INNOVATION FOR THE MANUFACTURING PROCESS

Increase production. Reduce consumption.
That’s your new added value.
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Born from the double level theory of Eng. Mario Appolonia, a specialist in the production of Ferrochrome, KAT® technology starts in 1990 with an experimental application, whose factual evidence motivates the inventor to deepen the study. The identification of the appropriate kind of refractory, the optimal sizing of the crucible and the adjustment of the distance between electrodes wheelbase as a function of the applied power, made KAT® technology reach the requirements for effective industrialization.

Since 1992, this process innovation becomes established on national territory. In 2000, KAT® lands in Eastern Europe by Darfo Albania Sh.p.k. In 2009, based on this success, Engineer Appolonia registers this process, getting the International Patent. In 2011, this patent obtains the reference of Prof. Giuseppe Silva, Professor of Metallurgy at the Polytechnic of Milan, which certifies its validity and practical value.

From the propensity of Eng. Appolonia to reach further targets, it came out the real need to create an operative structure, able to consolidate the heritage of skills and know-how and able to address the modern challenges facing the new markets.

That is how the present KAT Technology was born.

Our team is highly motivated, able to provide technical support to the customer until the achievement of important results and to ensure our targets in order to optimize the production of Ferrochrome, that is:

• PRODUCT QUALITY IMPROVEMENT;
• SIMPLIFIED TECHNOLOGICAL PROCESS;
• COST REDUCTION;
• INCREASE IN PRODUCTION CAPACITY;
• MORE SAFETY with the reduction of air-dispersed pollutants and of occupational risk factors;
• WORKPLACE IMPROVEMENT with the optimization of the microclimate.
FERROCHROME AND KAT® TECHNOLOGY: DO MORE, DO BETTER

The Ferrochrome alloy is essential for the production of stainless steel and special steels, widely used and of high quality, typically characterized by a high corrosion resistance and a low tendency to magnetization. The processing cycle of Ferro-alloys involves the use of electric arc submerged furnaces, in which the chemical reduction of the mineral occurs by coal (Coke) or its derivatives. In the production of Ferrochrome we face the complex aspects of the physical-chemical reactions between metal and slag which differ depending on the types of chromium minerals, but that must meet specific requirements of temperature and viscosity, to allow a correct separation of the two liquid phases (metal-slag).

The current difficulty in completely obtaining a metallic phase in the liquid state, caused by the presence of eutectic and high temperatures, results in significant metal losses caused by occlusion in the slag. Here comes the KAT® technology.

KAT® offers a technological update and an adaptation of the whole plant segment, with its mechanical and electrical parameters in function of the power of the furnace, reworked suitably and specifically to maximize the efficiency of ore-metal transformation and to optimize the quality of the product, while reducing production costs.

Our dedicated service consists in the following operative steps:

**Planning and designing**
- on-site technical surveys and acquisition of production parameters in operating conditions;
- first adjustment of charging programs software;
- preparation of executive projects related to the plant of the crucible, tapping machines and casting pit;

**Work execution and staff training**
- carpentry installation and building works supervision and coordination;
- furnace and casting personnel coaching and on-site training;
- metallurgists and chemical laboratory operators coaching and on-site training;

**Testing and coaching**
- modified implant areas and tapping machines testing;
- updated system start-up;
- customer support until full achievement of set targets and KAT® technology system-based management autonomy (from 3 to 6 months after the start-up);
- monitoring and post-sales assistance with the provision of a dedicated management software to ensure unaltered production targets.

Thanks to a technologically advanced designing system, KAT technology is able to satisfy every customer’s request, formulating an acting plan that ranges from simple modular incremental change to complete turnkey installation of a new production plant.
However, this production method widely used on an industrial scale, highlights some critical notes:

- the high viscosity of the slag in the crucible prevents the Coke (characterized by alveolar structure) to perform its reducing action with the correct gas-solid exchange. It follows a not entirely satisfactory ore-metal transformation and an excessive consumption of Coke compared with the results obtained;
- in consequence of a higher ore consumption, the produced slag is increased;
- the process, from an energy point of view, is inherently inefficient: the cyclical emptying of the crucible involves thermal downturns and electrical conductivity drops, because the charge of Fe-Cr is highly resistive. In these conditions, the furnace suffers of constant power loss;
- the separation of the metal from the slag occurs outside the crucible and in more stages: this circumstance does not allow to obtain a well emulsified metal thus promoting the occlusion of the reduction gas, resulting in porosity of the solidified metal. Under these operating conditions we obtain a spongy metal, which is polluted by the occluded slag. Furthermore, a part of the metal is lost because of occlusion in the slag;
- while material handling generates airborne pollutants which are harmful to operators, handling processes (subsequent to the tapping) increase the occupational risk factors;
- the formation of metallic micropowders, due to the handling and the separation of the solid phases, drastically worsens the microclimate in the workplace.

**Slag-related or gas-related defects represent a critical feature** for a Ferro-alloy that in turn, polluting the steel bath, impairs the final product which reveals a wide range of defects in workmanship. Surface and internal defects result in cracks and inclusions which force the steel mill to perform reworks and expensive interventions.
The adoption of KAT® technology brings the following productive advantages:

- the Coke performs its reducing action under thermodynamic ideal conditions, resulting in a more efficient reduction process. Thus the double level ensures efficiency in the ore-metal transformation and a lower consumption of metallurgical coke;
- in consequence of a lower consumption of ore, the produced slag is decreased;
- the process is energy efficient: the permanence of a certain amount of liquid in the crucible stabilizes the system thermodynamics and keeps the inside thermal conductivity constant. The use of the double level allows the furnace to operate in steady state condition;
- the separation of the metal from the slag is clear and it occurs already in the furnace, thanks to the prolonged chemical-physical action of the slags and the double level action. The correct homogenization and degassing of the Fe-Cr ensures a clearly improved quality of the Ferro-alloy (compact and well emulsified), thus eliminating Ferrochrome losses due to occlusion in the slag;
- the post-casting operations are deleted: this circumstance reduces occupational risk factors and improves the microclimate, because the formation of the metallic micropowders due to the handling is eliminated.

