Advant BrauSystem in full control of new German brewery

German beer producer Freiberger Brauhaus AG selected ABB's Advant BrauSystem for the control and automation of its new, ultra-modern brewery in Saxony. Production data with the state-of-the-art installation, which is based on the ABB Advant® Open Control System, are impressive and lie well above the average for German breweries. In addition, Advant BrauSystem has helped to lower heat consumption and allowed a considerable reduction in staff. Besides the control and monitoring equipment, ABB also delivered the building services management system and other electrical installations for the brewery.

The new brewery of *Freiberger Brauhaus AG* in Saxony, Germany, has an annual production capacity of more than 60 million liters of beer and ranks as one of the most modern and efficient breweries in Europe **1**. Top priorities of the brewery planners were, in addition to guaranteeing highest quality for the end-product, the economic and efficient use of energy and raw materials as well as a minimal impact on the environment.

Exceptionally good production data are achieved on the one hand as a result of the future-oriented organizational structure and brewing process, and on the other due to the ABB Advant BrauSystem [1] – an Advant Open Control System (OCS) for industrial processes (see box) – that was selected for its automation. The 8.3 kWh of electrical power and 340 liters of fresh water required to brew one hundred liters of beer lie well below the average figures for German breweries, which in the case of the electrical power is 11.5 kWh per hundred liters. Furthermore, the Freiberger brewery produces 680,000 liters of beer per year and employee, more than double the average in Germany (320,000 liters per employee per annum); power demand in the rest of the brewery is also low at 30 kWh per 100 liters beer (average 45 kWh per 100 liters).

The parent company of *Freiberger Brauhaus AG, Eichbaum Brauerei AG* of Mannheim, Germany, invested some US$ 45 million in the new production facility, which has a workforce of approximately 120. The Freiberger brewery takes up an area of 11,680 m^2 on a site totalling 91,941 m^2 in size.

Klaus Winkelmann
ABB Automatisierungsanlagen Cottbus GmbH

Besides Advant BrauSystem, ABB's scope of supply included all of the electrical installations. The benefits of 'one-stop shopping' for the process control and electrical equipment were one of the reasons for the automation contract being awarded to ABB.

Automation in the brewery

Advant BrauSystem allows most of the brewing process to be operated fully automatically. The process begins with the delivery of the malt, which can be un-

ABB Advant® Open Control System

With its Advant® Open Control System (OCS), ABB offers a standard, state-of-the-art platform with open system architecture for the automation of industrial processes. The system is characterized throughout by an object-oriented and distributed structure, high-performance operator stations, very high availability and ease of maintenance. All process and operator stations are linked by the System-bus MB 300. The process control stations communicate with I/O units by means of field buses.

Every stage in the industrial process can be controlled and monitored from each of the process operator stations. The station hardware is based on the workstation technology of Hewlett-Packard.

ABB Advant BrauSystem

Advant BrauSystem, which uses Advant OCS as a general platform, represents a dedicated solution for the beer-brewing industry. It benefits from more than 20 years of experience gained by ABB as an international supplier of brewery automation systems.

The range of software allows overall operation and monitoring of breweries, from the supply of the malt to bottling, with either fully automatic operation (weekly brewing programme, recipe control) or manual/automatic isolated operation.

The new brewery of Freiberger Brauhaus AG in Saxony, Germany. The production data achieved by the ultra-modern plant lie well above the average for German breweries. **1**

