DP Advanced Automatic Control

Solution

DP CleanTech

Creating value from waste

Advantages of Automation

The economic success of biomass and waste to energy power plants is dependent on high and stable levels of plant performance and plant availability. The role of process automation in maximising such factors is an important consideration in power plant design.

The financial benefits of automation are well demonstrated, and most biomass and waste to energy power plants in mature markets are now highly automated. On the other hand, biomass power plants in developing markets are generally less automated, yet the need for automation is arguably greater.

Operating challenges such as variability in fuel types and fuel quality are often more prevalent in such markets, necessitating constant adjustments to plant equipment. High levels of automation can maximize plant performance by more precisely and effectively adjusting for prevailing conditions. Automation can also reduce equipment degradation; increase efficiencies and improve productivity levels.

DP Understands Automation

DP's technology and knowhow has been deployed in ~ 90 plants worldwide, and as a leading provider and experienced operator of end to end power plant solutions, DP is highly qualified to offer automation technology solutions that help to optimize power plant investments.

As a biomass industry leader for over 30 years, DP has deployed its experience and knowhow to develop a fully automated control system which can be implemented with DP's boiler products as either a fully integrated solution for new DP projects, or as a retrofit or upgrade exercise to significantly improve performance and reduce operational costs.

The DP Advanced Automatic Control System (DPAAC) is designed and engineered to meet the following requirements.

- Automation - 100% automatic operation of boiler and power plant processes.
- Performance - Advanced control functions to achieve stable boiler operation and higher efficiency.
- Fuel flexibility - Advanced sensors detect variations in fuel - such as moisture content – to automatically make adjustments which will maintain stable steam generation.
- Safety - Integrated boiler protection and Safety Instrumented Systems.

Operation Principles

DPAAC monitors and controls the complete boiler process in order to regulate boiler load. The load is regulated by automatic adjustment of the control systems related to the five main boiler process flows, using control logic and interlocking safety data to ensure the highest efficiency and reliable safety parameters.

Real-time operation data is transferred from online field devices to the process controller, which is pre-programmed to automatically trigger field regulation devices upon detecting specific changes in boiler operating conditions. Alternatively control functions can be manually deployed. Examples would include opening a de-superheater valve to reduce live steam temperature; or increasing the speed of a motor to increase fuel flow.

Summary of Benefits

Improved boiler and power plant performance

Reduced O&M cost

Increased availability

Detailed Features and Benefits*

Product Features	Impact	Business Benefits*
100% automated boiler processes	• Less human involvement • Less human error • Lower employee overheads • Extended plant lifetime	• Reduced O&M cost
Increased stability of boiler operation/reduced fluctuations	• Increased steam production • Fewer unscheduled stoppages • Less maintenance	• Increased availability
Improved combustion	• Lower emissions of CO and NOx	
Higher adaptability to variations in fuel quality and moisture content	• Stable operation • Increased steam production	• Increased revenue
Higher boiler and system efficiency	• Increased steam production • Reduced fuel consumption	
Higher burnout rate (UBC less than 5%)	• Increased steam production • Reduced fuel consumption	• Increased earnings
Reduced carry over and fly ash quantity	• Reduced fly ash removal costs	

*typical benefits from DP references

DPAAC System Functions and Components

DP Advanced Automatic Control System (DPAAC)

System Functions

Graphical User Interface and Process Visualization

Advanced Automatic Process Control (PID, Structured Programming, Fuzzy Logic)

Process Variables	Control Functions

• Fuel
• Combustion Air:
  ○ Primary Air
  ○ Secondary Air
  ○ Ignition Air
• Feed Water
• Steam
• Flue Gas
• Cooling Water
	1. Boiler Load Control (Master)
	2. Fuel Handling Control
	3. Fuel Feeding Control
	4. Combustion Grate Control (Fuel Layer)
	5. Feed Water Control (including Boiler Drum Level)
	6. Deaerator Control
	7. Furnace Control
	8. Combustion Air Control
	9. Combustion Air Distribution Control
	10. Evaporator Control
	11. Air Preheater and Flue Gas Cooler
	12. Steam (Superheaters and Desuperheaters)
	13. Furnace and Flue Gas Path Purging
	14. Start-up Burner Control
	15. Flue Gas Control
	16. Flue Gas Treatment Control
	17. Fly Ash Removal Control
	18. Bottom-ash Removal Control
	19. Drain and Vent Control
	20. Main Steam Control

Information: Data Analysis, Reporting and Trending

Safety: Boiler Protection Interlock/Master Fuel Trip and Safety Instrumented Systems

System Components

Workstations and Human Machine Interfaces (HMI)

Software: Siemens SIMATIC PSC7 and WinCC HMI platform

Hardware: Siemens SIMATIC S7 300 and 400 Series Process Controllers

Network & Communications: Ethernet, TCP/IP, Modbus

Field Instruments (Input)	Field Regulation Devices (Output)
• Level switch/sensor • Differential pressure transmitter • Pressure sensor/transmitter • Thermocouple • Oxygen sensor • Flow meter	• Regulating Valves • Shut-off Valves • Pneumatic Dampers • Electric Motors • Variable Frequency Drives (VFDs)

Advantages of the DPAAC System

• “Plug and play” simplicity

The system is preprogrammed, prefabricated and factory tested offsite for easy onsite installation and minimal site commissioning time.

