Electrical control valve actuators on oil and gas production separators

Electrical control valve actuators on oil and gas production separators
White Paper 18th August 2014
Redefining Flow Control

Overview

Wherever there are oil and gas production facilities there is one specific piece of equipment that is almost always present, the separator. Depending on the nature of the reservoir, oil, gas and water are present in varying proportions. The first stage of any hydrocarbon production process once the product has started to flow from the well is to separate the gas from the liquids and the hydrocarbon liquids from the produced water.

This is also true of unconventional oil and gas production, such as coal seam gas, shale oil or shale gas production. For shale facilities the hydrocarbon product needs to be separated initially from the flow back water and later from the produced water. Flow back water is the return of the hydraulic fracturing fluids used in “fracking”. Produced water is the water that is naturally present in the geological formations. This is often quite salty.

The proportion between the volumes of hydrocarbon product and the produced water will determine the capacity and nature of the separator. Fundamentally the process is the same for all sites regardless of whether the producing well is on-shore or off-shore. The three phase (oil, gas, water) separator is a fundamental requirement.

Separator operation

Oil, gas and water, mixed together, enters the separator from the wellhead via the wellhead pipework and the flow is usually controlled by the wellhead choke. Inside the separator, gravity works on the water so it settles at the separator base.

Oil floats on top of the water and, above the oil, gas is collected. A mist extractor will remove any further liquid from the gas which is drawn off from the top of the separator vessel. There is usually a weir over which the oil can flow into a separate compartment to be piped away. This leaves the water, which is drained from the base of the vessel.
Redefining Flow Control

From a control point of view there are a few key parameters. The first is the volumetric flow into the separator vessel. This is controlled by the inlet valve position, often the wellhead choke valve. The outflows from the vessel are controlled by three control valves.

The pressure inside the vessel is controlled by the gas outlet control valve. This is operated from a pressure controller using a pressure sensor to measure the internal pressure of the vessel. Control of the level of the interface between the water and oil is of primary importance to ensure that there is no carryover of liquids through the gas pipework due to high liquid level, nor any blow-by of gas into the liquid pipework due to an excessively low liquid level. A level sensor determines the position of the water oil interface. This feeds to the water outlet control valve, via a controller, to make sure that the outflow of water maintains the oil water interface within the tolerance bands.

The outflow of oil is similarly controlled by a level controller taking a reading from an oil level transmitter and controlling the oil outlet valve.

The control of the separator is a continuous process maintaining the two levels and the internal pressure of the vessel within the required tolerance bands for various flow rates from the well.

Piping and instrumentation diagram (P&ID) for a typical separator

---

Redefining Flow Control
The control valves associated with the separator vary in sophistication; sometimes level control is simply an on/off function. When a level reaches a certain point, the outlet valve is opened until the level drops to the lower tolerance band, at which point the valve is shut. However, much smoother continuous control can be achieved by proportionally positioning the control valves to accommodate a more steady flow of water and oil from the separator. This allows the downstream production equipment to operate with a minimum of fluctuation and disruption.

Downstream equipment could include, for example, scrubbers and gas conditioning on the gas side, water treatment on the water side and desulphurisation on the oil side.

There are both horizontal and vertical types of separators. Generally speaking horizontal types are used where there are larger volumes of gas. The vertical types have good solid handling capability but are harder to service. They also have a smaller footprint.

Separator problems

Typical problems for a separator would be:
- Liquid carryover into the gas line
- Gas blow-by into the liquids line
- Emulsification of the interface between the oil and the water
- Foaming

There are various methods of minimising the emulsification and foaming problems using baffles and vortices. However, the avoidance of blow-by and carryover issues are functions of the manipulation of the inlet and outlet control valves.

In addition to the process control valves there are ESD (Emergency Shutdown) valves to isolate the separator. The separator must also have the capacity to accommodate slugs and surges in the well flow.

Many well sites are in remote locations and present their own sets of problems:

- There may be extremes of temperature and precipitation at the site. Wellhead equipment therefore needs to be robust, durable and reliable, to minimise the maintenance requirements.
- The remoteness of the wellhead may preclude the possibility of a power supply from a conventional electric grid.
- Sometimes the produced gas pressure can be used as a power source, but producers are reluctant to vent produced gas to the atmosphere, particularly on unconventional production facilities where there may already be a high degree of environmental constraint.

For these reasons, many remote well sites are solar powered, resulting in the control and supervisory equipment being restricted to the minimum of power consumption to operate the drill site.

Once the main hydraulic fracturing or dewatering pumps with their associated generators leave the site and the well is in its normal production mode, a simple solar powered control system is often employed.
The system may include a remote terminal unit and telemetry, coupled with high-efficiency actuators that require minimal current draw to provide the optimum solution for wellhead and separator control.

The conventional spring diaphragm pneumatic control valve for pressure and level control requires either the produce gas or an instrument air supply to run the actuators. Alternatively, low power electric control valve actuators can operate from a DC solar power unit.

Electric control valve actuators for this type of application require certification for hazardous environments as well as a robust enclosure. They must also have the ability to constantly adjust valve position to accommodate a changing flow rate from the well.

Simple compact devices that have good environmental protection are essential so that a minimum of maintenance is required over the operating life of the well.

Because some unconventional production wells have a shorter life than conventional wells, the equipment needs to provide all of the functionality but at a cost that allows pay back over the shorter well life. Electric actuators that can provide the required functionality and reliability at a competitive price point are therefore attractive for automating well site separators.

*Rotork CVA electric control valve actuators on a separator skid. Control and motion power supplied by a solar energy package.*