New sinter plant at Dragon Steel, Taiwan

The new sinter plant at Dragon Steel incorporates all the latest design and operational technologies from Siemens VAI to maximise sinter output and quality while minimising its physical and environmental footprint. Examples include intensive mixing and granulation, twin-layer charging, selective waste-gas recirculation and the Sinter VAiron process optimisation system.

As part of a major programme to expand its product portfolio to include high quality flat products, Dragon Steel decided to build a completely new greenfield steelmaking complex in the harbour area of Taichung (see Figure 1). For phase 1 of this major investment, which was completed in the first half of 2010, Siemens VAI supplied the sinter plant, a blast furnace with a diameter of 12m and an inner volume exceeding 3,200m³, and two 2-strand slab casters. This article focuses on the design features and operational results of the sinter plant.

**DESIGN FEATURES**

Sinter plant No. 1 (see Figure 2), supplied by Siemens VAI in co-operation with consortium partner CTCI Machinery Corporation, was designed with a suction area of 248m² and a nominal production capacity of 7,440t of sinter per day. The plant incorporates the latest sintering technologies to ensure a high and constant sinter quality, low operating costs and minimum environmental impact. Examples of the innovative solutions and technological packages include the intensive mixing and granulation system, twin-layer charging system, selective waste gas recirculation system to reduce the volume of sinter waste gas and pollutants released to the environment, integrated desulphurisation, de-nitrification and dioxin removal facilities, and circular dip-rail sinter cooler together with a number of unique design features, including off-gas recovery and the Sinter VAiron process-optimisation system.

With a footprint of only 43,020m² (478 x 90m), this sinter plant is one of the narrowest facilities of its type in the world. Table 1 lists the main technical features of the plant and Figure 3 shows a schematic layout.

**RAW MIX HOMOGENEITY AND AGGLOMERATION**

The materials used for the mixing and preparation of the sinter raw mix are stored in 26 bins with storage volumes of up to 380m³ (16 for iron ores and revert materials, 4 for fluxes, 2 for coke breeze, 2 for dust, 1 for burnt lime

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*Siemens VAI*
This setup provides a high degree of flexibility with respect to the selection of materials and charging ratios during ongoing operations. The raw mix recipe and the ratios of the various materials extracted from the bins are controlled by dosing belt scales with accuracies of ±0.5% of the set feed rate. The material is deposited in layers onto a conveyor belt and then transported to the mixing station.

To eliminate the need for blending beds and reduce investment costs for preparing an optimum sinter raw mix, an intensive mixing and granulation system was installed. This highly compact system consists of an intensive mixer (Eirich vertical shaft-type mixer; see Figure 4) and a granulation drum. With its high-speed mixing tools and rotating shell, this mixer creates a very homogenous raw mix which is then transferred to the granulation drum where it is agglomerated using hydrated lime prior to charging onto the sinter strand.

To reduce the number of transfer points, the granulation drum is mounted directly on top of the sinter-charging system. Installation meant that blending yards were not necessary – a major benefit for the company considering the limited space available in Taichung’s harbour area.

**TWIN LAYER CHARGING**

This system was installed for the first time at Dragon Steel. In comparison with conventional charging systems, this solution increases the permeability of the sinter bed, results in greater fuel efficiency and allows a more intensive and uniform ignition of the sinter layer. Figure 5 shows entry of sinter raw mix into the ignition furnace.

High permeability of the sinter bed is a decisive factor for ensuring high sinter plant productivity. A simple yet
An elegant solution to improving the porosity of the sinter bed was developed by taking advantage of the natural size segregation of the raw materials in the charging hopper. In this system the raw mix is deposited onto the sinter strand in two separate layers with different size fractions. The first coarser layer (approximately half of the total raw mix volume) is fed directly onto the sinter strand. The second layer, which includes an increased portion of solid fuel, is charged onto the first layer by means of a conventional drum-feeder system.

SELECTIVE WASTE GAS RECIRCULATION
A selective waste gas recirculation system was implemented in which approximately 30-40% of the sinter off-gas is recirculated to the process to help reduce solid fuel consumption (see Figure 6). Contrary to other off-gas recirculation systems in which a portion of the total off-gas is recirculated (with a relatively low mean temperature and CO content), in the Siemens VAI solution only the off-gas from selected wind boxes is recirculated to the sinter strand. The wind boxes designated for off-gas recirculation were chosen primarily on the basis of the heat, CO and O2 contents of the off-gas. In addition to the positive impact on the sintering operations, the off-gas volume directed to the stack is also lowered. This means that the dimensions of the downstream off-gas cleaning facilities could be reduced, leading to a decrease in the related installation and operational costs.

ENVIRONMENTAL PROTECTION
A sinter plant is one of the largest sources of emissions in a steelworks, however, thanks to the installation of advanced environmental protection systems, its low emission values
are exemplary. The sinter waste gas flowing to the stack is first de-dusted in an electrostatic precipitator, then hydrated lime is injected into the waste gas stream to bind the SOx compounds. The gas is further cleaned in a flat-bag filter where the concentrations of dust and SOx are reduced to the required levels. In a subsequent catalytic NOx and dioxin removal system, NOx compounds are reduced to nitrogen and water using ammonia (NH3) as a reducing agent and dioxin is decomposed to carbon dioxide, water and hydrogen chloride.

