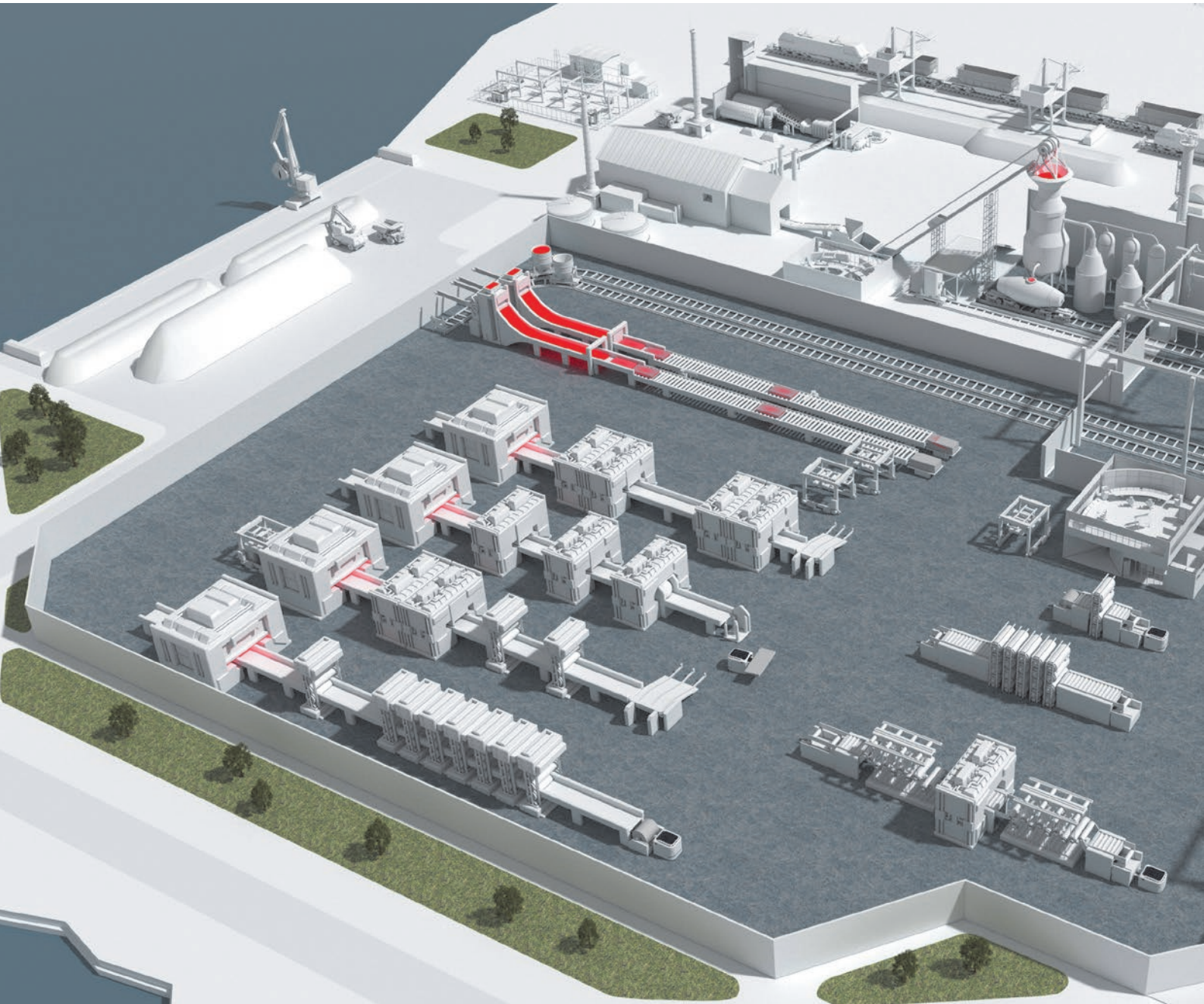
METALLURGY

Electromagnetic stirring (LF-EMS)

Maximize quality and cost-efficiency in ladle furnace

Reducing cost and improving quality

The first electromagnetic stirrer was installed by ABB on an electric arc furnace (EAF) in 1947 and since then some 160 units have been supplied worldwide. In the 1960's ABB's experience of EAF stirrers was then applied to ladle applications and, in 1965, the first ladle furnace was commissioned at SKF Steel (now Ovako Steel) and was equipped with ladle furnace EMS from ABB. Today more than 140 LF-EMS systems have been supplied to steelmakers around the world.



