New Process Control Systems in the Energy Sector

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1. Introduction

The energy sector (thermal power plants, geothermal power plants, and the like) is transitioning at a rapid pace resulting from broader deregulation of the electric power industry, the rapidly increasing price of crude oil, and the reduction of global greenhouse gas as mandated by the Kyoto Protocol. Influenced by these trends, control systems in the energy sector are becoming more cost effective, and advancing towards greater reliability, globalization and the use of open standards.

Under these circumstances, Fuji Electric released the MICREX-NX new process control system in September 2004.

This paper describes the need for information control systems in the energy sector, and, as examples of actual applications that use the MICREX-NX, introduces a boiler control system for an independent power producer (IPP) by way of Mitsui Engineering and Shipbuilding (hereafter abbreviated as MES), and a geothermal power plant control system to be deployed in Iceland.

2. Trends of New Process Control Systems in the Energy Sector

2.1 Circumstances surrounding the energy sector

(1) Further deregulation of the electric power retailing market

As of 2005 in Japan, with the deregulation of the electric power retailing market, the range of PPS (power producer and suppliers) was expanded to 6,600 V and 50 kW or more, and transfer charges have been eliminated when supplying power across the service areas of power companies. As a result, market competition has been more severe.

(2) Greenhouse gas emission credits

With the reduction in global greenhouse gases as mandated by enactment of the Kyoto Protocol, the buying and selling of greenhouse emissions credits is accelerating. It is much more effective to acquire emission credits abroad, in countries working toward energy conservation, than in countries where energy conservation measures have already been advanced, and this is expected to the construction of geothermal power plants, natural gas thermal power plants and the like overseas.

(3) Further reduction of fossil fuels

West Texas Intermediate (WTI) crude futures in April 2006 rose rapidly to more than $72 per barrel as the result of increased demand from China and India, the Iraq war, and so on. The trend toward a reduction in fossil fuels (and new energy development) is expected to continue in the future.

2.2 Need for new process control systems in the energy sector

(1) Highly reliable and cost effective systems

Under the present conditions of intensifying competition due to the deregulation of the electric power retailing market, new process control systems are required to provide even higher reliability and cost effectiveness than in the past.

(a) Instead of the controller in a conventional custom distributed control system (DCS), general-purpose, highly functional and highly reliable programmable controllers (PLC) are being used as components, to ensure the overall functionality, performance and reliability of the system product.

(b) Total cost is being reduced through the use of open standards technology, lower expenses through mass-production, and by accumulating technology and expertise that can be reused over the long-term.

(2) Lower total cost of ownership (TCO)

In addition to lowering the initial investment, reducing the costs of maintenance, equipment updating, and the like will help to decrease the TCO.

(3) Promotion of reusable software

Fuji Electric has a successful track record of delivering many boiler control systems, and has accumulated much technical expertise in automation, labor savings, optimal operation, operational and maintenance support, equipment diagnostics, and the like. New process control systems must facilitate the reuse of this expertise, so as to provide that expertise to the user.

(4) Globalization

In the summer of 2006, the Japanese government launched a plan whereby Japanese companies, in cooperation with other companies involved in reducing greenhouse gas emissions of developed countries, can purchase greenhouse gas emission credits, and as a result, Japanese companies are accelerating their overseas efforts for reducing greenhouse gas emissions. Also, capital investment is increasing in Southeast Asia and the so-called BRICs (Brazil, Russia, India and China) where high economic growth is continuing.

Therefore, process control systems for the energy sector are not only required to have English-language specifications, but also must be global systems for which parts can be procured and maintenance service performed overseas.

3. Example Applications of the MICREX-NX New Process Control System

3.1 The features of MICREX-NX

This section describes the advantages of using the MICREX-NX as a new process control system in the energy sector.

(1) Highly reliable system

The MICREX-NX enables the configuration of a control system having high reliability and availability by cross multiplying redundant transmission lines, operator stations (OS), servers, and controllers (AS: automation systems). Moreover, a dual-redundant AS uses an event synchronous method and is applicable to plants that do not permit even a short-term stoppage of the control operation.

(2) Software library

Fuji Electric's acquired energy sector expertise (programs) can be stored in libraries with a simple copy-and-paste procedure, and then reused.

Main examples of the software library are listed below.

- ○ Unit master controller, boiler master controller
- ○ ACC (boiler combustion control)
- ○ Feed water control, reactor pressure control, main steam temperature control
- ○ Boiler local control, turbine local control
- ○ Burner automatic control

(3) Support of globalization

The MICREX-NX or Siemens' PCS7 may be selected for overseas destinations. After delivery, Fuji Electric's overseas base or Siemens' after-sales service network, scattered throughout the world, may be used for maintenance servicing.

(4) Effective use of customers' assets

When updating existing control equipment made by Fuji Electric, a customer's hardware and software may continue to be used while changing over sequentially to a MICREX-NX-based system. Thus, customers' assets can be utilized effectively and changed over to the latest control system.