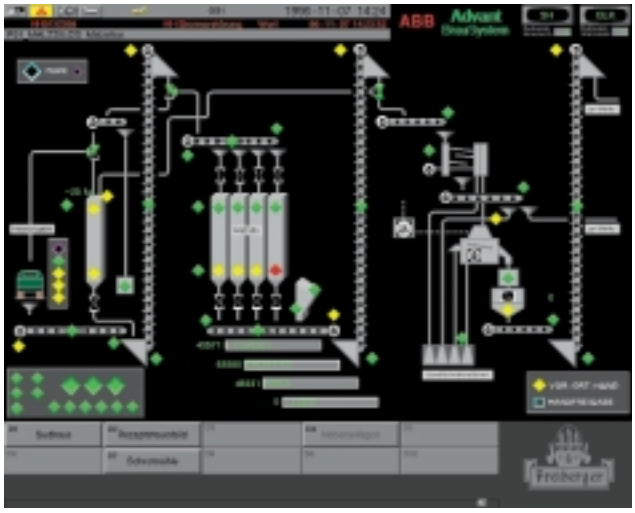
loaded at a rate of up to 50 t per hour and is stored in four silos, each capable of holding 80 t **2**. The malt is afterwards processed in a bruising plant with a six-roller mill and hot-water conditioning system. Both the malt-receiving facility and the bruising plant are coupled to a dust extraction system. The mass flow rate of the extraction fan is 180 m^3/h. A fully automatic jet exhaust-air cleaning system measuring 60 m^2 in area filters the forced air.

The subsequent production processes take place in the brew-house and are also fully automated (**3** to **8**). In this four-unit plant, the bruised malt passes together with the mashing water via a mixer pipe to the mash tun, which has a design capacity of 35,000 liters. Mashing proceeds without dust or lumps being produced. The mash tun has a surface area of 28 m^2 and is heated at a rate of one kelvin per minute. A mash pump with a capacity of 260 m^3/h carries out the finish mashing, which takes approximately 2.7 hours.

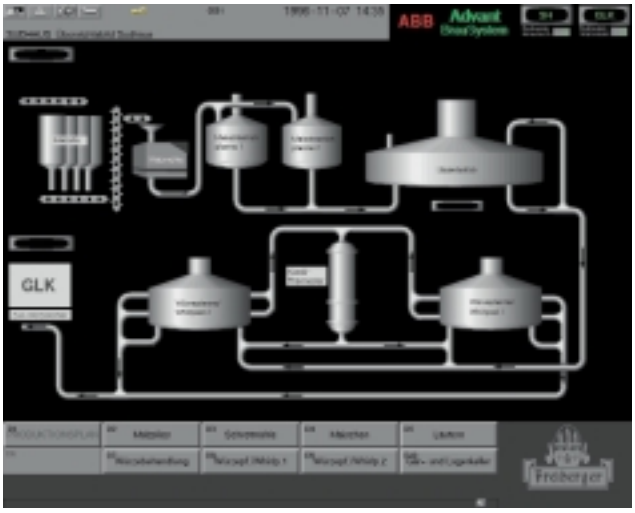
The wort is produced in a clarifying vat with a diameter of 7.8 m and a capacity of 99,400 liters; this process takes three hours. The wet remains of the malt pass via an intermediate silo to the main collecting silo with a capacity of 170 m^3. A 10,000-liter tank collects the process water.

Two whirlpool wort coppers, each with a diameter of 5.7 m and a capacity of 55,000 liters, are used to boil the wort. The two-zone boiling apparatus has an evaporation rating of 4,000 liters per hour. A vapour condenser saves primary energy by reducing the steam consumption. The hops are added in two doses, the first usually consisting of hop extract and the second of hop-aroma pellets. The facility for producing lactic acid consists of 8,000-liter fermentation tanks, an infeed tank (1,000 liters), a heat-exchanger for cooling the front wort to 46 °C, and a pump. The pH-value for the wort is set to 5.2.

A heat-exchanger with 390 plates is used to treat the wort at the rate of 60,000 liters per hour. After removal of the coarse dregs the wort is cooled in the whirlpool copper from a temperature of 98 °C to 7 °C. Afterwards, the cooling water is heated from 5 °C to 86 °C, being stored as mashing liquor at this temperature. Pitching of the wort with barm (yeast) is carried out automatically. The yeast cell



Fully automatic control of the main plant in the brewery is based on Advant BrauSystem and supported by modern process operator stations. The screenshot shows an overview of the malt silo. **2**



Screenshot showing an overview of the brew-house with the clarifying vat and the wort coppers. The alarm bar at the top appears simultaneously on all the operator station VDUs. At the bottom are the 'soft keys' used to operate the plant. **3**

number lies between 15 and 25 million per minute.

