Harnessing Green Energy

FOUNDATION™ Fieldbus: Control in the Field helps Nicaragua achieve its aggressive renewable energy agenda

Having been awarded the concession for a geothermal field in Nicaragua, US geothermal power specialist Ram Power and their design engineer POWER Engineers evaluated the available technologies and opted for a standard control system to be located centrally in the control building. The decentralized field devices (e.g., pressure and temperature transmitters and control valves) at the San Jacinto Steamfield are linked to the central controller over a FOUNDATION fieldbus (FF) Modbus over Ethernet gateway. In using this approach, Ram Power was able to exploit the advantages of FF control in the field to implement the required control loops, thereby moving the actual control function from the control room to the field devices.

There's a renewable energy explosion underway in Nicaragua and for a country with the largest dependence on oil in the region, the lowest percentage of the population with access to electricity and the highest energy costs in Central America, it's not a moment too soon.

The Cordillera de Maribios mountain range is a 70-km-long active volcano chain lining the Pacific's Ring of Fire. Home to the San Jacinto Tizate geothermal project, it is located in the Nicaraguan Depression, a major topographic and tectonic geological phenomenon and hotbed of geothermal activity. Prospects are good. In a 2012 report carried out by the Multilateral Investment Fund in collaboration with Bloomberg New Energy Finance "Climatescope", Nicaragua ranked second only to Brazil in its positive geothermal investment climate and ability to attract investors.

In 2001, the San Jacinto Tizate geothermal concession and its estimated total capacity of 277 MW (mean value) was awarded to US-based Ram Power Corporation, a leader in operating clean, sustainable, and renewable geothermal energy projects in the Americas. Pursuant to the terms of the San Jacinto Exploitation Agreement, Ram Power is developing the project in two phases. Already completed, phase I has been in commercial operation since January 9, 2012. Phase II is to be completed in December 2012, bringing in an additional output of 36 net MW.

Both of the concession's geothermal power plants were built using single-flash condensing turbine development – the most cost-effective and efficient system for extracting geothermal energy. In single-flash technology, high pressure and temperature two-phase geothermal brine (mostly water and steam) "flash" into a low-pressure separator. The steam is sent to the turbine to generate power and the remaining fluid is injected back into the geothermal reservoir to be reheated.

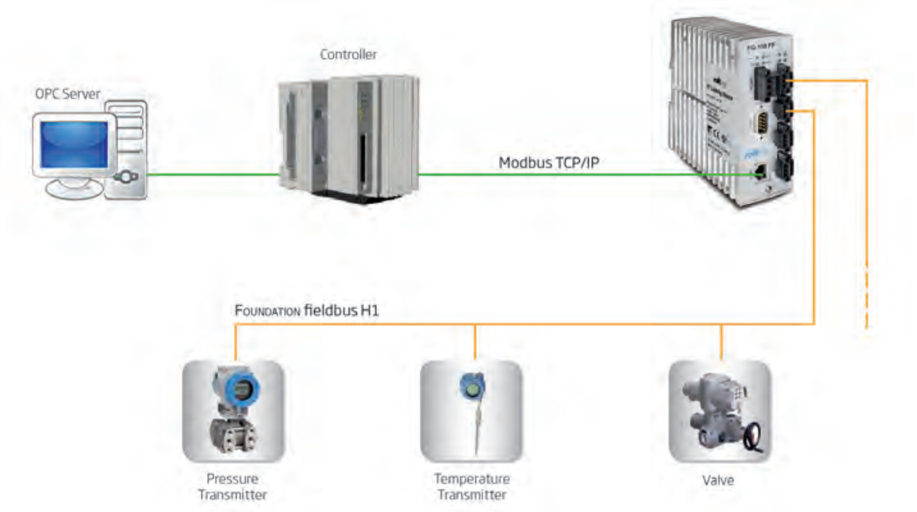

Figure 1: Remote field devices are connected to the central controller via Modbus/TCP and remote gateways.

With the large distances between the central control building and the remote steamfield installations, and need for improved reliability and availability, Ram Power – together with its design engineer – focused on devising a decentralized control system to operate the power plant. The project team considered several alternatives for the control system, such as deploying individual controllers directly at the wells or direct remote control from the central control system; however, these were ruled out due to cost and reliability considerations.

The design engineer installed a traditional DCS controller in a centralized room that would communicate over Ethernet via Modbus/TCP. The fiber optics Ethernet network at San Jacinto Tizate employs gateways to connect to the power plant's individual wells. The gateway serves two purposes: 1) it links the controller to the local FOUNDATION Fieldbus segment and 2) it acts as a FF host for the field devices located directly at the wells. For a schematic of the architecture, please see Figure 1.

