SHUKOS COMPONENTS LIMITED

UNCOMMON SIMPLICITY INTO INNOVATION ™

ADJUSTABLE ELECTROMAGNETIC FLUID FLOW CONTROL VALVE.

FREQUENTLY ASKED QUESTIONS

 20. Feb. 2012

The adjustable electromagnetic fluid flow control valve was developed by SHUKOS COMPONENTS LIMITED and its founder. It utilises a principle of operation, which is based on a scrollable ferromagnetic occluder, exposed in the electromagnetic field created by an offset pair of poles.

Appearance of this invention in the flow control industry is equivalent to another type of electric machine, appearing among well known, synchronous, asynchronous, DC and others, with the difference that the variety of the flow control devices is very limited compared to electric machines. Time will show how successful this technology is in different applications, although the current development and test results are very promising.

The purpose of this document is to clarify some questions and concerns posed by engineers evaluating the workability of the SHUKOS Valve™ for their applications. The valve's parameters below are given for example purposes only and represent one of the currently existing products. We welcome any custom requirements you may have and will discuss any available options.

1. Technical Parameters of the Valve

1.1. Electrical parameters

The valve is actuated by a single **coil** wound by a copper enameled wire. Its **resistance** at 20ºC is 135±5 Ohm; the coil **inductance** at 0.1, 1.0 and 10.0 kHz is 500, 210 and 80 mH accordingly. ***Note:*** that inductance was measured when coil was assembled in the valve to allow for influence of the whole of the magnetic circuit. The maximum **power** of the coil is 6.5 W and the maximum **voltage** is 35V.

Input signal to the coil is electric **current** and in particular the current (not voltage) determines the output signal (flow) of the valve. The input **voltage** and the **power** depend on the current and resistance (impedance) of the coil, which depends on the coil temperature. Examples of the input vs. output characteristics of the valve are shown further.

Operation of the valve is silent on pure DC. If AC or PWM supply is used then unit may emit noise of corresponding frequencies. Therefore if pure DC supply can not be used a non audible frequency range for PWM should be considered, e. g. in consumer products.

1.2. Fluid Parameters

Having brass, nickel and zinc plated steel parts as well as viton® seals coming into a contact with the fluid flow, the valve can safely control non aggressive fluids such as air, Natural and LP gases. However, shall our costumers indicate so, we are prepared to evaluate different **materials** for another type of **media**.

We indicate a **maximum inlet pressure** of the valve at 15 kPa (60" WC), which is common for gas cooking appliances, although the current valve sealing and body would withstand much higher stress.

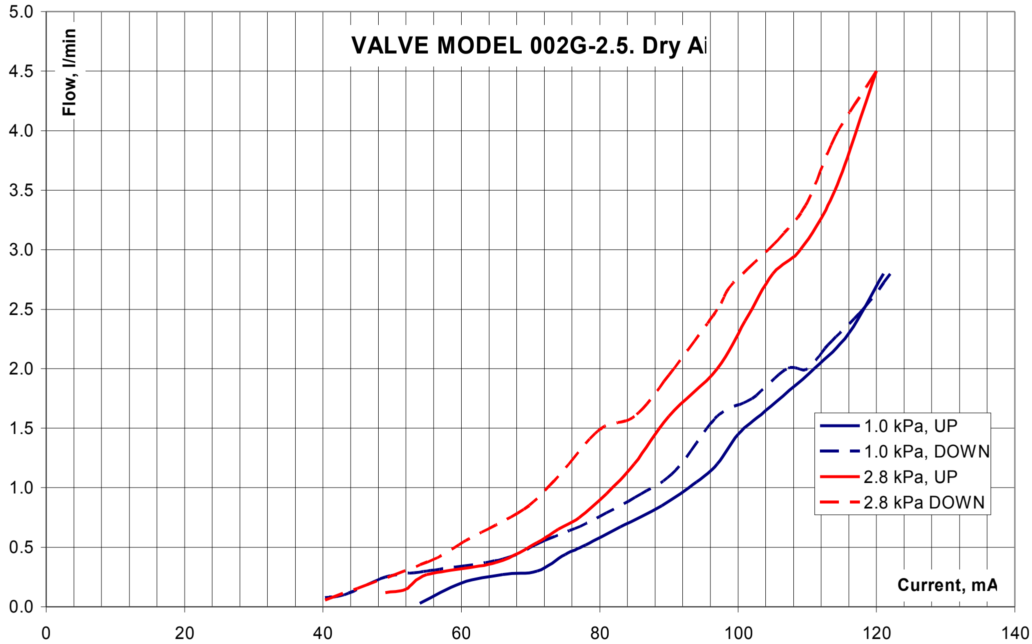
The **operating inlet pressure** at which the valve is currently working is 1.00 kPa and 2.75 kPa (4" and 11" WC), but another value can be examined on request.

