China’s Largest Refinery

Dushanzi Refinery, Xinjiang, China

The Dushanzi Refinery in Xinjiang, China, is part of The National Development and Reform Commission’s execution plan to process 82 million metric tonnes (90 million tons) of new oil in China by 2010. With an approximate investment of US$4 billion, it will make Dushanzi Refinery the largest refinery in China. The plant will process oil from the Kazakhstan–China crude oil pipeline. Once the plant is put into operation in August, 2009, it will have the capability to process 9.1 million metric tonnes (10 million tons) of crude oil in a year and 1.1 million metric tonnes (1.2 million tons) of ethylene a year, in addition to other valuable chemicals. The Dushanzi Refinery utilizes the largest engine/compressor train in the world.

**Dushanzi Requires Reliability**

China is relying on Dushanzi to supply the country with massive amounts of oil, ethylene, and other chemicals. It is vital that the refinery have continuous and uninterrupted production, while at the same time providing a safe working environment for the employees. Shutdowns are extremely expensive, leading to increased production and maintenance costs.

**Dushanzi Chooses Woodward**

Woodward was selected as the control of choice for all three of Dushanzi’s new critical compressor trains (cracked gas, ethylene, and propylene) due to Woodward’s highly reliable control platforms, advanced compressor protection algorithms, and ability to control very difficult ITCC applications. The Woodward MicroNet TMR® control platform meets all of Dushanzi’s, Linde’s, and Siemens’ stringent system control, protection, and plant interface requirements. Woodward’s IEC61508 certified system, competitive price, outstanding reputation, and friendly relationship with Siemens were additional reasons given by Dushanzi representatives for choosing Woodward equipment for this project.
**Integrated Turbine and Compressor Control (ITCC) Challenge**

There were multiple control challenges involved with successfully completing this project. One was the detailed engineering required to implement triple redundancy logic for the high number of system inputs and outputs, ensuring system up-time and allowing for on-line repairs. A second was the engineering of specialized compressor algorithms to ensure correct control point calculations even with the use of multiple intercoolers within a single loop. Another challenge was the implementation of surge anticipation logic and loop optimization algorithms to ensure that each compressor train operates at its highest efficiency level no matter the compression load.

**Woodward Equipment Installed**

For each of the 3 trains, Woodward supplied the following:

- MicroNet TMR System
- Citect HMI
- 5009C software with minor modifications
- Entire Cabinet

**Woodward Customization**

The Dushanzi project requires a control system that can be custom programmed to meet the specific site operating requirements, with the flexibility to perform on-line dynamic and control changes. Woodward’s GAP (graphical application programmer) programming environment was used to program the control, to integrate all system functionality, and to allow site engineers to make on-line system adjustments as needed. Woodward’s compressor control engineers also customized the system control and protection logic at site, to improve the overall performance and allow for smoother start-ups.
**MicroNet TMR with ITCC Logic**

A MicroNet TMR based system was installed on each compressor train to start/stop, control, and protect the entire train. The MicroNet TMR is responsible for maintaining each compressor train at its optimum control point while protecting the compressor from reverse flow (surge) conditions in the event a plant upset or transient pushes a compressor loop towards its surge limit line. A MicroNet TMR control system was installed on each of the following plant compressor trains:

- Cracked gas compressor train - 5 stages
- Ethylene compressor train - 5 stages
- Propylene compressor train - 3 stages

To save cost and complexity, Woodward’s Integrated Turbine Compressor Control (ITCC) algorithms were utilized within each turbine compressor train controller. The following major system functions were integrated within one Woodward MicroNet TMR system for each train:

- Turbine speed control
- Turbine overspeed protection
- Compressor anti-surge protection logic
- Compressor surge detection logic
- Compressor surge recovery logic
- Compressor performance control
- Unit start/stop sequence logic
- Turning gear logic (added)
- Suction pressure control
- Inlet pressure control
- Delta pressure protection
- Dual gas startup logic (air or charge gas)
- Extraction/exhaust temperature protection
- Decoupling logic from ITCC to speed setpoint
- Cascade bias logic with P2 override
- IEC61508 SIL-3 safety logic
- Lube oil control & protection logic
- Seal oil control (up to 6 PID loops)
- Water level/pump control