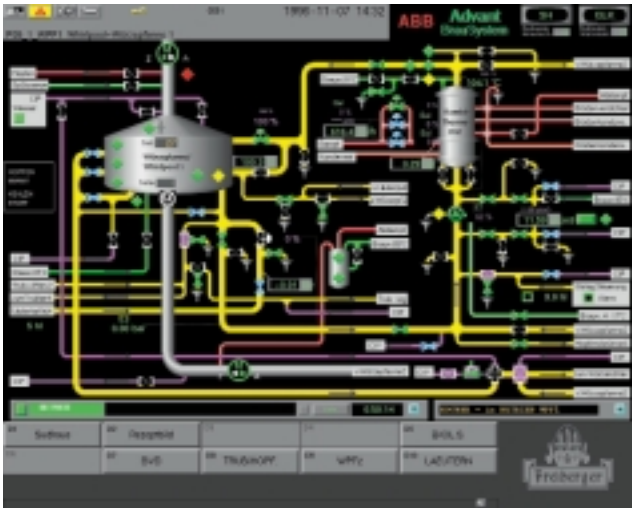
To clean the brewing plant there is a decentralized CIP[1] system consisting of two 10,000-liter tanks for caustic solution and water, and a fresh-water vessel. The purifying liquids are transported by a pump, driven by a frequency-controlled drive, through a ring main pipe to the brewing vessels, which are fitted with spray nozzles. After cleaning, these purifying liquids are returned by two self-priming pumps. The CIP equipment is also controlled by Advant BrauSystem.

Also covered by the process automation are the fermentation and storage areas and the yeast and pressure tanks.

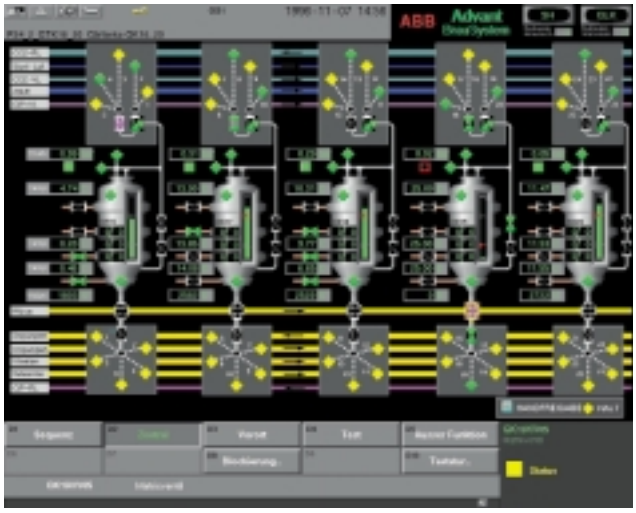
View of the modern brewing facility at Freiberger Brauhaus AG **4**

Fermentation takes place in a 'one-tank process'. Each charge is pitched with a fresh amount of yeast. The carbonic acid produced during the fermentation is liquified and used to re-carbonize the beer prior to bottling. Filtering is carried out by a multiple tube filter with metering unit for the diatomite suspension filtration, a PVPP[2] stabilizing filter with regeneration system, and a particulate filter. The end-product is finally carbonized with up to 12 g of cabonic acid per liter and stored under pressure in six tanks, each with a volume of 150,000 liters, ready for bottling.

The refrigerating plant is rated at 2,200 kW. Ammonia is used as refrigerant instead of chlorofluorocarbon (CFC) as it is known to be far less damaging to the ozone layer than the latter. Recooling of the cooling water is achieved by coupling each of the three piston compressors of the compressed-air plant to a heat-exchanger. The heat from the recuperator is used to heat the mashing liquor. If required, the compressors can be individually connected or disconnected as a function of the load.