(5) Other

A time stamp function that reads digital input (DI) data at high-speed and is capable of time management can be used as a high-speed fault recorder for a power plant, and is useful in the first analysis of failure factors if an accident occur. Moreover, in the future, safety control systems will be used in protective circuits such as the main fuel trip (MFT) circuit of a power plant.

3.2 Example delivery to an IPP

(1) Facility overview

This plant is the largest biomass power plant in Japan that uses scrap chips of construction material as fuel. The plant was built by MES and is operated by an IPP.

Scrap chips of construction material are purchased from biomass raw fuel vendors and fuel suppliers established by waste disposal companies in the Tokyo metropolitan area, and electric power is generated by fluidized bed boilers and steam turbines using refuse paper and plastic fuel (RPF). The entire output of 50,000 kW is sold to the Tokyo Electric Power Co., Inc. The plant is scheduled to operate for 345 days per year.

Moreover, this plant is expected to become a large-scale business model for new energy, from input to output, in accordance with the Renewables Portfolio Standard (RPS). Figure 1 shows a portion of a new process control system prior to shipping.

(2) System configuration

This system uses the MICREX-NX new process control system. Figure 2 shows the system configuration. Operation is basically implemented with a desktop type human communication interface (HCI). The controller realizes high reliability through dual-redundancy of the control unit and power supply.

A functional overview of main component devices is listed below.

(a) Automation system (AS) (dual redundancy): 1 set

Automated boiler control (ABC) and local control are realized on a single station.

Fig.1 MICREX-NX panels for an independent power producer

Fig.2 Configuration of control system for an independent power producer

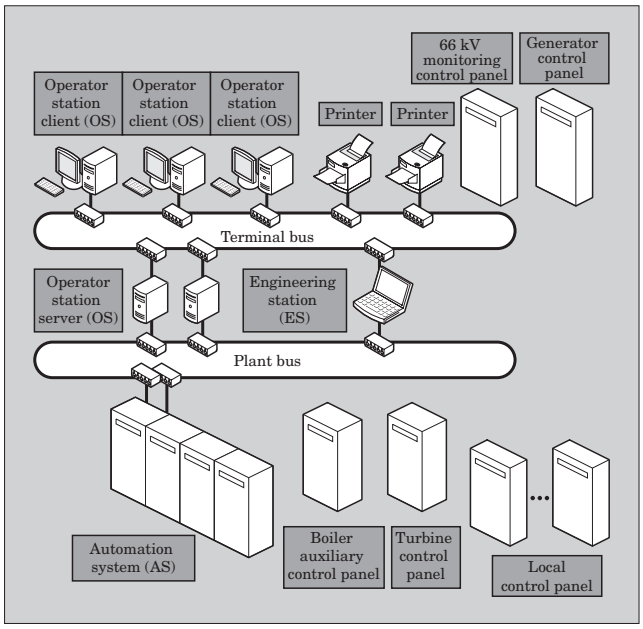
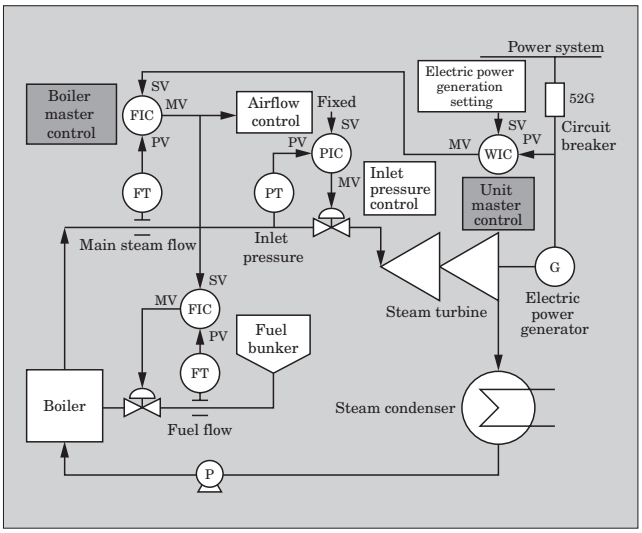


Fig.3 Overview of basic control system for an independent power producer



(b) Operator station (OS): 3 units

An OS is an HCI from which the operator is able to monitor and operate the equipment. The following monitoring and operation is performed with an OS.

- ○ Loop monitoring and operation
- ○ Auxiliary mode selection and start/stop operation
- ○ Equipment monitoring via a graphic screen

(c) OS server (dual redundancy): 1 unit

The OS server enables central control of process data, alarms, operating history and other plant data.

(d) Engineering station (ES): 1 unit

The ES generates and modifies control programs for the controller, graphic screens and logging forms.

(e) Boiler auxiliary control panel: 1 set

This control panel has an MFT relay circuit to stop the equipment safely, even in cases where the DCS is functioning abnormally.

