customers worldwide with service and maintenance. Combined with our metallurgical know-how, this makes ABB an ideal partner in the selection and installing of electromagnetic products.
Benefits

High heating rate and lower carbon pickup
EMS has strong stirring effect for the steel phase, but at the same time has reduced fluctuation of the slag surface. This feature makes the EMS is ideal for high heating rate and lower carbon pickup during heating. The calm slag surface minimize the carbon pickup during heating and also make it possible to operate with shorter arcs. The shorter arc operation will reduce the slag builder additions.

Precise temperature and chemistry control
The stirring power of LF-EMS is higher than argon gas stirring. The strong and efficient stirring of LF-EMS leads to much better mixing in the ladle, which is beneficial to the precise temperature and chemistry control.

Alloy additions
Electromagnetic stirring with high power in upward direction creates a slag free “eye” beneficial for alloy addition. After the alloys have been added, the open “eye” can be closed by reversing the stirring direction.

Faster inclusion removal
Induction stirring has a solid and well-documented reputation for producing clean steel. The existing results show that the adjustable turbulent energy distributed in the steel bulk gives excellent mixing and rapid removal of inclusions which makes it possible to obtain lower total oxygen contents. The total oxygen content in the ball-bearing steel produced with electromagnetic stirring and Ar-gas bubbling in an ABB reference in USA is presented in Figure 3.

It is clearly shown that the EMS will give much lower total oxygen content than Ar-gas stirring in the quality steel products. The reference results from a number of LF-MES installations show that for the stainless steel production, the LF-EMS is an essential equipment for improving the steel cleanliness.

Less O and N pickup
The controlled stirring with unbroken slag layer by electromagnetic stirring (EMS) will protect the steel from the influence of the ambient atmosphere and thus minimizing the excess re-oxidation of Al and the pickup of N and H. It can be seen from Figure 4 that the Al fading rate is some 5 times higher for the Ar-gas stirred ladle compared to the EMS ladle. It is also to be noted that the lower Al fading rate will also save the Al consumption in the ladle treatment with EMS.

Efficient de-slagging
Electromagnetic stirring is a very efficient tool to promote deslagging in the tilting stand.

Fig. 3 Total Oxygen content in ball-bearing steel produced with gas and electromagnetic stirring respectively

Fig. 4 Comparison of aluminum fading rate between gas stirring and EMS stirring during LF process.
Reliable partner with unique features

Long term commitment in the Steel Industry
- Stirrers for molten steel since the 1940’s
- Vast metallurgical know-how
- Joint development projects with leading steel companies

Market leader with complete program
- Stirrers for all types of applications
- More than 2000 stirrers and brakes supplied

Unique know-how in stirrer design
- Advanced 3-D computer simulations of EMS applications to customer processes
- Optimized design for maximum performance and minimum power requirement
- Innovative and unique solutions such as ModMEMS and DualMEMS

Long life and minimum maintenance
- Rigid windings and forced cooling
- No re-impregnation of coils

Highly efficient power supplies with latest technology
- Use of standard motor drive produced in high volumes
- Low energy losses
- Minimum floor space requirements using Single- or Multidrive solutions
- Symmetrical currents increase the available stirring power for non symmetrical loads
- Advanced digital control technology
- Field bus communication interface of various types

Local presence world wide
- Global network
- Local service
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