***TECHNICAL ARTICLE***
***ON***
***PROPORTIONAL FLOW CONTROL VALVES***

## *TECHNICAL BACKGROUND*

IQ Valves new breed of solenoid operated, patented proportional flow control valves are unparalleled in the valve industry. Our proportional valve line outperforms the competition in many ways.

The critical specifications engineers evaluate when selecting a high performance proportional flow control valve are linearity, frequency response and hysteresis. Other important features are repeatability, power consumption, leakage, life expectancy and cost.

Engineers at IQ Valves have advanced the state-of-the-art of proportional valves by designing units that meet the high performance end of all the above mentioned specifications while keeping the valve simple enough to hold costs down. IQ Valves has achieved an unparalleled linearity, an exceptionally high frequency response of 250 Hz. and low hysteresis using a unique solenoid construction.

### *True Proportionality*

In the past, proportionality in valves was accomplished by using a linear solenoid or dithering an on/off solenoid. There are two types of linear solenoids. One uses a pulse-width modulated (PWM) electrical input signal to eliminate the effects of stiction. This reduces the frequency response of the valve. The second type of linear solenoid eliminates stiction by suspending the moving part (the armature) to eliminate metal-to-metal contact. While this has been the preferred choice, it involves a complex design and is expensive to manufacture. Dithering puts more burden on the complexity of the electronic circuitry and still does not yield the linearity needed in most closed-loop applications. For these reasons a truly proportional, more sophisticated, linear solenoid such as IQ Valves is preferred.

## *Linearity*

In conventional proportional solenoids, reshaping the magnetic flux to achieve linearity involves the use of complex, tightly toleranced parts and difficult welding/brazing processes. For example, an axisymmetric tubular construction consisting of three parts made of different materials is achieved by a complicated fixturing/welding or brazing process. Within this tubular construction, the movement of the armature must be precisely controlled to ensure it never touches the sides of the armature housing as it travels in and out.

Engineers at IQ Valves have overcome these deficiencies by relocating the moving parts outside the core and situating the magnetic flux paths associated with linearizing the force-displacement characteristics outside the coil

Keeping the moving parts outside the core of the coil eliminates both the tightly toleranced parts and the rubbing of the armature within the armature housing. This also eliminates the need for welding or brazing

## *Frequency Response and Hysteresis*

High frequency response and low hysteresis are achieved by eliminating any metal-to-metal contact between the armature and its surroundings and minimizing the weight of the armature. In high performance valves, suspending the armature between a pair of thin, flat springs eliminates metal-to-metal contact.

In IQ Valves design no part of the magnetic circuit is captured between the two flat suspension springs. This simplifies the design, reduces the number of parts within the assembly and eliminates tight tolerances on those parts.

The weight of the armature assembly also plays a major role in the frequency response of the solenoid and the valve. In IQ Valves design, the suspended armature is optimized to occupy a minimum space thus reducing weight. Also other key parts in the suspending mechanism are made of inexpensive, light weight non-magnetic materials. This design yields a very high frequency response in excess of 250 Hz and a low hysteresis of 3-5 %.

## *Flow Rate*

In the prior art, proportional valves were either designed for low flow or high flow but never both. IQ Valves has adapted this design to accommodate a wide range of flows with orifice sizes ranging from 0.032" to 0.625".

The valve flow turn-down ratio (an indicator of the resolution of the valve) is in excess of 20,000 to 1. This means our valve can handle flows as high as 200 liters per minute but it can also accurately and proportionally control a flow as low as 10 cc/minute without losing proportionality or linearity.

*Leakage and Other Design Features*

The valve itself is a two-way poppet design with either metal or elastomeric poppet material. Leakage of bubble tight to 1cc/minute is typical. The operating pressures range from less than one PSI up to 250 PSI. IQ Valves design isolates the magnetic and electric components from the working medium by a separation diaphragm. This makes the valve suitable for both liquid as well as gaseous applications.

## ***APPLICATIONS INFORMATION***

IQ Valves new family of proportional valves are opening up applications where previously engineers "made do" with on/off valves. IQ Valves proportional valves are presently being used in the following applications.

*Medical Respiratory Care Industry*

IQ Valves proportional valve is presently used in medical ventilators for use in hospitals. This is a typical application for a high performance proportional valve. Here a pair of valves are used in tandem to precisely meter, mix and deliver air and oxygen on demand in the right quantities. Ventilators typically have an on-board computer that determines the air/oxygen mix and sends a signal to the valves. As the valves respond to these command signals, the output flow is measured by a flow meter and fed back to the computer.

In this closed loop application these valves must meet very stringent requirements. A ventilator must be able to respond quickly to patient demands on a breath by breath basis. Our valves deliver a maximum flow rate of 200 LPM yet have the resolution of

0.01 LPM. IQ Valves valves are capable of meeting these requirements due to the linear proportional performance and the high frequency response of the solenoid.

*Energy and Alternative Fuels Industries*

IQ Valves proportional valve is utilized in the precise metering of fuel to a portable turbine engine used to generate electricity. The same valve is suitable for diesel, gasoline, propane and natural gas. In this metering application the engine rpm is measured and fed back to the engine's main computer and the computer sends command signals to the valve which in turn adjusts itself to meet the ever changing engine load requirements. For an example of flow rates, the natural gas flow rate varies anywhere from 10 scfm to 40 scfm.

In a second fuels application, our valve is used in a similar closed-loop system as just described but it is within a piston type engine. The valve is part of an air/fuel ratio controller used on stationary engines found at oil-well heads. These engines use raw fuel right out of the oil well which exposes these valves to contamination so severe, actual pebbles have been found inside the valves. Yet, in spite of stones floating around in the flow path, these robust valves still function.

The fuel cell industry also uses IQ Valves proportional valves to meter fluids in both the fuel and water systems found within a typical fuel cell unit.

*Additional Applications*

Other current applications include water purification systems, mass flowmeters and oxy-acetelene welding.