• Highly compatible hardware

Modular process control and compatible network hardware means DPAAC can be easily integrated into new or existing DCS, SCADA or PLC based system architectures.

• Highly reliable system

Siemens SIMATIC process automation hardware is well proven to be highly dependable and features redundant process controllers and network and communication devices.

• Easy to use

The Graphical User Interface and process visualization is straightforward, and operator training is simple.

• Reduces unplanned shutdowns

Powerful reporting and data analysis functions enable rapid diagnosis of problems and troubleshooting capabilities.

• No installation downtime

DP’s step-by-step commissioning process means that retrofit implementation can be achieved with little or no disruption.

Technical Information

DPAAC is a distributed computer system which runs in real-time to supervise, manage and control the boiler system as required by the operator.

It consists of five key components:

CONTROL SOFTWARE (DP PROPRIETARY KNOWHOW)

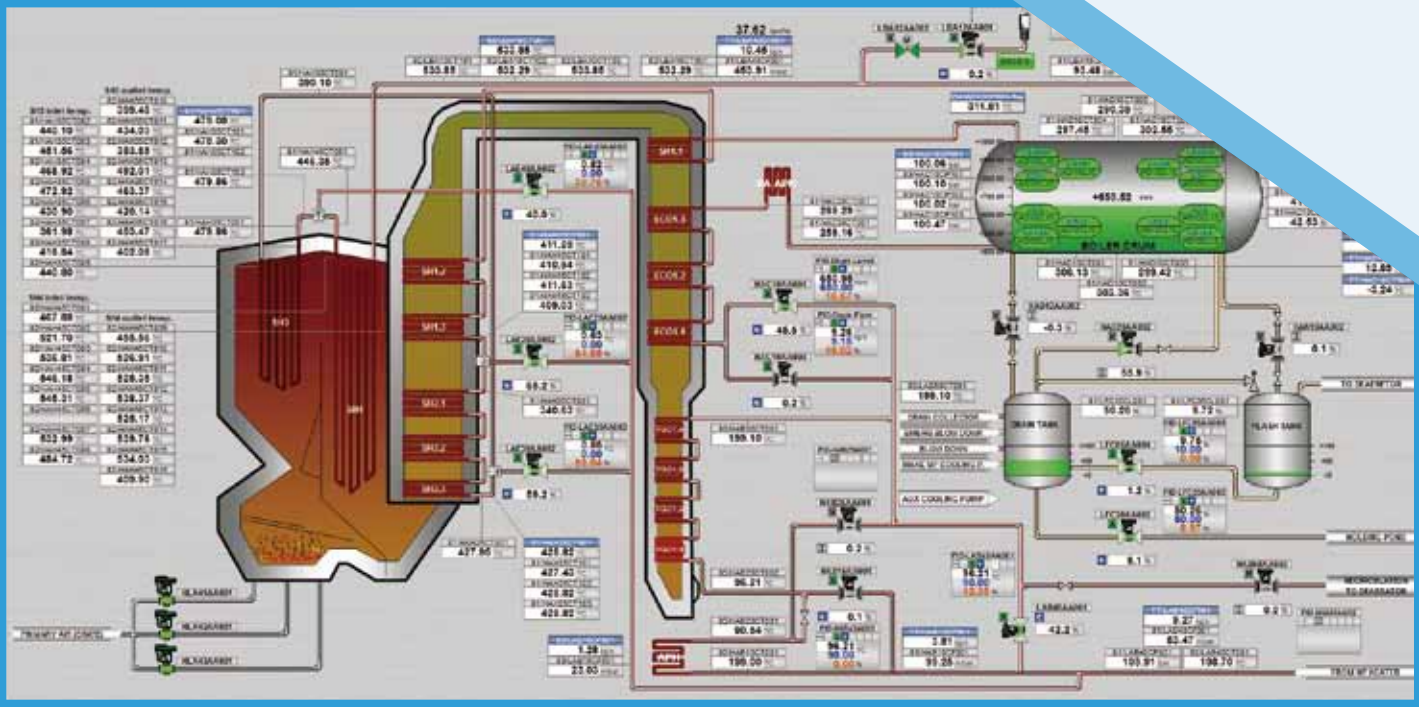
- Using our expert boiler design and operational knowledge, DP has developed proprietaty advanced system control functions which enable stable and fully automated process control of the boiler plant.
- DPAAC is implemented through a combination of PID controllers, advanced structured programming language, fuzzy logic and process control software.

