The new VAI FUCHS ultimate EAF: Dawn of a New Era in Electric Steelmaking

T. Narholz, B. Villemin

Through the combination of advanced electric steelmaking technologies and design features VAI FUCHS is now in a position to offer an electric arc furnace capable of producing approximately 1,800,000 tons of liquid steel per annum. Referred to as the ULTIMATE EAF, this furnace features a tapping weight of 120 tons and an average tap-to-tap time of only 30 minutes. How such a furnace could look, the respective design figures and which technologies are employed is the topic of this paper.

INTRODUCTION

During the past twenty years electric steelmaking has been the primary driving force behind the growth in the steel industry. Modern EAF-based steelmaking plants feature following main advantages:

• Relatively low investment costs compared to the integrated blast-furnace/oxygen steelmaking route
• Utilization of a wide range of raw materials such as scrap, DRI, HBI and hot metal
• Ability to fulfill a wide range of production targets and steel qualities to meet the specific market requirements
• Low operational and thus conversion costs, promoting a relatively short return-on-investment.

For more than 35 years VAI FUCHS has been a frontrunner in the development of new technologies for electric steelmaking. Highlights include the introduction of water-cooled equipment, current-conducting electrode arms, single-point roof lifting, shaft furnaces, twin-shell EAFs and refining combined burner systems for enhancing productivity. Innovation has always been a trademark of the company philosophy. To date, VAI FUCHS has supplied more than 100 electric arc furnaces of AC and DC design, including shaft furnaces for scrap pre-heating and twin-shell EAF installations.

As a result of their continued emphasis on research and development and through the combination of all of their advanced technologies and EAF design features VAI FUCHS is now in a position to offer a new generation of electric arc furnaces. Referred to as the ULTIMATE series, a single EAF vessel with a tapping weight of 120 ton and an average tap-to-tap time of about 30 minutes is now capable of producing approximately 1,800,000 tons of steel per annum. The possibility of previously unattained productivity levels at record-low conversion costs now opens the door to a new era in electric steelmaking. A general view of an ULTIMATE EAF can be seen in Figure 1.

PLANT DESIGN

General

The new ULTIMATE EAF has been designed by VAI FUCHS on the basis of extensive know-how and plant-building experience in electric steelmaking. In addition to changes in the basic design of the EAF, a number of additional improvements were carried out in connection with the mechanical equipment, power supply, water-cooled parts, robotic systems, measurement units, oxygen- and carbon-injection systems, process control, automation as well as on dedusting and environmental equipment. Overall plant logistics were also reviewed to avoid operational bottlenecks, to perfectly match the capacities of all EAF-related facilities and systems with each other, and to ensure an optimized production route for achieving the designed production targets.

On the basis of detailed calculations in combination with the results from various operating plants the main design features of this new furnace type can be summarized in Table 1.
Equipment and Systems

An ULTIMATE EAF includes the installation of the following equipment and systems, each of which is reliably operating in various furnaces worldwide:

- Automatic scrap bucket pre-positioning
- Door-cleaning robot
- Contact-free temperature measurement of the steel bath
- Ultra-high-power oxygen- and carbon-injection technology with RCB (Refining Combined Burner)
- Automatic tap control from the main EAF pulpit via video camera
- Automatic slag detection during tapping with the IRIS system (InfraRed Identification System)
- Tap-hole cleaning robot
- Crane equipped with two auxiliary hooks for quick electrode exchange
- Electrode stand with spray-water cooling.

As proven in more than 35 installations worldwide (status: September 2004), the RCB oxygen- and carbon-injection system (Figures 2 and 3) boosts the exothermic energy input and actively promotes postcombustion. Deep bath penetration with highly effective oxygen/carbon reactions are ensured on the basis of the unique design of the system’s nose panel (Figure 4). The door cleaning robot keeps the door area free of scrap during charging. Therefore, a door burner or door lance is no longer necessary. The IRIS slag detection system exactly defines the ideal tapping time for minimized slag carry-over (Figure 5). With the tap-hole-cleaning robot not only are tap-hole cleaning times considerably shortened and plant availability increased, but risks to maintenance operators are also greatly reduced (Figure 6).
The mechanical components of an ULTIMATE EAF have been specially designed on the basis of the latest operational feedback and process requirements. Their advantages and reliability are already well proven in existing VAI FUCHS installations. Design features of key mechanical components include:

- Strong, simple and reliable construction (heavy mill-type)
- High vessel shell designed to allow for one-bucket charging
- Gantry design with single-point roof-lifting system
- Prismatic roller-guide system for electrode columns to reduce vibration
- Split-shell EAF design with the upper vessel section divided into the following panel sections (Figure 7):
  (a) Steel-panel section in the upper part
  (b) Copper-panel section in the lower part and in the slag zone, including specially fixed high-velocity panels for O2 and carbon injection (RCB)
- Tightest possible sealing between the panels and panel fixation on the shell cage to avoid panel movement (Figure 8)
- Improved, sturdy construction of the tilt platform,

Also, it would be possible to reduce the number of operators of an ULTIMATE EAF to three persons per shift:
1 EAF pulpit operator
1 Floor operator
1 Crane operator.

Consumption Figures
The use of modern calculation programs have shown that the operation of an ULTIMATE EAF would result in reduced power-off times, a more constant production level, improved consumption figures and lower overall costs. The expected performance figures of this furnace type are summarized in Table 2.

To achieve a 30 minute tap-to-tap time the power-on time is maximized through an optimization of physical and chemical process-related factors. The power-off time is reduced through the clever utilization of existing equipment and tools.

### Table 2: Specific Consumption Figures (Calculated).

<table>
<thead>
<tr>
<th>Material</th>
<th>Consumption (Metric Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>340 KWh/tLS</td>
</tr>
<tr>
<td>Electrodes</td>
<td>1.2 kg/tLS</td>
</tr>
<tr>
<td>Oxygen</td>
<td>35 Nm³/tLS</td>
</tr>
<tr>
<td>Gas</td>
<td>5 Nm³/tLS</td>
</tr>
<tr>
<td>Charge coal</td>
<td>10 kg/tLS</td>
</tr>
<tr>
<td>Coal powder</td>
<td>7 kg/tLS</td>
</tr>
<tr>
<td>Lime</td>
<td>40 kg/tLS</td>
</tr>
</tbody>
</table>

*LS = Liquid Steel

### Figure 6: Tap-Hole-Cleaning Robot.

### Figure 7: Panel Arrangement for High-Shell EAF Design.

### Figure 8: Panel Sealing and Fixation.

### AIM on-line

L’indirizzo Internet dell’AIM è:

www.aimnet.it

Gli indirizzi di posta elettronica sono: aim@aimnet.it per la segreteria, met.aim@aimnet.it per la redazione della rivista "la metallurgia italiana".