Process control system for the world's largest coking plant

The controls, electrics and all system components for the Carbonaria coking plant have been integrated into one large Industrial^{IT} system. The design of the interface between the process operation and the plant control system guarantees the routing of information in all directions in real time, and any operator with the appropriate permission can see or manage the desired information.

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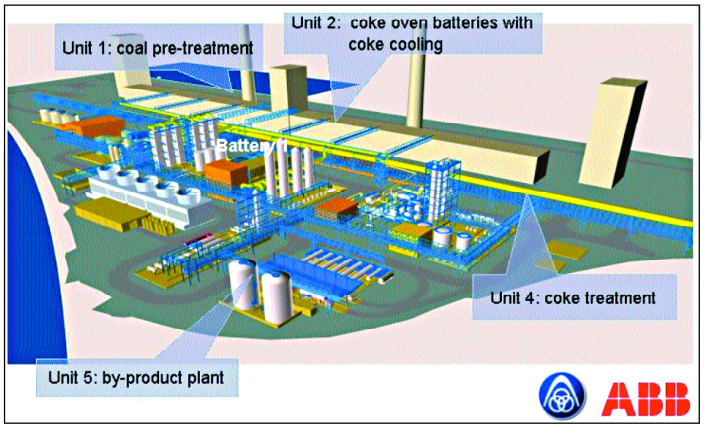
The paper describes the philosophy and design of the Profibus system for the Carbonaria coke plant in Schwelgern. The system uses the Industrial^{IT} concept where all automation levels within the plant are continuously connected within a network and where data flow includes plant control, engineering and individual measuring sensors. By means of the Profibus DP/PA (Decentalised Periphery/Process Automation), the system field devices are connected directly to the process control system and can be configured and parameterised with Engineer^{IT}.

For optimal and reliable operation the design of the control system addresses the operational configuration of the coking plant, namely, coal pre-treatment, coke oven batteries with coke cooling, coke treatment and the by-product plant. The seamless integration of Enterprise Resource Planning (ERP) components into the Industrial^{IT} environment is extremely advantageous for successful process control and cost-effective operation of this modern coking plant.

Introduction

After approximately three years of construction the first coke oven battery began operations in March 2003, followed by the second battery in May 2003. The new coking plant is an investment of approximately €800million with an annual production of 2.5Mt of high-quality coke to the two blast furnaces of ThyssenKrupp Stahl, Duisburg; which is 70% of the corporate demand (see *Figure 1*). The advantageous transport along the river Rhine is reflected in the price for coke, and the integration of the coking plant into the corporate energy network is a further economic advantage. In comparison to the previous coking plant at August Thyssen (6 batteries, 354 oven chambers), the daily number of push-out operations is reduced from 560 to 135, as there are only two coke oven batteries with 140 chambers in total. The single chamber pressure control system proven in combination with the excellent sealing systems exceeds the legal requirements for emissions.



● **Figure 1** ***Schwelgern Coke plant-production units***

The achievement of these goals reflects the design and performance of the control system and the holistic nature of ABB's Industrial^{IT} information management system. This provides a seamless flow of information from the field device to the Enterprise Resource Management System and vice versa.

General design

The coking plant comprises four production units:

- Unit 1 coal pre-treatment
- Unit 2/3 coke oven batteries including coke cooling
- Unit 4 coke treatment
- Unit 5 by-product plant

Components	Number
I/Os	25,000
Function plans	20,000
Measuring devices	5,000
Power feeders	1,180
Closed loop controls	500
Switchgear panels	300
Dell workstations	120
Assorted Profibus lines	48
Package units	40
Controllers	35

● **Table 1** ***Schwelgern coke plant, process system components***

As the general contractor for the controls and electrics it was ABB's task to integrate all system components to one large Industrial^{IT} system. This was performed by the use of several components from the Industrial^{IT} portfolio, namely:

- Control^{IT} for basic automation
- Operate^{IT} for operating and monitoring level
- Engineer^{IT} for configuration and parameter setting of field devices

With its 25,000 I/Os the coking plant is the world's largest Profibus system for industrial plants and incorporates third-party systems (package units) and field devices which are connected via Profibus DP/PA directly to the process control system (see *Table 1*).

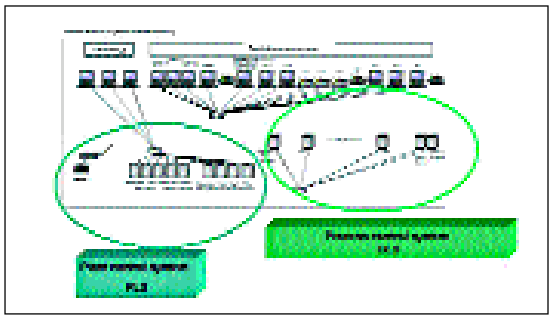
Design of control system

The design of the coking plant, with the four production units, is reflected in the design of the control system (see *Figure 2*). For each production unit there is its corresponding control sub-system and, by application of this approach, each production unit can operate independently of the other systems for a certain time. The superior, more abstract functions, are located in the central processor in which the mathematical models for production control and optimisation are executed. The instructions from the central processor to the four sub-systems are transmitted via a gigabit TCP/IP network.

Plant and process control systems

In the central processor there are two important modules: The process control system (PLS) that takes care of the process operation in the field and the plant control system (BLS), which is responsible for the overriding control, data management and statistics. The Industrial^{IT} design of the data and information routing and appropriate distribution of data is essential for the seamless flow of data (see *Figure 3*).

