Intelligent valve actuators in the mining industry

White Paper

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Overview

In mining, as in other hazardous industries, flow control equipment makes a vital contribution to efficiency and safety. Numerous operations, both on the surface and underground, depend upon the reliable control of fluids and gases which is generally achieved using valves, actuators and associated equipment.

Underground areas of application include pumping stations, ventilating and cooling systems, dust suppression and dewatering plant. On the surface, coal seam gas production, transportation and storage, process water treatment, refining, smelting and pipelines for slurries and tailings are among the applications requiring reliable valve actuation and control.

A wide range of flow control equipment is utilised for these duties, including electric and electro-hydraulic actuators. Intelligent, non-intrusive features have been available with increasing levels of sophistication with electric actuators since the 1990s, providing increased functionality with reduced maintenance in numerous isolating and modulating valve applications.

More recently, the introduction of electro-hydraulic actuators with the same intelligent non-intrusive functionality has extended the scope of the technology to include critical failsafe valve duties.

Fig 1 – The latest generation of Skilmatic electro-hydraulic failsafe actuators incorporate proven Rotork IQ3 intelligent electric actuator technology. Communication and data logging capabilities have been increased in response to end users’ desire to access more valve related data, both in the field and in the control room.
Robust construction

In every case, for long term reliability the actuator must be designed to withstand the environmental challenges of the operating location. In the mining industry these challenges can be particularly severe; exposure to grit, dust, moisture, pollutants and corrosive materials can all be expected. Combined with appropriate surface finishes, enclosure specifications conforming to IP68 provide the protection necessary to survive these extreme conditions including prolonged periods of total submersion. The use of O ring seals on spigot joints is the well proven way of achieving this level of environmental protection and sealing the flame paths required for explosionproof electrical equipment. Resistance to corrosive damage is further enhanced by local control buttons and switches that do not penetrate the enclosure wall, eliminating another potential weak point.

For both hazardous and non-hazardous equipment, the security of using static O ring sealing is optimised by the practice of double-sealing, whereby the electrical terminal housing of an actuator is separately sealed from the rest of the actuator’s internal electrical and mechanical parts. With double-sealing, the internal parts of the actuator are permanently protected even when the terminal cover is removed for site wiring. The introduction of non-intrusive actuator commissioning and interrogation has dramatically increased the significance of this feature for modern intelligent electric actuators, since once the actuator is site-wired there is no need to remove electrical covers again for setting switches, commissioning and retrieving data that the actuator stores.

In other words, the electrical and electronic control and monitoring components of the actuator are permanently protected by design, from the moment the last cover is fitted during manufacture.

Fig 2 – Double-sealing explained.
Redefining Flow Control

Fig 3 – The construction of the Rotork IQ3 intelligent non-intrusive electric actuator, illustrating the simple and reliable gear train, the direct drive handwheel and separate thrust base, which enables the actuator to be removed without affecting the valve position. On the left, the toughened glass indicator window is the focus of attention for valve position indication, non-intrusive set-up and commissioning menus and local display of operating and diagnostic data stored in the on-board datalogger.

Non-intrusive communication

Secure within the enclosure, the combination of a robust and simple mechanical drive train, solid state torque sensing and electronic controls with data capture and asset management capabilities all contribute to the intelligent actuator’s ability to deliver a long working life with minimal maintenance. Two-way, non-intrusive wireless communication between the actuator and control centre enables the user to manage flow control assets with security and efficiency, facilitating long term low cost of ownership.

Looking at the functional areas one-by-one, torque sensing using piezo technology with an integrated amplifier accurately measures the motor thrust being applied to the valve via the actuator centre column gearing. Unlike mechanical alternatives, this system is unaffected by mechanical wear and therefore maintains absolute accuracy and repeatability throughout the life of the actuator.

Position sensing is supported with using absolute encoding technology. A recent breakthrough in this area has created an encoder with only four moving parts which can measure thousands of output turns with built-in redundancy and self-checking. Unlike previous designs, this increases position sensing reliability while providing zero-power position measurement, meaning that even if the valve is operated manually by the actuator handwheel when the power is switched off, the actuator will always remember where the valve is positioned. All movements are recorded, logged and stored in the actuator datalogger with a non-volatile EEPROM memory. Manual movements are recorded and logged without the use of an auxiliary power supply.

For non-intrusive calibration and commissioning the actuator is addressed with a hand held setting tool and a secured Bluetooth connection. The actuator indication window is the focus of attention for setting operational parameters and displaying valve, actuator and process information in real time directly at the actuator. This display can include menu driven setting information, current and historical status, process performance and diagnostics. For example, changes to the valve operating torque characteristics can be displayed, traced and identified. This data is stored in the actuator’s datalogger, from where it can wirelessly downloaded to a PC, using the hand held setting tool. The data is optimised for diagnostics and
preventative maintenance. Analysis using proprietary software delivers a detailed window into the process, enabling preventative maintenance to be accurately planned in advance and helping to eliminate unscheduled interruptions to routine activity. In this way intelligent actuators can enable over-cautious regular maintenance to be replaced with a precisely timed schedule that provides the maintenance only when it is necessary. As well as optimising process efficiency, additional management benefits include reduced spare part stocking and administration, adding to the reduced overall cost of ownership.