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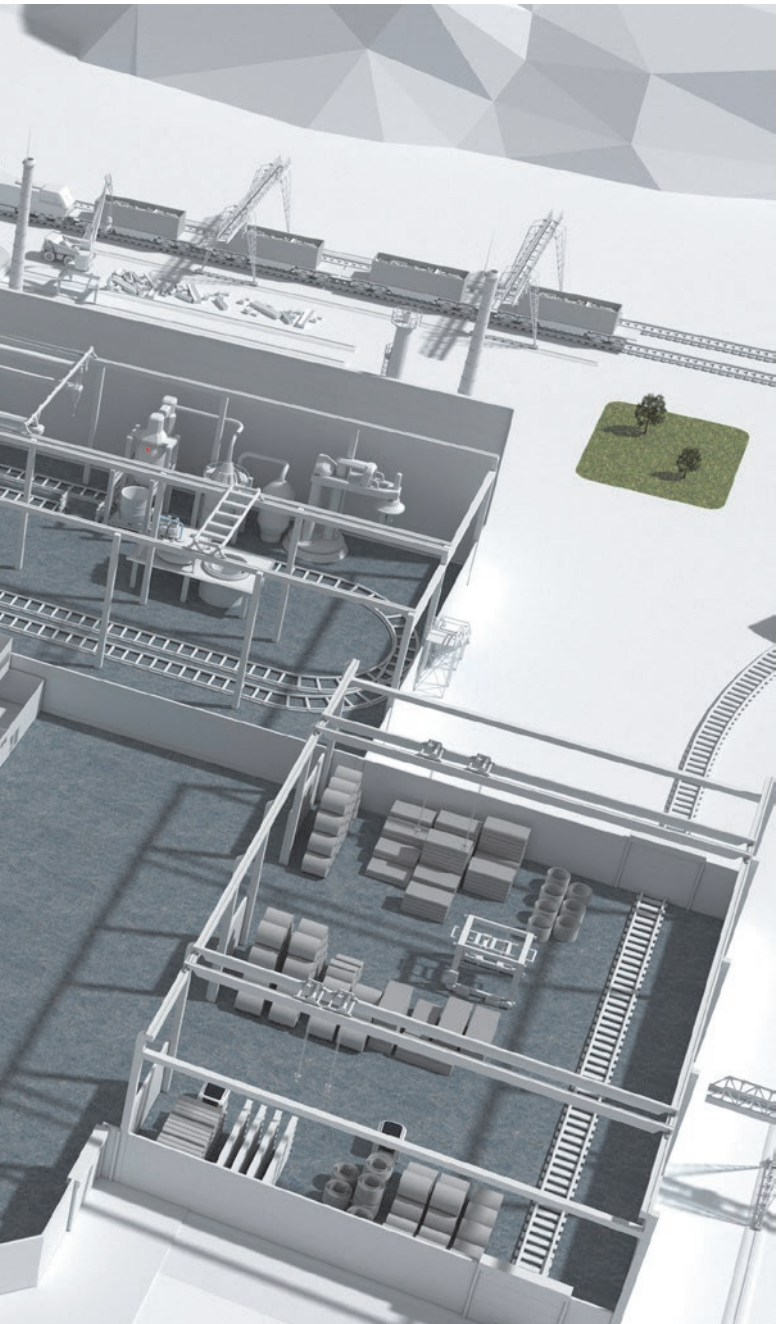
- Clean steel…
- Higher yield…
- Reliable stirring…
- Reproducible quality…

…are four of the things you can achieve with ABB electromagnetic stirring.



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Product features

Flexibility
A travelling magnetic field induced by the stirrer coil delivers a current which generates a stirring force in the liquid melt. 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 usually renders competing technologies such as gas plugs ineffective.

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

Local service
ABB provides specialized aftersales service and maintenance for metallurgical products including 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.

Electromagnetic stirring for optimal results

ABB has developed a complete set of stirrers for ladle furnace, covering a wide range of ladle furnace sizes from for 10 up to 330 tonnes, for steelmaking and ferroalloying production. Electromagnetic 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 such as de-slagging, 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, and provides optimum conditions for reproducible production of high-quality steel and precise logistics.

Installation system
A typical LF-EMS system, as shown in Figure 1, includes:

- electromagnetic stirrer
- frequency converter
- transformer
- cooling water station

The ladle shell directly facing the stirrer must be made of non-magnetic stainless steel to allow the magnetic field from the stirrer to penetrate the melt. Since the LF-EMS has no physical contact with the melt and contains no moving parts, maintenance requirements are minimal.