Detail of whirlpool wort copper 1 5



Screenshot of the fermentation tanks 6

Within the overall brewery automation scheme there are also some isolated automation configurations involving process control components from other companies, for example for the carbonization system and the separator. Other isolated systems are installed for the boiler house, the control of the mixing and equalizing basin and the load-optimization system, which ensures that advantage is taken of the lowest electricity tariffs. All of these isolated systems send their full range of data to Advant BrauSystem.

ABB Advant IMS plays a key role

The ABB Advant Information Management Station (IMS) with Oracle database links the production process to the administrative offices in the brewery, making it the gateway to the different data processing environments. Every SQL[3] system is able to access, via special software (SQL Connect), all objects in the process, including for example Microsoft Excel. Excel data can also be sent to the process operator stations. The user can view the entire information environment, with its distributed databases, from every angle as a uniform Oracle database. The information management stations also act as flexible servers for functions such as the weekly brewing programme, recipe management, preparing reports and determining trends, tracking charges and long-time data storage. In other words, everything that is required for quality assurance as defined in ISO 9000. The open architecture of OCS also allows SAP systems to be integrated.

Powerful process operator stations

The entire brewing process can be supervised and controlled by means of three process operator stations 9. Full graphics displays at the stations allow each operator to easily 'move around' the brewery. The use of windows allows different parts of the process – eg, the brewing plant or a filtration system – to be displayed on one monitor at the same time.

Hardware

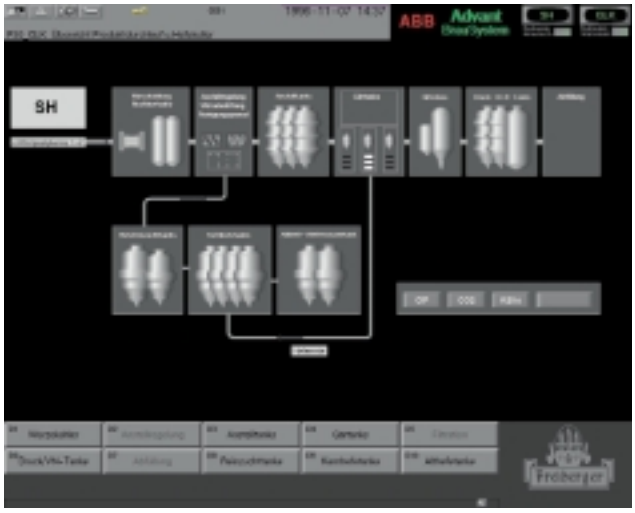
The hardware is based on workstation technology from Hewlett-Packard, with an HP-UNIX used as operating system. Six Advant Controllers of type AC 410 control all areas in the brewery, from delivery of the malt to bottling.

All the process and operating stations are connected together by a powerful bus (ABB MasterBus 300). Fiber-optic field buses link the process control stations to the distributed I/O units. These units allowed a considerable cost-saving during the installation of the automation system.

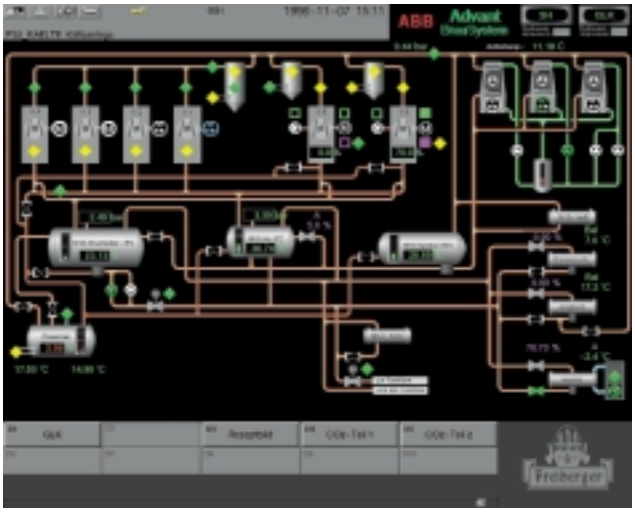
Quality assurance

One of the features upon which economic production and highest quality for the beer depends is the generation of reports. A report is prepared for each production unit, with a production ID number given for each brew batch. In the brew-house this is the brewing ID, in the fermentation process the beer ID, and in the filtration process the filtration ID. Also generated is a report on the basic recipe used. This is because the original recipe, which is automatically downloaded from the IMS, could have been altered by the operator. By pressing a 'preview' button the operator can open a window for the display of curves. Tools for analyzing the curves are also provided. This enables the operator