ENABLING HARDWARE

- Process controllers are encoded with DPAAC control software. DP employs the robust Siemens SIMATIC S7 300 series controllers for its configuration simplicity; and the S7 400 unit for full redundancy.

NETWORK AND COMMUNICATIONS

- DPAAC is a secure networked solution that uses mediums such as Ethernet, Profibus, RS485 and Modbus to communicate with all system-connected components, equipment and sub-systems.
- The high level of compatibility ensures that the installation and integration of DPAAC within a larger power plant DCS or industrial SCADA system is simple and straightforward.



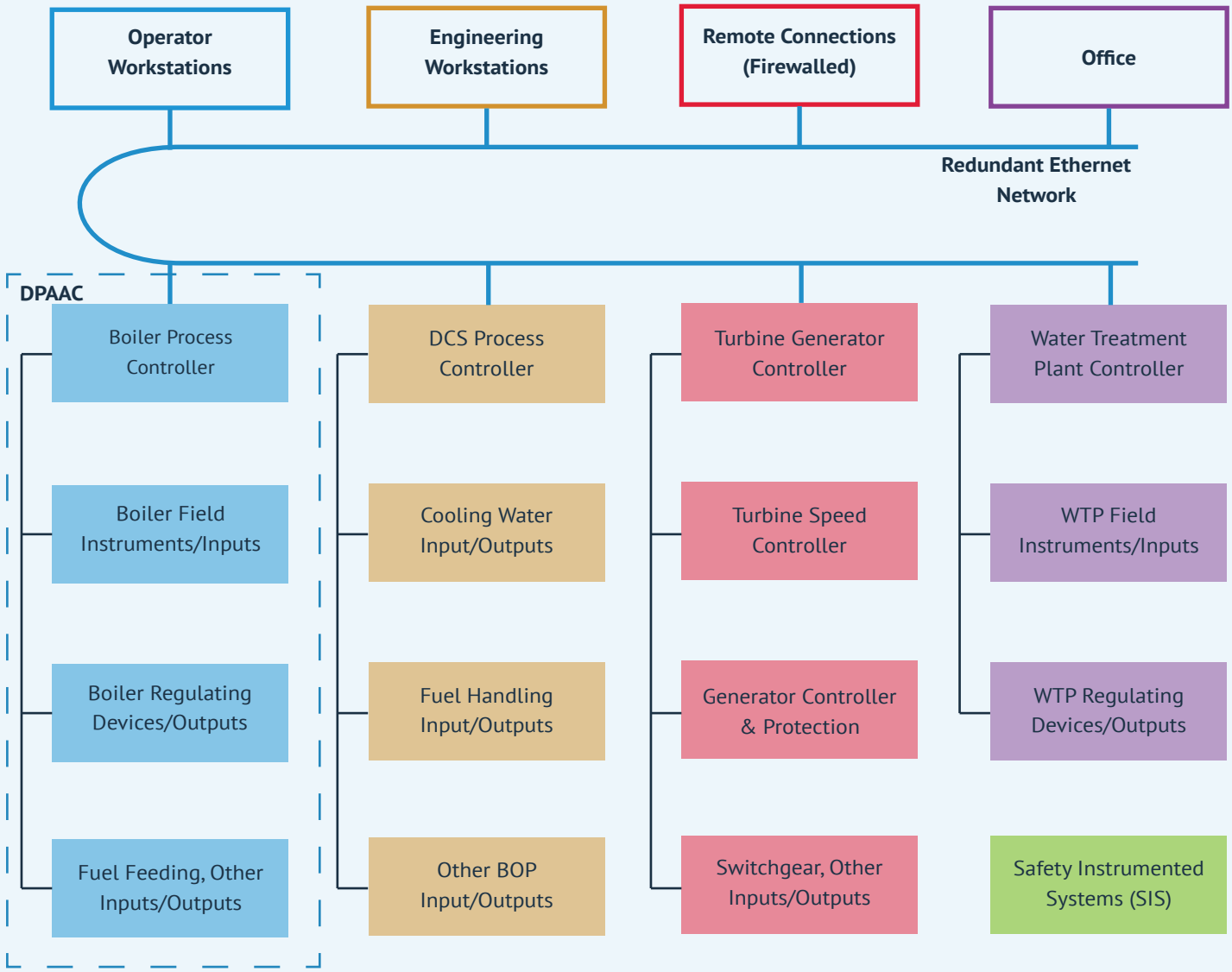
WORKSTATIONS AND HUMAN MACHINE INTERFACES (HMI)

- Plant and boiler operators can interact easily with DPAAC using standard computer workstations. Engineers can also run diagnostics and analysis on operation data and trends using engineering workstations.
- Our Graphical User Interface is based on the Siemens WinCC HMI platform which provides an easy-to-use and interactive visualization of the boiler process.