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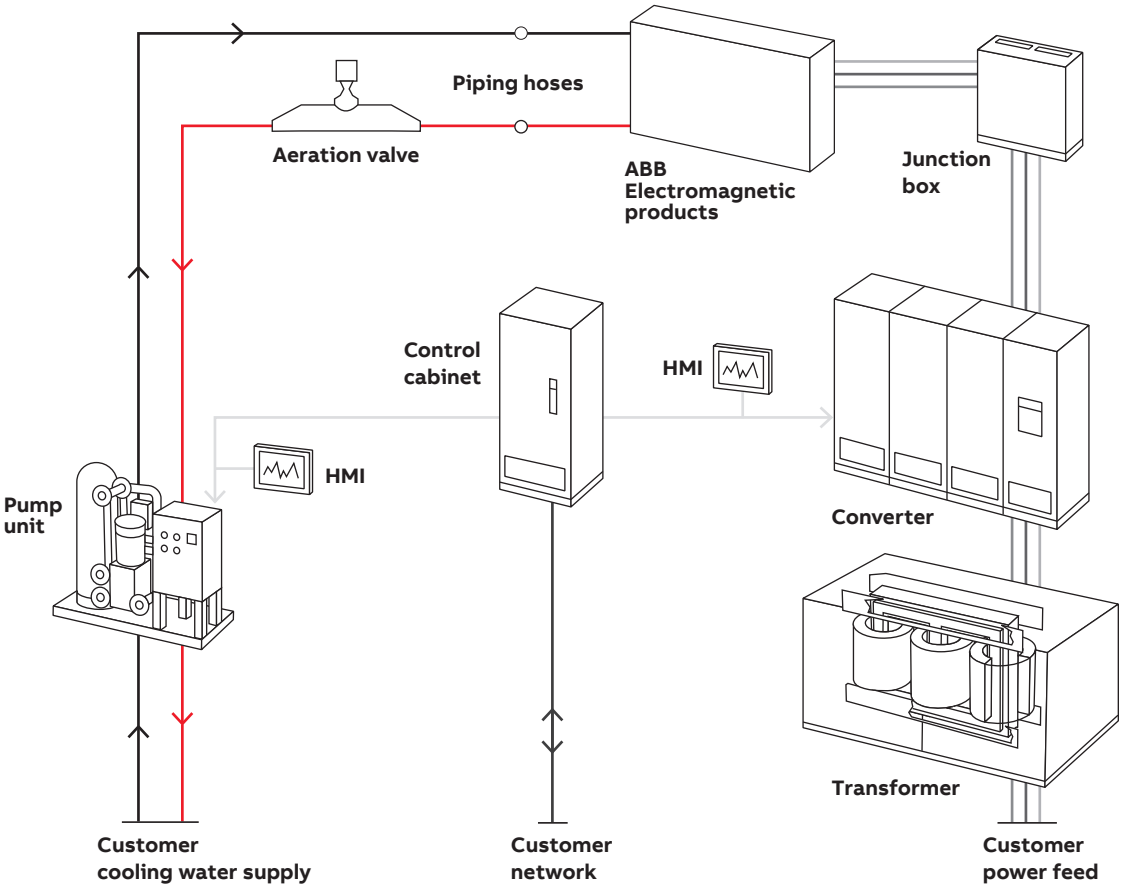
Fig. 1 LF-EMS system



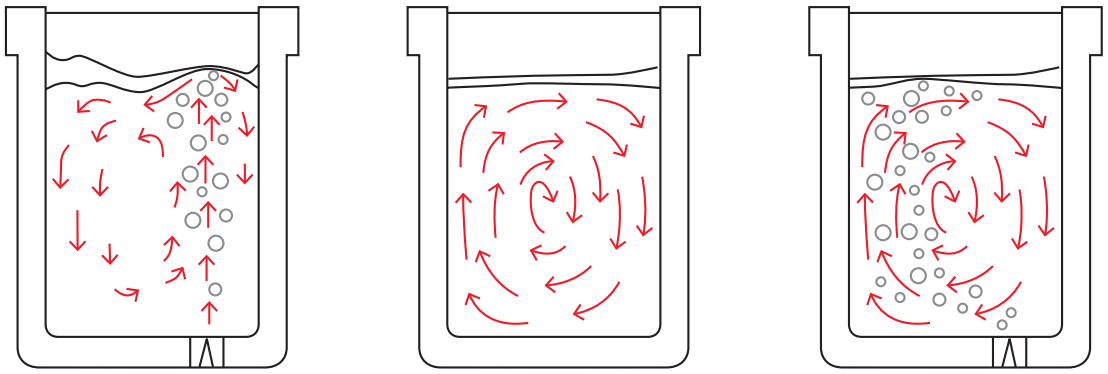


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Fig. 2 The schematic flow pattern in the ladle furnace by gas stirring (left), EMS (middle) and EMGAS stirring (right).