(f) Turbine control panel: 1 set

(g) Power generator control panel: 1 set

(h) 66 kV monitoring control panel: 1 set

(i) Local control panel: n sets

(3) System features

Figure 3 shows an overview of the basic control system. For fuel, this plant uses building scrap material, the properties of which can vary. The following control is implemented to improve the efficiency of the power generation.

(a) Unit master control

The output of a provided power generation control adjusts the quantity of calories burned by the boiler.

(b) Boiler master control

In order to maintain the required quantity of calories for the boiler, even when the fuel properties vary, a main steam flow control is provided as the boiler master control.

Moreover, the boiler outlet main steam pressure is adjusted with the turbine inlet pressure control, and the output of the power generator is determined by the values set for the boiler unit master. With the exception of the power used by the power plant itself, the total amount of generated electric power is sold to the Tokyo Electric Power Co., Inc.

3.3 Example delivery to a geothermal power plant in Iceland

(1) Facility overview

Geothermal power creates electricity by using a turbine generator with steam that has been separated from hot water and steam emitted from a drilled underground steamwell. Geothermal power is an energy source that is friendly to the global environment and that emits almost no CO_2 gas, which is a cause of global warming. Iceland is the world's leading user of geothermal heat as a natural energy source, and geothermal power accounts for approximately 15 % of the Iceland's domestic electric power energy. Recently, a geothermal power plant was newly constructed in Reykjanes, which is located approximately 20 km from the Svartsengi Geothermal Power Plant. Fuji Electric received orders for a turbine, electric power generator and electric instrumentation to equip this new plant, and has successfully delivered that equipment. Figure 4 shows a view of the entire Svartsengi Geothermal Power Plant that will operate the Reykjanes plant.

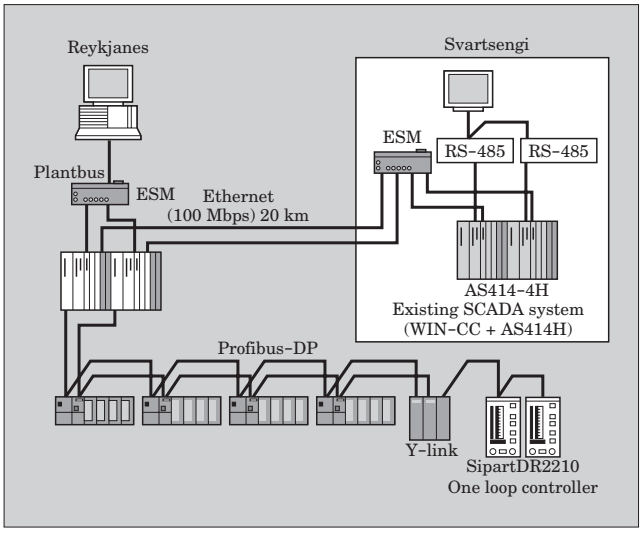
(2) System configuration

Two sets of new process control systems were delivered to Reykjanes. The main component devices for one set are listed below. Figure 5 shows the system configuration.

(a) PCS7 OS single server × 1 station

Fig.4 View of geothermal power plant in Iceland (Svartsengi Power Plant)

Fig.5 System configuration of geothermal power plant in Iceland



*1: P-CIM is a registered trademark of AFCON Software & Electronics Ltd.

*2: Ethernet is a registered trademark of Xerox Corp.

(b) PCS7 AS control station × 1 station
- ○ CPU: dual redundant
- ○ I/O: single
- ○ I/O bus (PROFIBUS): dual redundant

(3) System features

(a) Can be operated from an existing system made by Siemens

The existing monitoring and control system of the Svartsengi Geothermal Power Plant is configured from a supervisory control and data acquisition (SCADA) system known as P-CIM*1 and an S7 controller made by Siemens. Operation and monitoring of the new process control system of the newly built Reykjanes Geothermal Power Plant are also implemented from the Svartsengi Geothermal Power Plant, located 20 km away. For this reason, the Reykjanes control system uses Siemens' PCS7. Moreover, connection to the Svartsengi Power Plant is implemented with an Ethernet*2 connection, via the Siemens' S7, to configure a system capable of easily operating and monitoring the Reykjanes control system from the Svartsengi Power Plant.

(b) Use of high-speed fault recording

For the fault analysis in the case of a turbine trip, a digital input module is used that is capable of time stamping the main signals with 10ms accuracy.

(c) Time synchronization

The system time of the Reykjanes Power Plant is synchronized to the time received from the time stamp of the existing Svartsengi Power Plant.

4. Conclusion

Recent trends of the latest process control systems in the energy sector have been discussed and an overview of examples of delivered systems that use the MICREX-NX have been presented. Fuji Electric will continue to adapt to meet the diverse needs of our customers, and to develop and supply high value-added new process control systems to the energy sector.