[1] CIP Cleaning In Place
[2] PVPP Polyvinyl polypyrrolidone
[3] SQL Standard Query Language



Overview of the production process and the yeast cellar **7**



Screenshot of the refrigeration plant **8**

to obtain details from the Oracle relational database, which contains all of the necessary information on the batch being tested.

When checking the quality of the beer it is especially important to be able to track the path of each charge. Tracking is supported both by the relational structure of the Oracle database and the ID numbers, while it also gives the operator the opportunity to cross-reference the different reports. If, for example, the beer in a bottle has gone bad, the filtration ID supplies the data for the analysis. The filtration ID itself comprises different beer IDs, which in turn consist of a number of brewing IDs. To perform the analysis the operator enters the filtration ID on the screen, after which the monitor displays the appropriate fermentation and brewing reports. The operator thus knows which reports belong to the spoiled beer and can import them from the information management station.

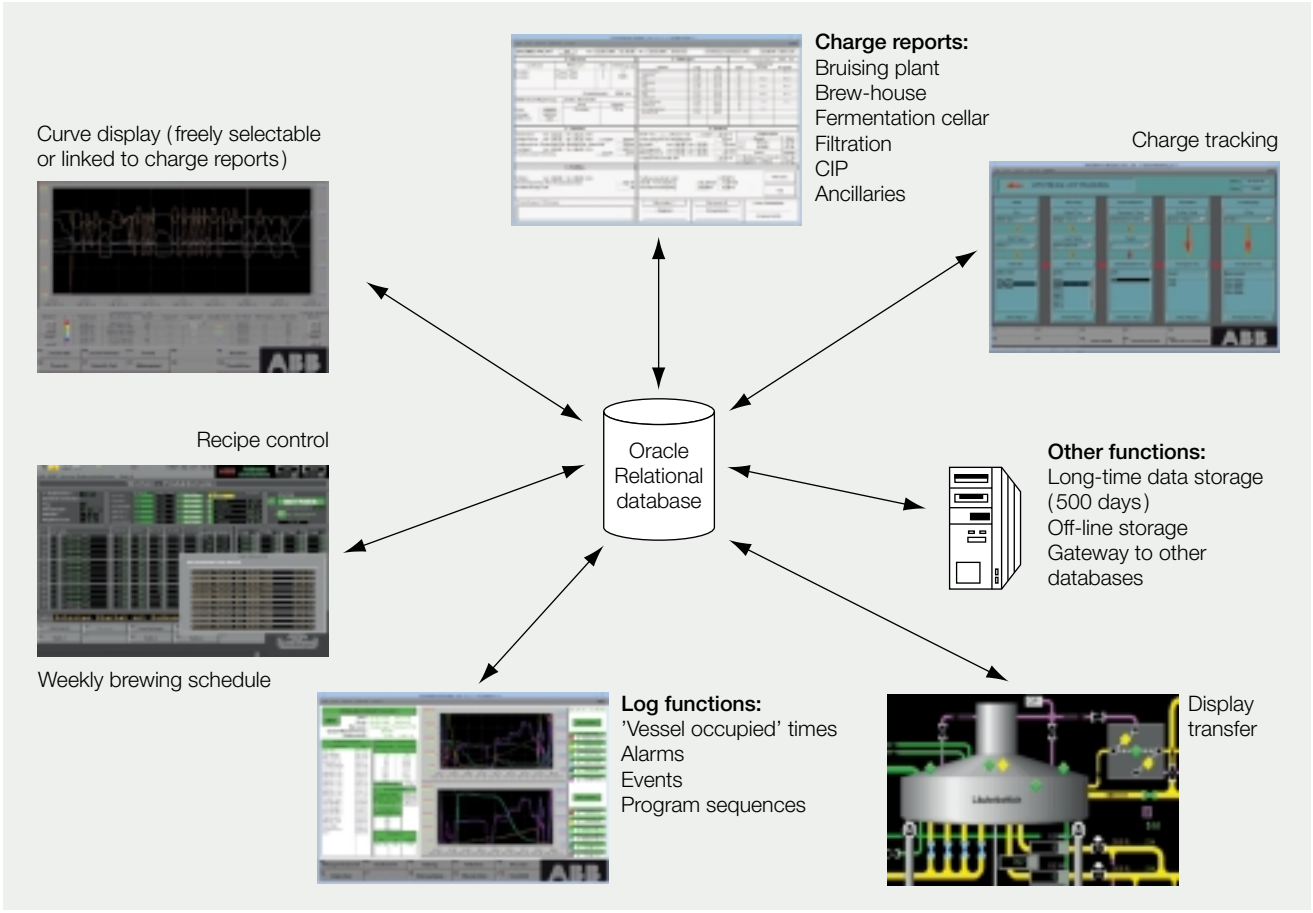
Central control room in the new brewery, with three process operator stations **9**