Flexible and reliable operation
Stirring direction (up or down) and stirring power, can be adjusted easily and precisely. An unbroken slag layer can, for instance, be kept over the steel during LF treatment and it is possible to open up a slag free steel surface (open eye), allowing alloys to be added directly into the steel bath, while reducing the risk of alloys getting stuck in the slag.

Electromagnetic stirring generates more turbulent energy in the ladle than competing technologies such as gas stirring. With LF-EMS it is possible to reach a melt flow rate of around 0.5~2.0 m/s, which results in a more homogeneous melt.

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

EMGAS for efficient de-sulphurization
For most metallurgical treatments electromagnetic stirring is superior to gas stirring, though gas stirring is particularly effective for creating the turbulent steel/slag interface beneficial to de-sulphurization and serves therefore as an excellent complement to electromagnetic stirring for this part of the process. For this reason ABB developed EMGAS, a solution combining the advantages of electromagnetic and gas stirring to provide greater flexibility in control of flow speed, gas plume and residence time, stirring energy, and steel/slag mixing. This ensures improved performance not only for de-sulphurization but through the various steps of the ladle furnace process.

In metallurgical processing, technologies for stirring and braking the melt are a prerequisite for achieving maximum quality and productivity. The resulting benefits in terms of reproducible quality and profitable production have been demonstrated repeatedly, often with payback times of less than a year.

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As the leading supplier of electromagnetic stirring and braking devices worldwide, our extensive metallurgical know-how and experience, our global network of experts and local service presence ensure we deliver solutions that generate real, long-term results for our customers.

Benefits

High heating rate and lower carbon pick-up
EMS delivers a strong stirring effect for the steel phase, while at the same time reducing fluctuation of the slag surface, making it ideal for a high heating rate and low carbon pick-up during heating. The calm slag surface minimizes carbon pick-up during heating and makes it possible to operate with shorter arcs, which in turn contributes to reducing slag builder additions.

Precise temperature and chemistry control
The stirring power of the LF-EMS is greater than that which gas stirring can provide. The strong and efficient electromagnetic stirring leads to much better mixing in the ladle, which allows for precise temperature and chemistry control.

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

Faster inclusion removal
Electromagnetic stirring has a solid and well-documented reputation for producing clean steel. In stainless steel production LF-EMS is especially important for effective inclusion removal. Results show that the adjustable turbulent energy distributed in the steel bulk gives excellent mixing and rapid removal of inclusions, making it possible to obtain a lower total oxygen content. Figure 3 illustrates the total oxygen content in ball-bearing steel for a steel manufacturer in the USA using electromagnetic stirring versus gas stirring. EMS is shown to give a much lower total oxygen content in these quality steel products than gas stirring. Reference results from a number of ABB installations worldwide have demonstrated that LF-EMS is an essential tool in improving steel cleanliness in stainless steel production.

Less O and N pick-up
ABB’s controlled electromagnetic stirring and the resulting unbroken slag layer helps protect the steel from the ambient atmosphere, thus minimizing excess re-oxidation of aluminium and pick-up of N and H. Figure 4 shows that the aluminium fading rate is five times higher in the gas stirred ladle compared to the ladle where EMS was applied. This reduction in aluminium fading rate provides for lower aluminium consumption in the ladle treatment.

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 vs electromagnetic stirring.

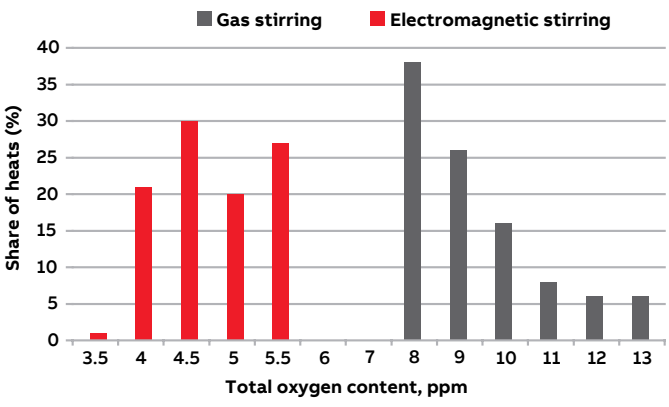
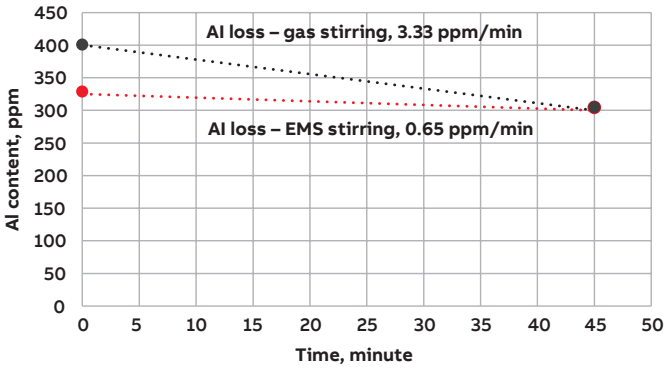


