Electromagnetic stirrers are used in continuous casting to improve product quality and increase continuous casting machine productivity. According to the position along the casting line and effects requested on the cast product, EMS are classified as:

- M-EMS (Mould Electromagnetic Stirrers)
- S-EMS (Strand Electromagnetic Stirrers)
- F-EMS (Final Electromagnetic Stirrers)

Rotational electromagnetic stirrers are equivalent to an asynchronous motor stator generally supplied by a three-phase, or sometimes two-phase, frequency converter. A rotating magnetic field is thus generated, which impose a main swirl flow and important longitudinal secondary flows to the molten steel.
Ergolines provides a complete stirrer reconditioning, replacing damaged or worn parts for stirrers of any brand and type and—according to the customer—also improves stirrers performances modifying their actual design.

In its workshop, Ergolines also provides an on-site check-up for stirrers to evaluate their operation or complete integrated tests for stirrers, frequency unit converters and power transformers.

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**BENEFITS**

The benefits obtained using one or more EMS in combination are summarized in the table.

<table>
<thead>
<tr>
<th>EMS type &amp; combination</th>
<th>M-EMS</th>
<th>M+F-EMS</th>
<th>M+S+F-EMS</th>
<th>M+S-EMS</th>
<th>S-EMS</th>
<th>S+F-EMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinhole &amp; blowhole</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Surface &amp; subsurface cracks</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Break-out reduction</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+*</td>
<td>+*</td>
</tr>
<tr>
<td>Solidification structure &amp; internal crack</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Centerline segregation, center porosity</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>V segregation</td>
<td>—</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+**</td>
<td>++</td>
</tr>
</tbody>
</table>

* With S-EMS in high position.
** With S-EMS in low position.

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**ERGOLINES TECHNOLOGY**

Ergolines is very close to the customer during the stirrer design stage. Every stirrer is a customized product developed in accordance with specific customer’s needs and requests. Thanks to this approach, Ergolines can guarantee:

- a lower power consumption (kW/ton produced) with same metallurgical benefits
- a complete integration of new electromagnetic stirrers in the existing casting machines
- a longer lifetime

The stirrer design is based on computer-aided design and 3-dimensional magneto-hydrodynamic simulation, aiming at achieving highest electric and fluid-dynamic efficiencies and ensuring an optimal windings cooling.

To define the stirrer position into the mould and/or along the CCM, Ergolines has developed some software programs which calculate steel cooling and solidification along the CCM to establish the right position of electromagnetic stirrers.

Regarding the stirrer cooling, this is designed to operate with low pressure water. The internal water circuit is designed to guarantee a well-balanced cooling for an optimal heat distribution, thus preventing areas with an excessive heat accumulation. The cooling is designed to have the lowest temperature difference into the stirrer to avoid dilatations. The cooling water flows from bottom to top to avoid the rubbing of any residual micro-particles with the coils and guarantee a longer stirrer lifespan.

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**SERVICE ACTIVITIES**

Ergolines provides a complete stirrer reconditioning, replacing damaged or worn parts for stirrers of any brand and type and—according to the customer—also improves stirrers performances modifying their actual design.

In its workshop, Ergolines also provides an on-site check-up for stirrers to evaluate their operation or complete integrated tests for stirrers, frequency unit converters and power transformers.
TYPICAL ERGOLINES EMS SYSTEM DESCRIPTION

M-EMS: EXTERNAL-TYPE

Mould electromagnetic stirrers (M-EMS) are installed around the mould body. Cooling is accomplished by a closed-loop, de-mineralized water circulation system. The coil manufacturing technology is “wet-insulation” type. High, reliable and long-lasting insulation properties are given by a special insulation technique with an overlapped double kapton-ribbon winding, and by a special proprietary resin treatment based on VPI (Vacuum-Pressure-Impregnation) technology, which ensures a longer coil lifespan.

M-EMS: INTERNAL-TYPE

Installed inside the mould body is cooled by primary cooling water circuit or through a dedicated cooling water system like the external type M-EMS.

M-EMS can be also provided in the “dry insulation type”, meaning that the copper conductor is a hollow tube with the cooling water flowing inside.

S-EMS AND F-EMS

Strand and final electromagnetic stirrer, used for higher quality demands usually for bigger section sizes, are installed along the strand in a position depending on the continuous casting machines characteristics, working parameters and the expected metallurgical effects. Cooling, manufacturing technology, insulation properties and materials are similar for the M-EMS, except particular precautions to be taken for the components exposed to heat radiation, that include either the use of heat resistant materials/components or special water-cooled equipment.

POWER TRANSFORMER AND FULL-DIGITAL FREQUENCY UNIT CONVERTER

Are provided to guarantee the power supply and manage electrical parameters (current, voltage and frequency). The Frequency Converter is specifically designed for operation at the low frequencies involved with EMS equipment.

COOLING WATER SYSTEM (DE-MINERALIZED WATER)

Equipped with 2 pumps, one bag filter, one heat exchanger, one stainless steel water tank and all necessary automation components and sensors for safe operations, including a water conductivity meter, is designed depending on number of strands and stirrers design. The system is locally controlled by a dedicated PLC switchboard with all commands, alarm signals and auxiliary devices. One system is intended to cool the EMSs of all strands, in parallel.

Power cables, junction boxes, stainless steel flexible hoses, cooling water instrumentations pipes are included in the supplies and are chosen according to steel plant characteristics and customer requirements.

Ergolines provides services for EMS system installation check-up, commissioning and personnel training.
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