MES – the link for integrated operations control

The present automation scheme spans the process control level plus a link-up to the Manufacturing Execution System (MES) functionality **10**, as represented for example by the weekly brewing programme, the recipe-controlled production or tracking of charges **11**.

Manufacturing Execution Systems have made it possible for a visionary idea in the 1980s to finally become reality: an integrated operations control system. In this context, 'integrated' means being functionally tied into both the hierarchically lower process control system and the production control system above the MES.

In the past, cost was not emphasized to the extent it is today and production was



Basic functions of Advant BrauSystem with added MES functionality **10**

CIP *Cleaning In Place*

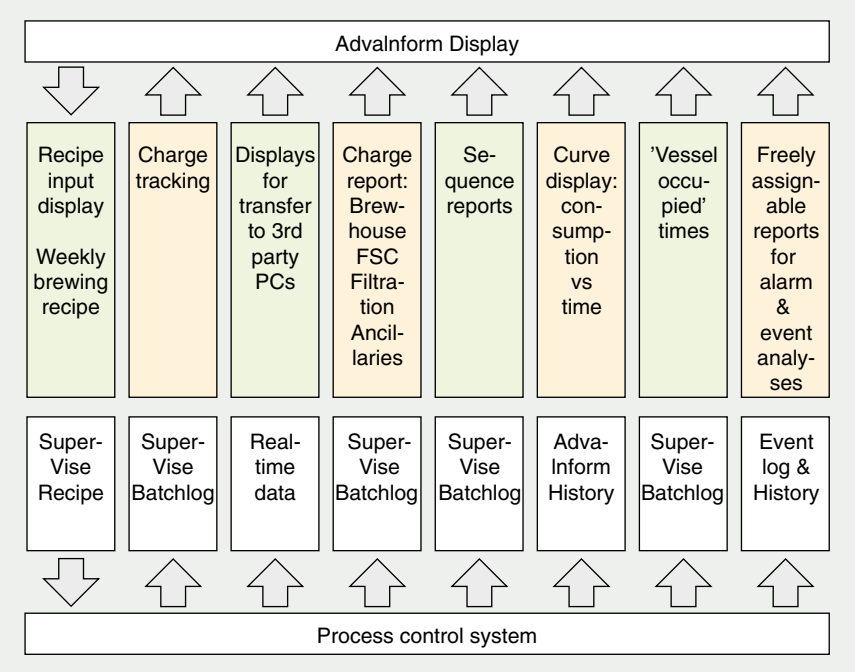
simpler, mainly due to the fact that there was less demand for different types of beer. Quality and environmental concerns were also given less attention than they are now. Such market pressures as there were did not call for plant-wide automation. Also, the technology available earlier did not have the capability it has today. This was true in particular of the distributed, relational databases and database management systems with standardized interfaces via which data is exchanged between the different hardware and software systems and users.