Cooling and Cooler Off-Gas Recovery

The hot sinter is cooled in a circular dip-rail cooler (see Figure 7). The special mechanical construction of the cooler charging chute ensures optimum particle size distribution within the cooler bed. Coarser sinter pieces are first deposited at the bottom of the cooler bed where there is a greater abundance of cooler air for cooling. The fine sinter fraction is then deposited onto the initial layer followed by charging of the mid-sized sinter fraction at the top. By sandwiching the finest sinter fraction between the coarser lower layer and the mid-sized upper layer, dust emissions are minimised.

Furthermore, the charging chute is designed in such a way that the sinter deposited onto the cooler pallets requires no levelling (Shuster principle). As a result, mechanical abrasion of the sinter is reduced, avoiding an unnecessary generation of fines. Hot off-air from the sinter cooler is recovered and subsequently used for a variety of purposes:

- Replenishment of the oxygen content of the recirculated sinter waste gas.
The expert system closely interacts with the recipe calculation model. If changes in the recipe are required due to changed process conditions or a different chemical composition of the raw materials, it automatically triggers a new calculation and activates the new recipe in the basic automation system.

**PROJECT COMPLETION**

Since start-up of the sinter plant in December 2009, output has continuously increased to a current production level of 7,600–8,200t sinter/day, commensurate with the downstream demands of the blast furnace and steel mill. In recognition of the fulfillment of all guaranteed performance figures (see Table 2), Siemens VAI has already received the Final Acceptance Certificate from Dragon Steel.

**NEW ORDERS RECEIVED**

Siemens VAI is currently installing a second sinter plant, a second blast furnace and a third 2-strand slab caster for phase 2 of the steelworks expansion project. The suction area of the sinter strand will be 387m², which will allow an additional sinter output of approximately 4Mt/yr.

The plant will be equipped with the same technologies and systems that are already installed in Sinter Plant No. 1 and start-up is scheduled for October 2012. When Phase 2 is completed, Dragon Steel will be capable of producing approximately 5.2Mt of steel per year. **MS**

**Table 2 Overview of performance figures of sinter plant No.1**

<table>
<thead>
<tr>
<th>Production data</th>
<th>Target values</th>
<th>During normal operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinter production, t/day</td>
<td>7,440</td>
<td>7,440–8,432</td>
</tr>
<tr>
<td>Discharge temperature max. °C</td>
<td>120</td>
<td>40–60</td>
</tr>
<tr>
<td>FeO content max. %</td>
<td>7.5</td>
<td>6–8</td>
</tr>
<tr>
<td>Under 5mm, %</td>
<td>max. 6</td>
<td>2–4</td>
</tr>
<tr>
<td>Over 50mm, %</td>
<td>max. 5</td>
<td>1–3</td>
</tr>
<tr>
<td>TI (ISO), %</td>
<td>min. 76</td>
<td>77–79</td>
</tr>
<tr>
<td>RDI, %</td>
<td>max. 38</td>
<td>22–28</td>
</tr>
<tr>
<td>Consumption of coke oven gas, Nm³/t sinter</td>
<td>max. 2.5</td>
<td>2.3–2.5</td>
</tr>
<tr>
<td>Dust content at waste gas stack, mg/Nm³</td>
<td>max. 20</td>
<td>&lt; 20</td>
</tr>
<tr>
<td>SOx ppm (−15% O₂)</td>
<td>max. 50</td>
<td>25–50</td>
</tr>
<tr>
<td>NOx ppm (−15% O₂)</td>
<td>max. 70</td>
<td>40–70</td>
</tr>
<tr>
<td>Dioxin ng-TEQ/Nm³ (−15% O₂)</td>
<td>max. 0.5</td>
<td>&lt; 0.5</td>
</tr>
<tr>
<td>Plant de-dusting efficiency, mg/Nm³</td>
<td>max. 20</td>
<td>&lt; 20</td>
</tr>
</tbody>
</table>

*Pre-drying and pre-heating of the lower sinter raw mix layer prior to the ignition furnace, thereby reducing the amount of coke breeze required for the sintering process*

*Thermal protection of the ignited surface of the sinter raw mix within an annealing hood*

*Combustion air in the ignition furnace to reduce the amount of coke-oven gas necessary for the ignition of the sinter bed*

**SIMETAL SINTER VAiron**

The latest generation of the Simetal Sinter VAiron process optimisation system was installed in the plant. This system covers typical Level 2 functions such as data exchange with the basic automation system, data storage and recall, data visualisation incorporating a user-friendly, freely configurable trending tool, and a sophisticated reporting facility (see Figure 8). Process models allow an ideal raw mix composition to be calculated to achieve a high quality sinter product. A recipe calculation model assists the operation team in administering raw mix recipes. If there is a change in the raw material composition, the process engineers can calculate the new recipe in advance.

A unique, closed-loop expert system is at the heart of the automation system. It cyclically evaluates the sintering process and displays the results in the form of process diagnoses. As soon as deviations from optimal process conditions are recognised, the expert system generates counter actions that can be executed automatically without operator interaction. The expert system optimises the sinter process with respect to:

* Longitudinal and transverse burn-through point control*
* Supervision of the return fines balance*
* Basicity and SiO₂ control*
* Coke rate control*

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