

Automation and Control Systems at Coal Preparation Plants in Czech Republic

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Abstract

The paper describes the status of automation and control systems at coal preparation plants in the Czech Republic. It discusses the control of coal preparation plant according the control levels: process, dispatch and management. The process control level is directly linked to the technological process; automation control of technological nodes such as coal preparation in a flotation, in a heavy liquid or in jigs, and control of other processes like dewatering. The paper mainly describes solutions from ATP Soukup Ltd., which operates in the field of automation of coal processing more than 15 years. The dispatching control level has to do with the management of the technological process. Here are used proprietary information systems operating in real time. The aim of these systems is to control of the process quality, especially to ensure the required quality parameters of produced coal. At the management control level it is mainly about the management of sales and related economic processes. In the coal preparation plants in the Czech Republic there are sales management information systems, which are closely linked to the coal preparation plant information system. These systems enable real-time monitoring the status of the expedition and the coal quality parameters (for example ash or water content).

INTRODUCTION

This paper discusses automation and control systems in coal preparation plants in the Czech Republic. The paper is only focused on black coal treatment (there is also brown coal mining in open pit mines in the Czech Republic). Black coal mining is concentrated in the region of Ostrava – Karvina and all the mining activities fall under OKD Joint Stock Company. Nowadays, there are five coal preparation plants in the area.

Description of the automation and control systems in the coal preparation plants depends on control level. There are three control levels: process control level, dispatching control level and management control level.

PROCESS CONTROL LEVEL

When speaking of the process control level of coal preparation plants, we are in the field of process automation of technological nodes, such as heavy liquid separation, jig separation, flotation, dewatering, homogenization, etc. This control level includes automatic direct control of technology (for example control of homogenization), from automatic regulation to data acquisition. General contractor in the area of process automation at coal preparation plants is ATP Soukup Ltd. The company provides its own solution of the control of technological nodes. This includes supply of sensors (more than a thousand analogue and binary sensors), weight systems and continual ash-meters, from the solution of PID control to direct control of machines.

Control of jig separation supplied by ATP Soukup Ltd. is based on ADiS modular control system (Amit Ltd.). There are several control loops that must be solved. The unit itself performs automatic pulsation control in

the jig. Several pulsation types can be selected: simple pulsation, where pulse rate per minute can be controlled, or multiple pulsations with the cycle period set in seconds. In addition, the system allows for further control loops: automatic control of bed elevation, air pressure control in jig field collectors, and bottom water flow control. Automation of the jiggling process increased cleaned product yield by 2 % (according to tests carried out by VŠB TU-Ostrava).

Flotation process is controlled by dosing the flotation agent according to the ash content of the flotation gangue with a correction using the rate of flow and the specific mass of the input raw material. As a stabilising element for the main control circuit, the level in the flotation machine is regulated by controlling the output of the flotation gangue. Implementations in coal preparation plants are always tailored to local conditions, flotation machine type, requirements of sludge management and dewatering systems.

Heavy liquid separation control includes: measuring the quantity of heavy ferromagnetic medium in the suspension, regulation of water or suspension dosage, density regulation, and regulation of the separating “cut” (control system by ATP Soukup Ltd).

Visualisation of technological processes in coal preparation plants is solved mainly by SCADA/HMI system Promotic (Microsys Ltd, Ostrava).

The latest control system launched at OKD Join Stock Company is a control system at ČSM Coal Preparation Plant. The system was implemented in Spring 2009. On the process control level, there is a solution by Temex Ltd, based on Siemens Simatic PLC control and Siemens SCADA system. All the devices are connected via Profibus.

DISPATCHING CONTROL LEVEL

Dispatching control level covers the control of the technological process as a whole. The key process on coal preparation plants is focused quality parameters of the produced coal, which should meet contracts requirements (the most important quality parameters are ash and water content). In the field of automation at this control level, we are talking about real time control systems. Nowadays the third generation of coal plant preparation information systems is used. The first generation, based on Digital PDP computers with RSX operation system, was run twenty years ago. It was followed by the next generation of information systems that was built on Digital ALPHA mainframe computers (with VMS operating system). The latest generation (since 2007) uses a standard hardware and software platform (Intel server, Windows Server 2003/2008), which makes the system easy to maintain. The third generation of information systems is supplied with a SQL database (Microsoft SQL Server 2005 or 2008).

The coal preparation plant information system works on the dispatching control level and ranks among "real-time" control systems. The system is connected to the process level, via a large number of sensors (more than 1,000) with real-time data acquisition. This allows on-line visualization of technological processes. The information system also automatically processes data obtained from track and road weights (Schenck, Wesico), which are used for weighing railway wagons and lorries. The key activity in product quality control is to collect on-line data from continual ash-meters (Enelex, Wilpo). Data acquired from ash-meters are processed and the system calculates a trend in the quality of the loading coal. The management of coal preparation plants have a tool that allows them to take control measures that make it possible to stick to quality parameters stated by a contract.

All collected or processed data are stored into databases. This makes it possible to keep the history of technological process, alarms, and workers' activity. This is background for compliance the product quality with ISO 9000 certification requirements. Another benefit brought by the information system is that monitoring workers' activity leads to an increase in productivity. Continuous supervision over the process provides managers with a tool allowing them to identify and analyze deviations from process regulations and control with eliminate their causes.

The coal preparation plant information system is built in a modular structure and has several software layers. Modularity makes it possible to make the system alive when technology is changing. Division into software layers (data acquisition layer, data processing layer, database layer, layer of alarms, user interface layer, system layer and communication layer) makes it easy to maintain and modify the software.

MANAGEMENT CONTROL LEVEL

Management control level has to do with economy and includes activities like planning or keeping balance.

This is an area of corporate information systems (ERP) with analytical processing. OKD mining company runs SAP R/3 corporation information system.

SAP R/3 is added to the local sales control systems. Sales control systems are strictly database oriented. They are usually connected to a coal mine laboratory to store precious measure of products quality (ash content, water content, calorific value, dilation, phosphorus content, sulfur).

The system also deals with daily loading plans, with an emphasis on the quality of products required by customers. Sales systems are connected to coal preparation plant information systems, which are operated on the dispatching control level. This allows for on-line monitoring of loading, according to daily plans with a check-in of quality parameters. Data from sales systems are transferred to SAP R/3, and serve as a basis for issuing invoices. Sales control system can also create all necessary transport documents (such as inland and export bills, train loading, quality reports). Other important things that the sales system can do include summary reports, loading statistics, and statistics of quality parameters (sorted by customers, type of coal etc.)

CONCLUSION

Standards of automation and control systems in coal preparation plants in the Czech Republic is currently very high on all of the control levels. The development of the three generations of systems has led to the implementation and usage of modular and scalable systems that fully cover the needs of coal preparation plant management. The deployment of these systems has led to direct savings as well as to improvements in the management of technological processes.

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