FIELD INSTRUMENTS AND REGULATION DEVICES

- Installed field instruments gather all process variables and operation input from the boiler island systems. Key variables are fuel, combustion air, feed water, steam and flue gas. The main attributes measured are quantity, flow, temperature and pressure.
- Data is gathered from safety- instrumented devices to inform alarm, interlocking and protection functions.
- Continuous monitoring of operating conditions such as temperature, vibration, voltage and current.
- The process controller automatically manipulates process variables such as fuel, combustion air and feedwater to ensure stable and efficient steam generation.

Typical DPAAC System Configuration



Boiler Design Performance Parameters with DPAAC System

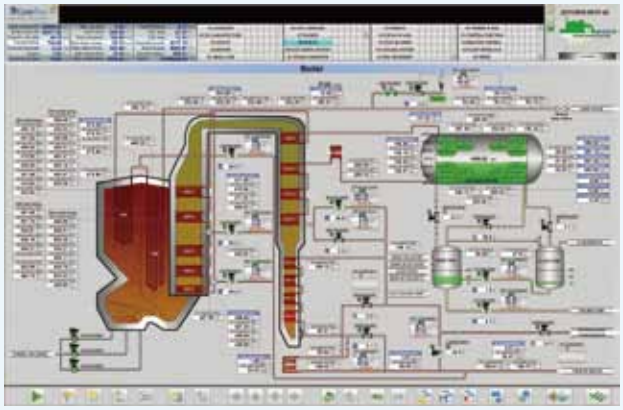
Component	Design parameter
System efficiency	⩾30%
Boiler efficiency	⩾90%
Boiler stability deviation	Less than ±2% deviation from 100% load
Steam pressure variation	Less than ±2 bar
Steam temperature variation	Less than ±5°C deviation
UBC burnout rate	<5%
Fly ash	<1% of fuel amount

Project Case Study

Mahachai, Thailand

Background

The world's first coconut waste biomass power plant capable of utilising all the waste from the coconut industry - including husks, stems and fronds – is located in Mahachai, Thailand. As well as pioneering the way in the utilisation of this highly complex fuel type - which is prone to cause equipment corrosion and fouling - there were additional problems of the seasonal variability in fuel quality. In the rainy season, moisture levels can reach 65%; and the variation in size of different coconut biomass residues makes combustion and handling difficult.



DPAAC Process visualisation - Mahachai

DP's longstanding experience and expertise in corrosive fuel combustion and technical solutions was used to make specific and innovative modifications to overcome the problems of fuel corrosion and fouling and varying fuel sizes. To overcome further fuel quality challenges, it was decided to use DPAAC system for the boiler island and the power plant. This unique 9.9MWe High Temperature High Pressure Biomass power plant with DP's automation was commissioned by DP experts, and has been in operation since April 2016.

Mahachai Green Power Plant Design

Variable	Design Parameter	Actual
Fuel	Coconut residues (husk, shell, bunch, frond, leaves, trunk)	
Fuel consumption	Design fuel mix: 323t/d (45% moisture) or 167t/d (dry) Calorific value: 8.35 MJ/KG	Up to 65%
Power output	9.9MWe (gross)	
Steam flow	40t/h	
Steam pressure	92bar	
Steam temperature	537°C	
Boiler efficiency	90%	
Net Plant efficiency/gross power plant efficiency	31%	
Availability	>8,000 hours / year	
Net heat rate	13,250kJ/kWh	

During the first year in operation (after commissioning), the plant has been operating at 94.2% availability and has exported 71,724,240 kWh of green power to the local grid.The plant consumes around 320 tons per day of coconut waste, as well as other biomass residue. The plant has a stable operation and runs at full load to generate 8 MWe of green power which is being fed into the public PEA grid, benefitting the plant owner, the local community and the environment.

About DP CleanTech

- DP CleanTech designs, engineers, manufactures and commissions biomass and waste-to-energy power plants, providing complete solutions for turning waste materials into clean energy.
- DP CleanTech has over 80 biomass power plant references around the world using high pressure, high temperature technology originally developed in Denmark.
- DP CleanTech built the first biomass power plant in China and is responsible for over 30% of the biomass power plants operating in China today.
- DP CleanTech is recognized as a world leader in the biomass clean energy field.

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