White paper WP/AutomatingWellpads-EN

ABB Measurement Products
Oil and gas production

Automating wellpad operations in the oil and gas industry

By John Green, ABB Inc.
Upstream Oil and Gas Products

Introduction

The advent of horizontal drilling and fracture techniques now permit the possibility of smaller environmental foot-prints for oil and natural gas production. Rather than spread many wells over a wide landscape, multiple well heads are being consolidated in a confined area. In this way, the many facets necessary for the production life-cycle–wellheads, separation equipment and tank storage along with production monitoring instruments and controls– are located in a geographically isolated area, reducing the physical and ecological footprint.

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Well lifecycle

Typically, in newly drilled wells, the oil, water, and gas flow freely to the surface through the well's Casing pipe with little or no wellbore augmentation required. When the flow of gas and liquids drops to a point known as the Critical Flow Rate, it is common to install a second pipe in the well known as the production Tubing, which is a concentric pipe within the Casing. The narrower production tube increases the flow velocity above a critical level necessary to maintain a free flowing well. With time, however, the natural pressure within the well reservoir begins to fall. Production declines, following the well-known downward curve. Backpressure resulting from the buildup of oil and water liquids in the Tubing slows production and can eventually bring flow to a halt.

Before this happens, or when oil prices rise, companies may resort to one or more enhancement techniques to improve production. A sampling of these techniques would include:

- **Intermittent lift**
  A main valve completely shuts off flow through the production Tubing, permitting natural pressure to build. At some point the natural pressure builds sufficiently to overcome the liquid backpressure. The valve is opened and flow continues, thereby lifting the liquids out of the wellbore. Flow will continue until liquid accumulation causes natural pressure to drop off again, decreasing the flow rate.
- **Plunger lift systems**
  Here a piston-like plunger sits at the bottom of the well tubing and serves as the interface seal between liquid buildup in the tube and the natural gas pressure below. Again, the main valve shuts off all flow through the tube until the natural gas pressure below builds to a level that can lift the plunger to the surface. The plunger brings the liquid oil and water with it, relieving the liquid backpressure to permit gas flow.
- **Gas injection**
  Various techniques introduce gas to the bottom of the well casing. The gas supplements the natural pressure, helping to lift liquids and/or plungers in the tube to the surface.
- **Submersible pumps**
  Positioned at the bottom of the well and typically electrically powered, these units artificially lift liquids to the surface to increase gas production.

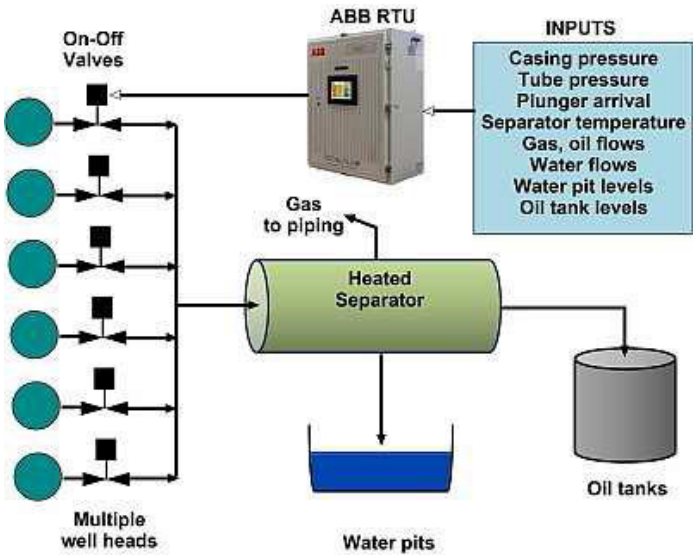

Figure 1: Wellpad with multiple wells, shared processing and storage, and automation controls.

Automating operations

In the intermittent and plunger lift systems, engineers can apply instrumentation to automate well operation. Pressure transmitters monitor the differential pressure between the production Tubing and the well Casing. Control software within a control device can automatically open or close the main valve when conditions dictate such action should occur. The well automatically cycles on and off at a rate that optimizes production.

With multiple (10 or more) wells situated within a wellpad, as mentioned above, engineers can extend the instrument functions further to optimize the entire wellpad production. These functions can include the associated separator, oil storage tanks, gas piping, water pits, flow and level transmitters, alarming, and emergency shutdown of individual wells or the entire wellpad.

The ABB solution

The ABB Totalflow XRCG4 fourth generation Remote Terminal Unit (RTU) can automate the operation of a single well or an entire wellpad. Engineers or Operators can specify this RTU with built-in, field-proven applications for site automation and optimization of Intermit or Plunger Lift wells. Or the user can program PLC software function blocks for customizing system operation.

A selection of Totalflow input-output (TFIO) modules provide analog, digital, and pulse IO as well as valve interface functions and communication ports.

The addition of micro-controller boards in a master-slave relationship permits scale-up from basic units. The boards offer exceptional processing speed and memory capacity, and run under the Windows® CE operating system. An integrated Ethernet port enables full networking capabilities. USB host and device ports permit firmware upgrades, local configuration, and data archiving. The front panel display may be a simple LED readout and/or a sophisticated Human Machine Interface (HMI) to show wellpad data in a variety of graphical formats.

Figure 2: Totalflow XRC^{G4} RTUs scale up to accomodate additional well heads, PLC processing functions and IO. New HMI permits monitoring of multiple well heads in a variety of graphical formats. Totalflow IO modules mount on DIN rails and interface with valves and communications.

The ABB RTU can be configured to measure and control virtually all the functions on the pad. It turns the wells on and off based on simple to complex algorithms, based on the users comfort level, to optimize production. Connected to appropriate sensors, it measures the water, oil, and gas produced. It also measures and controls separator temperatures and monitors oil and water tank levels. It shuts down individual wells or the entire wellpad in emergencies. Communications for measurement and control operations can be direct wired or wireless. Often powered by Solar Charging and Batteries, and with the system sized properly, operation can continue autonomously for multiple days. Aside from these pre-engineered lift applications for the oil and gas industry, ABB Totalflow RTUs permit creation of custom applications using generic IEC-61131 PLC programming tools. This solution supports six tools:

- Structured Text
- Function Block Diagram
- Instruction List
- Ladder Diagram
- Sequential Function Chart
- ISaGRAF Flow Chart

In this way users can develop custom applications for measuring and automating operations on their particular programming skills and experience.

TFIO module hardware for the ABB RTUs comes in DIN mountable enclosures that employ Phoenix contact technology for field wiring. The modules also interconnect with each other to provide the necessary power and interface signals along their bus. Generally, only the enclosure size limits the capacity of these IO modules.

The flexible and modular nature of ABB Totalflow XRCG4 RTUs provide complete pre-engineered or custom solutions for the oil and gas industry. The scalability of the system allows perfect adaptation for wellpad reinforcement, retrofit, and upgrades.

Contact us

ABB Inc.
Upstream Oil & Gas
Process Automation
7051 Industrial Blvd.
Bartlesville, OK 74006
Tel: +1 918 338 4888
+1 800 442 3097
Orders: totalflow.order@us.abb.com
Tech Support: totalflowsupport@us.abb.com
Quotes & Other: totalflow.inquiry@us.abb.com

www.abb.com

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