● **Figure 2** ***IndustrialIT design control system***



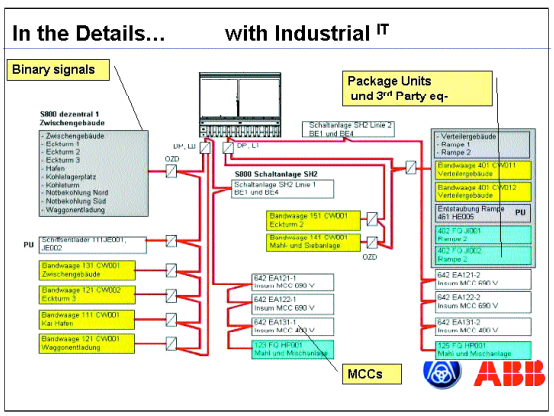
● **Figure 3** ***Process control at plant level***

Information management

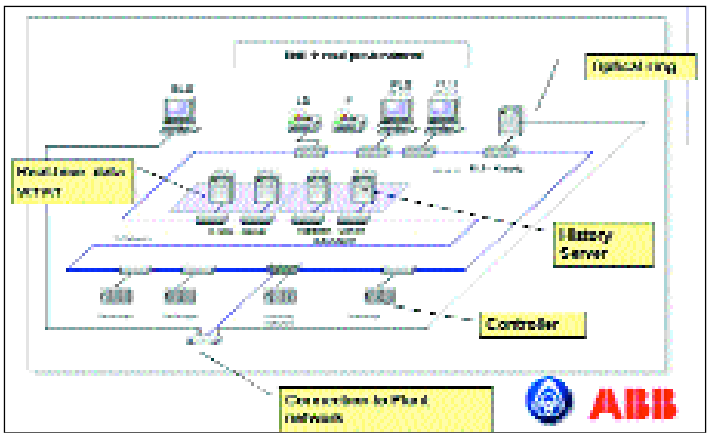
The design of the interface between the overriding control and the plant control system guarantees the routing of information in all directions in real time, and any operator with the appropriate permission can see or manage the desired information. This applies for data originating from the PLS as well as from 3rd party systems (see *Figure 4*).

Layout of a typical production unit control system

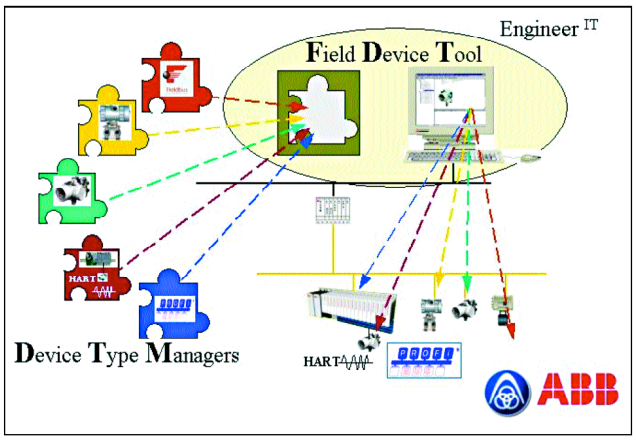
All data are transmitted via an optic fibre ring (see *Figure 5*) however, in the event of an interruption within this circular structure all members (controllers, servers) still remain online.



● **Figure 4** ***Information management***



● **Figure 5** ***System connections***



● **Figure 6** ***FDT/DTM interface***

The main components in a production unit are:

- Real-time data servers
- History data server
- Coupling server to the BLS
- Operator PCs
- Controllers

Depending on the demands and the importance for operation some components are installed in hot standby. The optical ring is connected to the gigabit network.

Field bus design

Downstream of the controllers the field devices are connected to the control system via Profibus, within which there are two mainstreams: Profibus PA and Profibus DP. With Profibus PA the electrical power is supplied with the Profibus. In the coking plant there is a mixture of both DP and PA, even at the same controller; a unique design for a large industrial application. The topology in the field network is either the ring (circular structure) or linear (star structure). With Industrial^{IT}, all signals (binary and analogue), motor control centre (MCC), and Package Units are integrated into one consistent information network.

Field device tool and device type manager

For the field devices the level of integration is deeper. There is a standardised interface between field device and the control system, comparable to a printer driver on a home computer (see *Figure 6*). The two software modules are named Device Type Manager (DTM) and Field Device Tool (FDT) and the software with the field device interfaces seamlessly to the controls, for example, parameterisation from remote can be performed easily. All components are based on international industrial standards (see *Figure 7*) so Industrial^{IT}-enabled components are not limited to ABB, but available from many suppliers of industrial control products.

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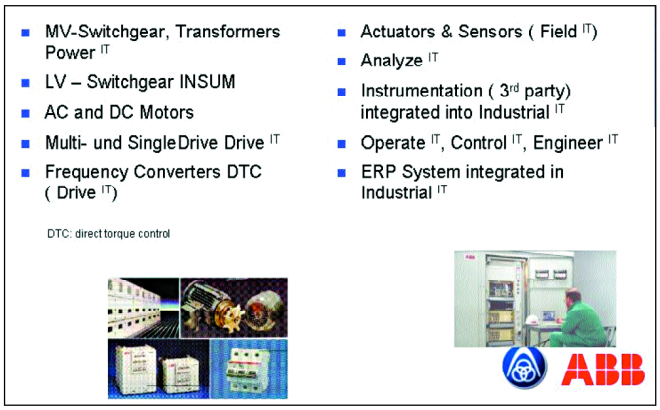

● **Figure 7** ***ABB products used in coke plant***