After evaluating available options, the project team selected the Softing FG-110 FF gateway to link the field devices to the FOUNDATION fieldbus technology. The Softing FG-110 FF supports data exchange between the control system and field devices, and provides connection capabilities with up to four FF H1 segments to operate as many as 64 field

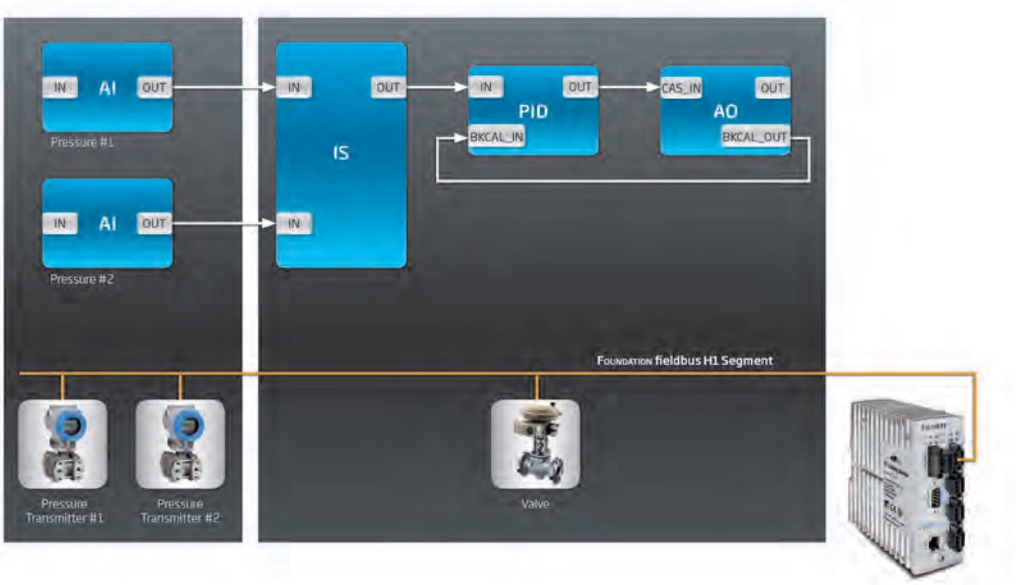

Figure 2: The CiF's PID function block uses process values to calculate valve input.

devices. By offering flexibility in mapping Modbus registers to individual FF functions, the FG-110 FF facilitates FF connectivity to a wide range of standard controllers.

The team's decision was motivated by the solution's easy operation as compared with other available options, by the parameterization support offered by its integrated website, and the fact that Softing is the recognized leader in Foundation Fieldbus technology (and in fact had written the FF stack for the motor operator valve being used in the steamfield). The FG-110 FF Modbus gateway and linking device use a Windows-based FF configuration tool to configure individual field devices and define necessary function block linking and scheduling. Another advantage of the Softing gateway is that, by processing the Modbus/TCP and FF High Speed Ethernet (HSE) protocol simultaneously, the control engineer can use the existing Ethernet infrastructure to run the complete FF configuration, and conduct monitoring and diagnostic tasks from the central control room. The final decision to employ the FG-110 FF was also motivated by the advantage of utilizing standard FF Device Description (DD) files. Unlike the specially adapted DD files used by other gateways, the standard format makes it possible to integrate all FF H1 field devices registered at the Fieldbus Foundation into the overall solution.

Once the FG-110 FF gateway is installed, the FF functionality, including CiF, is hooked up to a standard controller that supports Modbus/TCP communication. The CiF feature moves the complete controlling task to the field devices, which define the individual control loops and determine data exchange between the function blocks. Data exchange between individual field devices is synchronized using a common clock pulse.

The FF configuration, the FF Link Active Scheduler (LAS) and the FF Time Master work together to define and execute control in the field. Supported by the individual FF H1 field devices, the configuration tool first determines the input/output communication interface (i.e., data exchange) and defines the execution schedule for the individual function blocks. Once the configuration is downloaded to the different field devices in the FF H1 segment, communication between the field devices is facilitated by the LAS, thereby ensuring data exchange is compliant to previously defined control loops. The role of the LAS is not limited to the FG-110 FF gateway, but can be exploited by any compatible field device, thereby building in redundancy for the CiF function. A time master provides consistent timing information within the FF H1 segment during runtime and, thus, synchronizes the execution of the function blocks.

The CiF concept offers some advantages in comparison with traditional control approaches. For one, by synchronizing the control loop execution and data exchange, it offers enhanced deterministic controlling and shorter reaction times compared to a central controller. Second, the supported redundancy concept increases the availability and reliability of the control task. And lastly, the CiF application functions independently and is not reliant on the availability of the controller in the central control room or the network connection to the various wells.

The control application used for the San Jacinto Tizate geothermal project employs pressure process values twice deployed to exploit the advantages of the CiF feature; the input selector (IS) function block ensures redundancy. The resulting information is sent to the PID function block to calculate input. A schematic overview of the CiF can be seen in Figure 2.

Issues identified during implementation and commissioning of the large-scale geothermal project have been successfully resolved. Up and running, the system proves how CiF advantages such as truly distributed control can offer a perfect solution for remote applications such as geothermal wells. As Tom McAuliffe, the POWER Engineers' responsible control system engineer sums up, "After researching the available options, Ram Power settled on the Softing FG-110 FF gateway product. POWER configured and installed the FG-110 FF products and commissioned them with the help of Softing's technical support. Softing's technical people were very responsive and helpful. POWER made several recommendations to Softing as to how the product could be enhanced and these modifications have been incorporated in the next firmware version. There are four Softing modules installed in the San Jacinto geothermal wellfield that have been working reliably for the last year. If Ram Power, or POWER Engineers, were to implement another FF Control in the Field project, we would definitely use the Softing gateway product line again."

Figure 3: Remote cabinets located at the individual wells house the FG-110 FF gateway.

Author:
Dipl.-Inform. Georg Suess, Product Marketing, Softing Industrial Automation GmbH in Haar, Germany
email: georg.suess@softing.com

http://industrial.softing.com