**System integration**

Actuators are compatible with a range of communication and process controls systems which, using a field highway, report status feedback to the overall plant control system (DCS or PLC) where valve control commands are actioned. Various open systems including Foundation Fieldbus, Profibus, Modbus and DeviceNet are in use, whilst proprietary systems from equipment manufacturers are also available. Because it is specifically designed for the operating environments associated with valve actuators, the Rotork Pakscan system is widely adopted for system integration.

Pakscan allows the remote control of actuators and valves over a simple single twisted pair data highway, removing the need for heavy multicore cables. It also includes automatic inbuilt redundancy of the field network to ensure control will be maintained even in the event of equipment or cable failure. Available as a single or hot standby master station variant, Pakscan has the ability to control up to 240 actuators, and other field devices, using secure field communications. The field data highway cable may be up to 20 km in length so widely distributed valves in the plant can easily be incorporated into the network without the need for repeaters.

A recent development has introduced a wireless network version of the Pakscan system. This system establishes a secure wireless mesh network that is used to control actuators and other field devices throughout the plant and to gather the operating data for asset management and preventative maintenance from the connected valve actuators. In the wireless network, each actuator acts as an independent router to help signals get to their intended destination. A correctly designed network is

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*Fig 4 – Diagnostic screen from Rotork Insight software, illustrating data from the actuator showing valve operating torque profiles, downloaded by the hand held setting tool.*
configured to provide two or more paths between each actuator and the wireless coordinator. Therefore, if the normal traffic route is blocked or if a hardware or communication failure should occur, it can be overcome as the network dynamically determines an alternate route for the data to travel. This self-healing network mimics the loop-back capabilities of the established Pakscan two-wire loop.

All control data is encrypted using the Advanced Encryption Standard (AES). Additional encryption is incorporated into the system to prevent unauthorised devices joining the network and to prevent a message replay attack. The wireless network card gives the user access to all the standard control and monitoring features and data available from the wired Pakscan system, together with the diagnostic and asset management information stored as standard by the actuator datalogger and configuration files, which is otherwise only downloadable locally using the hand held commissioning and communication tool. The modular and flexible nature of the system allows the user to have the choice of a fully wired loop for control and monitoring, a fully wireless control and monitoring system or wired control with wireless monitoring.

A wireless network has been installed at the Newmont underground gold mine in Nevada, which utilises Geotube® dewatering technology to separate sediment from both ground and extraction process water (see Figure 6). The filter systems, which are installed above ground, are fabricated from a woven material which is permeable to water while retaining solids and sludge. Excess water drains through small pores, resulting in effective dewatering of the contained material, which is then processed to extract the gold.

The large scale filtration operation has been automated by the motorisation of 15 widely distributed inlet and isolating valves with Rotork IQ actuators and a Modicon PLC to supervise the operation of the plant.

A Pakscan master station communicates with the Modicon PLC using Modbus TCP Ethernet protocol for the monitoring and control of the valve actuators over a wireless Pakscan network. The wireless network eliminates the cost of installing any additional site wiring apart from the actuator power cables. All the actuators are in ‘line-of-sight’ of the Pakscan coordinator module, with the distance to each actuator ranging between 68 metres to 132 metres. The externally mounted coordinator is connected to the Pakscan master station in the control room by a 15 metre cable.

At the Mount Thorley Warkworth open cast coal mines in New South Wales, Rotork has supplied valve actuators for the pipework delivering water to the north and south coal processing (washing) plants from a new 2 gigalitre dam source.
This project has included an actuator for a pipeline supplying water to a new water cart fill point for routine dust suppression operations (see Figure 7). Each water cart fill is made up of 120 tonnes of water, delivered at a pressure high enough to overcome a 10 metre rise in the height of the pipework at the point of delivery.

Skilmatic actuators combine the simplicity of electrical operation with the precision of hydraulic control and the reliability of mechanical fail-safe action. With the incorporation of intelligent control and monitoring systems, the actuators provide a safe, reliable and cost-effective solution for two position, safety shutdown or precise modulating control applications.

Fig 6 – Rotork Skilmatic electro-hydraulic actuator at the Mount Thorley Warkworth mine.

The specification for the actuator to operate the isolation valve on the water cart fill point was very demanding, calling for a solar powered, 24 VDC SIL-rated electric fail safe actuator, capable of closing a 500 mm butterfly valve in 10 seconds. Rotork has been able to satisfy these criteria with the Skilmatic electro-hydraulic product. The self-contained electrically powered actuators - comprising integrated control module, hydraulic manifold and a power unit consisting of a motor, hydraulic pump and reservoir - utilise an integral spring mechanism to provide a reliable means of positioning valves to a pre-determined safe position.

Fig 7 - Rotork intelligent electric valve actuator installed at a copper mine. These actuators have been installed within the water recirculation sections of the site for the provision of safe isolation and control points to protect and correctly run a key element of the mine’s operation.