The KAT® technology provides two alternating castings with distinct tapping for ferroalloy and slag. The molten metal and the slag flow into specific runners at different heights of the furnace: the metal is tapped from a hole situated in the lower part, the slag from a hole situated in the highest part.

The innovation of KAT® technology is given by a dual mode action, a dedicated formulation concerning the slag chemistry and an on-site adaptation of the systems.

The reformulation of the slag chemistry involves a dedicated and adaptable parametric approach on the basis of production campaigns, whose aim is the perfect separation of the metal from the slag already in the furnace.

The plant design update involves:

- sizing of the crucible in terms of diameter and volume;
- optimal recalculation of electrodes wheelbase as a function of the transformer power;
- careful selection of a new refractory lining suitable for the containment and preservation of the material in the liquid state;
- designing of a new casting pit layout to allow the separated tapping of the two liquids phases.

This step allows to optimize the chemical reduction process, to reduce energy consumption and to maintain a well-defined amount of liquid material in the crucible, in order to ensure continuity of casting in the long term and simplification of the production process.
The benefits of using KAT® technology can be summarized in the following comparing table.

<table>
<thead>
<tr>
<th>TRADITIONAL TECHNOLOGY</th>
<th>KAT® technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty in obtaining the two solid phases (metal-slag) separation <strong>outside</strong> the crucible</td>
<td>Clear separation of the two liquid phases (metal-slag) <strong>inside</strong> the crucible</td>
</tr>
<tr>
<td><strong>Low efficiency</strong> of the ore-metal transformation [83÷84%]</td>
<td><strong>High efficiency</strong> of the ore-metal transformation [90÷91%]</td>
</tr>
<tr>
<td><strong>High energy</strong> consumption</td>
<td><strong>Reduced energy</strong> consumption [- 8÷9%]</td>
</tr>
<tr>
<td><strong>High</strong> consumption of raw materials (metallurgical Coke + Chrome ore)</td>
<td><strong>Reduced</strong> consumption of raw materials [- 8÷9%]</td>
</tr>
<tr>
<td><strong>Loss of metal</strong> in slag [c.a. 7%]</td>
<td><strong>Minimum loss of metal</strong> in slag [c.a. 0,5÷1% max]</td>
</tr>
<tr>
<td><strong>Loss of Cr₂O₃</strong> in slag [c.a. 12-13%]</td>
<td><strong>Minimum loss of Cr₂O₃</strong> in slag [4% max]</td>
</tr>
<tr>
<td>Insufficiently emulsified and porous metal</td>
<td><strong>Perfectly emulsified</strong> and compact metal</td>
</tr>
<tr>
<td><strong>High rate of micropowders and worsened microclimate</strong></td>
<td><strong>Low rate of micropowders and improved microclimate</strong></td>
</tr>
<tr>
<td>Post-casting operations increase occupational risk factors</td>
<td>No post-casting operations and reduced occupational risk factors</td>
</tr>
</tbody>
</table>

**Simplified technological process**

**Increase in production capacity** [+ 8%]

**Cost reduction** [- 8%]

**Better product quality**

**Workplace improvement**

**More safety**
For instance, in case of a 20 MW EAF, the benefits of using KAT® technology rather than traditional technology while producing Hc FeCr Cr65% are the following:

## TRADITIONAL FURNACE | FURNACE WITH KAT® technology

<table>
<thead>
<tr>
<th></th>
<th>Traditional</th>
<th>KAT® Technology</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromite consumption [kg/ton]</td>
<td>2.970</td>
<td>2.730</td>
<td>-8%</td>
</tr>
<tr>
<td>Electric energy consumption [kWh/ton]</td>
<td>4.450</td>
<td>4.050</td>
<td>-9%</td>
</tr>
<tr>
<td>Metallurgical Coke consumption [Kg/ton]</td>
<td>520</td>
<td>475</td>
<td>-8.5%</td>
</tr>
<tr>
<td>Monthly FerroChrome production [Kg/ton]</td>
<td>2.840</td>
<td>3.070</td>
<td>+230</td>
</tr>
</tbody>
</table>

**Production increase** on an **annual** basis [ton] + 2.760

**Revenues increase** on an **annual** basis [USD] + 2.760,000
The KAT® technology has an International Patent regarding advanced methodologies for the production of Ferro Chrome alloys and for the development of related technology systems.

KAT® has also been referenced by Prof. Giuseppe Silva, Professor of Metallurgy at the Polytechnic of Milan, who certifies its uniqueness and practical value.

Innovation dynamics give success to companies that keep up with evolution of markets.

Being at the forefront is our source of pride, a philosophy to interpret the evolutionary trajectories that enable companies to leverage their technology assets.
The extensive know-how in the field of steel allows us to provide, in a wide range of interventions, **highly qualified technical assistance and advice** to companies operating in this sector.

- **Study of the improvement of production methods:**
  - Ferro Chrome carburetor;
  - Ferro Chrome BTP (low phosphorus content);
  - Ferro Chrome Charge Chrome;
  - Ferro manganese carburetor;
  - Ferro manganese super refined;

- **Sampling of raw materials** (ISO 9002);

- **Certified chemical analysis** of raw materials and products;

- **Analytical laboratory** methodologies and standard operating procedures **supervision**;

- **Electrical and mechanical management optimization** of furnace and service systems;

- **Installation of** Chromite and Ferro-alloy fines **briquetting plants.**