ABB Industrial^{IT} helps Bulgarian integrated steelworks improve blast furnace performance

Kremikovtzi Steelworks, Bulgaria.

First hot metal from BF#1.

Kremikovtzi Corporation, the Bulgarian integrated steelworks and one of the country's biggest industrial complexes, is modernizing its production facilities dating back to the early 1960s. A major step has been taken with the recommissioning of blast furnace #1, which had been shut down for eleven years. As part of the blast furnace revamp project, ABB has supplied a state-of-the-art control system based on its Industrial^{IT} open architecture platform.

Harsh environment in the steelworks.

Bulgarian Prime Minister Simeon Saxe-Coburg-Gotha at the official inauguration.

General background

The Kremikovtzi integrated steelworks, located 18 km from the Bulgarian capital Sofia, was established in the early 1960s and privatized in 1999. Its production facilities were based on ex-USSR technology. Three blast furnaces, each with a useful volume of 1,033 m^3 and a production capacity of 550,000 tpy of hot metal, liquid iron, were built in 1963, 1965 and 1969, respectively.

The metallurgical cycle was closed over the last 20 years with the commissioning of the rolling mill finishing lines based on West European and Japanese technologies. Besides the blast furnaces, the steelworks today includes a steel melting shop, slab reheating furnaces, slabbing and blooming mill, hot strip mill, cold rolling mills, pickling lines, temper line, electrolytic tinning line and color coating line. Other on-going projects include the installation of two 800,000 tpy single-strand slab casters. The current production capacity of the integrated steelworks is 1.7 million tons of long and flat products.

Due to financial constraints after the privatization, the modernization of the steelworks has been focused on improving quality and extending the product range with the assistance of an Italian technical team. Italy is in fact one of the steelworks' main customers for flat products.

One of the main modernization projects to date has been the revamp of blast furnace (BF) #1, which had been shut down for 11 years. It now has a production capacity of 2,200 – 2,300 t/24 h of hot metal.

Start-up of revamped blast furnace

The official inauguration of the revamped blast furnace #1 took place on November 5, 2002 in the presence of the Bulgarian Prime Minister, the former King Simeon Saxe-Coburg-Gotha, together with 1,000 guests.

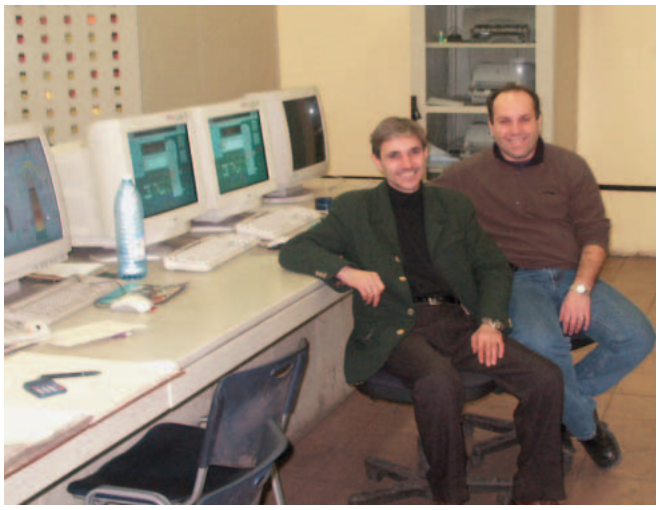
In his speech to the guests and employees, the Prime Minister said: "I am pleased that Kremikovtzi has brought us together for such a good reason: the inauguration of the revamped blast furnace #1. This investment of Euro 56.2 million is the biggest in Bulgaria this year. I hope it will have a positive impact on your work and also on the Bulgarian economy. This is really a major achievement and we, as Bulgarians and Europeans, are proud of it. I was really impressed by what I saw."

Blast furnace #1 at Kremikovtzi

As the first step in the metallurgical cycle, the blast furnace reduces and converts metal oxides into hot metal, liquid iron. Iron ore, coke and limestone are weighed on a scale car and transferred from the stock house via a skip car up the hoist bridge to the top of the blast furnace, which is lined with refractory brick. The actual charging of the burden is accomplished with a double-cone (bell) distribution device, which provides a gas-tight seal.

Preheated air, hot blast, is blown into the bottom, hearth, of the blast furnace by a blower via the hot air blast main and 14 tuyeres (nozzles). The hot blast ascends to the top of the blast furnace, undergoing different chemical reactions. The charged burden, in turn, descends to the hearth below the tuyeres and is converted into hot metal and slag.

Two Operate^{IT} Process Portal workplaces in the control room.



Blast furnace shop technologist Mr. Lachezar Hristov and Mr. Kolyo Stoilov, Automation Systems Manager at ABB Bulgaria.

The hot metal exits through an iron notch, while the slag is drawn off in a slag notch. At the same time, the hot gas rising to the top of the blast furnace passes from the uptakes to the gas cleaning plant, which includes dust collectors, venturi meters and cyclone dust separators. The cleaned gas is then used as fuel to heat the air to 1,200 °C in the stoves of BF #1 currently in operation.

Stove control system based on Industrial^{IT}

The Czech company Virkovice was awarded the contract for the revamping of the stoves. They built one completely new stove and modernized the burning system of two others, replacing the old burners with new ceramic ones.

One problem was that there did not exist any Bulgarian company that had ever installed a BF stove control system. After the evaluation of different companies, the customer decided to place the order for the new control system with ABB. “The final choice was made because ABB was ready to take full responsibility for the complex execution of the project,” says Eng. Hristo Valkanov, Commissioning Team Manager and Deputy Manager with responsibility for the engineering activities at Kremikovtzi. “ABB’s experience and good references of projects relating to burning processes were also important factors.”