Fig. 4 Comparison of aluminium fading rate between gas stirring and electromagnetic stirring during LF process.



Reliable partner with unique features

Long-term commitment to the steel industry
- Stirrers for molten steel since the 1940's
- Vast metallurgical know-how
- Joint development projects with leading steel manufacturers

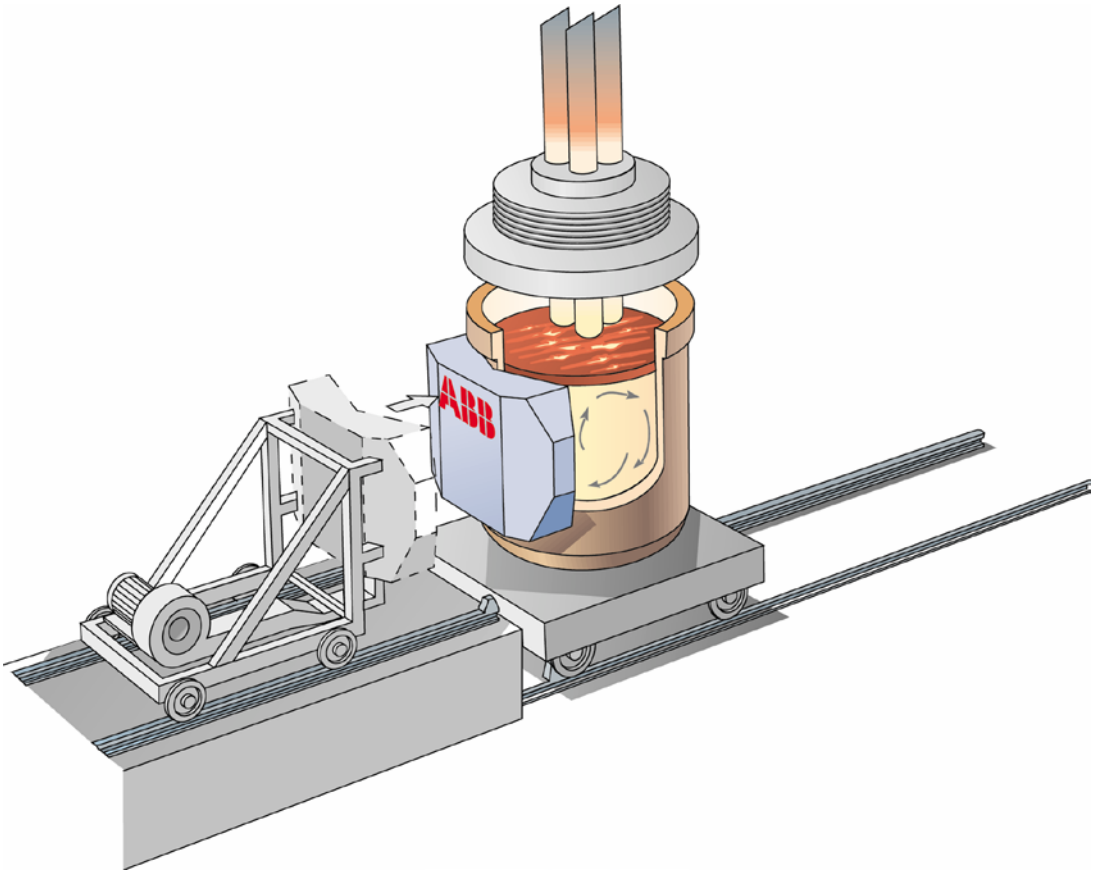
Market leader with complete program
- Stirrers for all types of applications
- More than 2000 stirrers and brakes supplied

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

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 interfaces of various types

Global network, local presence
- Global network of metallurgical experts
- Local service organization near you



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