Open process control systems and their standardized communication interfaces (eg, SQL and TCP/IP) as well as Management Execution Systems and Enterprise Resource Planning (ERP) systems offer today a level of functionality that was originally intended for computer-aided production. Extending the ABB Advant OCS with MES functionality has added system capability that enables operators to increase their productivity.

ABB Advant OCS thus provides the basis for company-wide communication. On the one hand new functions for the immediate process control tasks can be easily integrated, while on the other support is provided for higher-level control and management assignments. To expand the possibilities offered by Advant OCS in this area, ABB developed AdvaTalk Extensions. This is a tool which allows communication with special programs via a simple operator interface. For example, there is an AdvaTalk link to the mathematics software Matlab and, via Advant OCS user access, to a comprehensive library of mathematical and statistical functions for optimizing processes.

Also available today are AdvaTalk Extensions to batch systems, to the ERP system SAP R/3 and to Oracle GEMS. AdvaTalk also supports the functional design of core parts of an MES and its link to the ERP level (eg, the acquisition and management of historical data from a wide range of data sources). The AdvaEnterprise Historian System is even able to store historical data from 2,500 sources and at a sampling rate of 15 s for an entire year in just one gigabyte.

ABB Advant OCS is based on generally recognized standards that allow links to other systems, for example object man-



Standard software components and applications in the area of operation of the Manufacturing Execution System (MES) **11**

FSC *Fermentation/storage cellar*

agement functions, SQL Connect software or Microsoft standards, such as OLE and Corba. Users in laboratories, etc, can easily link Advant OCS via known MES functionality paths to laboratory information management systems.

AdvaTalk can also be used to create links between planning systems and an MES. This makes it possible to visualize production requirements in the MES and, conversely, inform the planning system of actual production data.

To build up the database it is necessary to determine and track all of the materials used in the production process: raw materials, additives, waste, byproducts and end-products. The MES can be extended by adding weighing, metering and distribution systems; further additions can be batch-sequence check and management systems. To simplify transactions with materials and printed forms showing the output, etc, terminals and barcode readers can be installed.

Further expansion with ERP

Further expansion options for the brewery target the operations and production control level. Modern-day control systems represent 'integration paths' for the transmission of information: horizontal paths within a level and vertical paths from the process information through the operations and production-related information to the ERP system. All data in the real-time databases of the system should be accessible from all levels – even from the ERP systems. The technological platform for this has been installed in the new Freiberger brewery.

Electrical equipment

Besides the control equipment, ABB also delivered the power supply system for the brewery, including transformer substations, medium-voltage and low-voltage switchgear, and the building services equipment. The absence of interface problems makes operation and maintenance of the brewery easier.

Project targets have been surpassed

After two years of commercial operation it can be said that the production data given in the specifications drawn up by *Eichbaum Brauerei AG* and ABB have been even surpassed. This fact is underscored not only by the comparatively low specific consumption of materials and energy but also by the fewer operating staff needed. All of these results are 'best of class' in the industry.

Part of this success is the result of the modular, extendable structure selected for the brewery by *Eichbaum*, who were responsible for the overall planning.

The good production and consumption data is also a direct result of the installed Advant BrauSystem, the design of which will also accommodate any later extensions of the brewery undertaken by the owners.

Reference

[1] K. Winkelmann: ABB Advant BrauSystem. ABB Automatisierungsanlagen Cottbus GmbH.

Author

Klaus Winkelmann
ABB Automatisierungsanlagen
Cottbus GmbH
Gaglower Str 17/18
D-03048 Cottbus
Germany
Telefax: +49 355 596 595
E-mail:
klaus.winkelmann@deaac.mail.abb.de