Another complication was the extremely short time available for the execution of this project, namely four months for the engineering, delivery, installation and commissioning. The programming in fact was completed in four weeks, while the commissioning was done in 1.5 weeks.

The new stove control system supplied by ABB is based on its Industrial^{IT} platform. The hardware includes four AC800M controllers with PM856 processor modules from the Control^{IT} family of products, power supply modules for 220/24 V and around 200 S800L I/Os for each controller. The controller cabinets were assembled locally in Bulgaria.

The control network is based on ABB’s standard Ethernet protocol. Physically, it has been installed like an FO network, which provides additional protection against the high level of electromagnetic disturbances typically occurring in a steelworks environment.

In the BF control room there are two operator stations based on the Operate^{IT} SCADA Portal. The control software Control Builder has been installed in one of the operator stations for supervision and maintenance of the control system.

In addition to the control equipment, ABB has supplied the low-voltage distribution and control equipment for the various stove auxiliaries. The LV equipment includes incoming circuit breakers and bus ties of Isomax S6S type, with automatic changeover to ensure an uninterruptible power supply. Each object such as valves and fans is supplied and controlled via a relay-based feeder. This arrangement provides the necessary protection of the loads and cables, with coordinated discrimination between the upstream and the downstream circuit breakers. It also ensures the reliable transfer of data to the control system.

The LV equipment was assembled and commissioned locally in Bulgaria under the supervision of ABB.

Three of BF#1's stoves.

General view of BF#1 after its modernization.

Operation and control of the stoves

Bast furnace #1 has four stoves for heating the hot blast. One of them can be switched between BF #1 and #2. Each stove normally supplies the BF with the hot blast for about one hour. It is then heated by burning the gas from the BF for about two hours, after which cold blast is injected into the stove, where it is heated by the hot refractory. The BF therefore normally needs three stoves, one for supplying the hot blast, one for heating and one serving as hot standby. One stove is consequently connected to the blast furnace all the time.

Each stove is equipped with nine valves, one fan (blower) with frequency inverter and one control valve for the gas. Two PID controllers in each AC800M control the air and gas flows (gas/air ratio). Each object has its own faceplate on the operator station screen. This also presents in real time technical/engineering settings, trend curves of important analog signals, a list of alarms and a list of events. Furthermore, there is an overview display of all the stoves, while each stove has a detailed display. There are three normal operating modes: isolated, heating of the stoves and heating of the air blast, as well as a service mode. The AC800M controllers are responsible for executing the changeovers between the different operating modes. There are four different kinds of changeover: manual changeover by the operator from a local control board, individual changeover from the operator station, cyclical changeover from the operator station and automatic changeover.

In the manual mode the operator has the right to actuate any of the objects for local operation. There are no interlocks between the objects, but the operations are recorded and the commands are transferred via the controller.

In the individual mode the operator gives a command to activate only the right object with a push-button from a faceplate on the operator station. An indication is shown on the display of the object to be controlled. The other objects are interlocked and cannot be operated.

The cyclical mode is similar to the individual mode, but all commands are given, one after the other, by the controller (not by the operator). The operator can only give a command for a changeover from this mode to another one.

Finally, in the automatic mode the control system determines the working mode to be selected and automatically executes the changeover. In this case the operator acts as a supervisor and only intervenes in the event of a malfunction. If a malfunction occurs, the control system gives the operator a lot of information to enable him to locate it immediately and address the problem.

Commissioning Team Leader Hrisko Valkanov from Kremikovtzi.

Electrical Room with ABB´s Control System.

Results and benefits of the new stove control system

Prior to the installation of the new ABB control system the changeover of the stoves was done manually with the actuation of relevant valves, fans, etc. With the new control system all the necessary activation of these objects is accomplished via commands from the control system.

"Our task is merely to follow the indications and to monitor the process," says Eng. Nikolay Todorov, Chief Gas Technologist at Kremikovtzi. "In my opinion the system is user-friendly. This simplifies our work and the number of actions is minimized."

"Now after the completion of the job, I can express our satisfaction over our cooperation with ABB and the results achieved," comments Eng. Hristo Valkanov. "The project was completed without any delay. Only a few adjustments had to be made to the operation of the control system after the start-up of the production of the stoves on November 5, 2002."

The General Contractor, the Czech company Vitkovice, also states that the advanced ABB control system meets all the technical requirements. The overall performance of the stove control system is in fact of crucial importance to the overall performance of blast furnace #1.

ABB's specialists were responsible for the training of the blast furnace personnel. This included on-the-job training during the commissioning of the control system "Our staff very quickly got used to operating the new control system," says Eng. Lachezar Hristov, Blast Furnace Shop Technologist. "It is now a real pleasure for them to work in the new way. One of the advantages of the ABB system is that it not only provides real-time information but is also a complete control system. It manages the entire technological sequence of the stove operation."

Important benefits of the new control system are that it eliminates human errors and that only one operator is needed in each shift. Furthermore, the participation of a shift gas technologist is no longer necessary due to the high level of automation.

Thanks to the great precision of the new control system, the stoves can now operate in the most economical and technologically correct way. This lowers the operational costs and improves the BF performance.

A BF stove control system has to meet very exacting demands in terms of stability and reliability. A normal blast furnace campaign can extend over a period of up to ten years without any interruptions. It consequently has to be supplied continuously with hot blast from one of the stoves, while the others are being heated or are in the hot standby mode. Using Industrial IT, the ABB stove control system more than well satisfies these demands.

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