There are several ways to set the **minimum flow level** of the valve. This level can be significantly lower than the minimum flow required for the safe combustion of any known cooktop burner. The output of the first (the smallest) burner on the demo video* is turned down below 100 W (340 BTU/h), which is below 0.05 L/min (0.1 SCFH) at 2.75 kPa (11" WC), on LPG. Therefore, in the case of this valve it is down to the burner's ability to maintain a small, safely burning flame, low enough for the "cooking rice" or "melting chocolate" performances and without sooting.

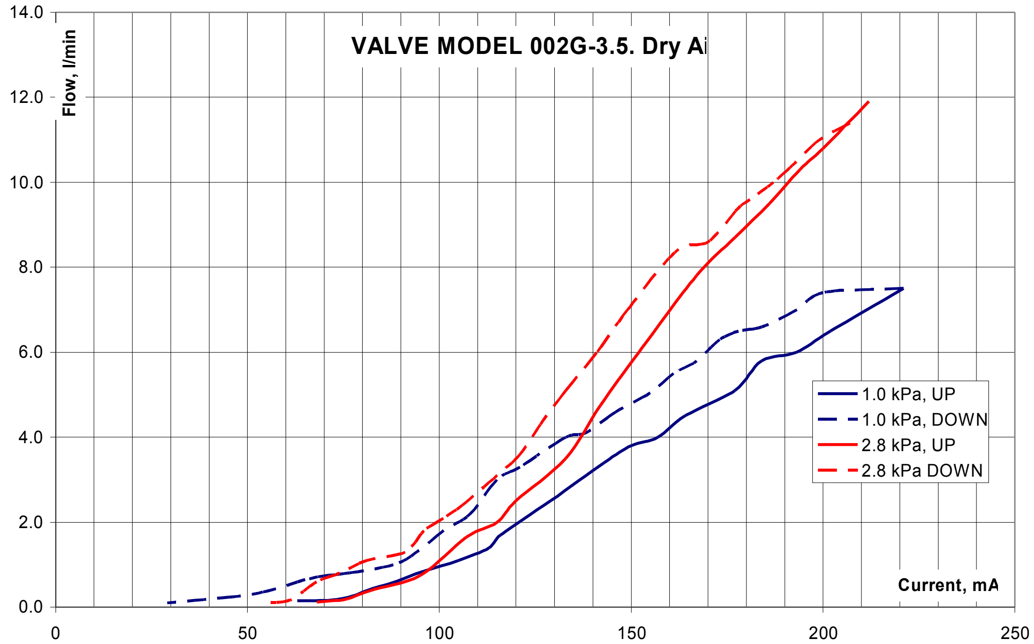
The **maximum flow** through the valve is limited by the orifice diameter inside the valve which is currently 3.5 mm and at 1.00 kPa (4" WC) of the inlet pressure the flow of dry air reaches 7.4 L/min (15.7 SCFH), and at 2.75 kPa (11" WC) – 11.9 L/min (25.2 SCFH). This approximately equals to 5,55 kW (19 kBTU/h) on NG and almost trebles the power output on LPG.

1.3. Output Curves

There are several parameters affecting **Flow vs. Current curve** of the valve. Two charts below show the test curves for identical valves except the diameter of the internal orifice: one is 2.5 mm, another 3.5 mm.



* Published on the "Products" page (www.shukos.co.nz/products)



The discrepancy between the "UP" and "DOWN" curves is due to the **hysteresis** which is intrinsical to all electromagnetic devices. If necessary, this effect can be reduced by some design changes or could be dealt with electronically. Also the hysteresis effect is reduced by the limiting factor of a burner jet (injector) orifice.

Although one valve design potentially could satisfy different burner sizes running on different gases, it is very advisable to have at least one different valve design for NG and another one for LPG. This would enable the user to fully utilise the most of the valve's range. **Please note,** when ordering the valves, the several options of the flow output usually do not involve any extra cost.

2. Design Limits

The **valve's size** depends on the bobbin dimensions. Our supplier has a wide range of available bobbins and we will be prepared to invest in custom injection moulding tools for high production volumes.

Current valve's (002G) OD is 33 mm (1.300") and Length is 45 mm (1.772") excluding fittings. Within these dimensions the orifice Ø can be up to 4 mm (0.158") providing for the flow coefficient (C_V) of 0.3. **Maximum pressure** is 1600 PSI if the temperature of the brass parts does not exceed 150ºC (300ºF), which is way beyond the cooking appliances applications. For example, we are currently developing a similar size valve for refrigeration, which is able to control liquid at 18 bar.

Other **available valve sizes** (OD / Length excluding fittings / Max Orifice Ø):

1. 24 mm (0.945″) / 45 mm (1.772″) / 2 mm (0.080″).
2. 50 mm (1.969″) / 55 mm (2.165″) / 6 mm (0.236″).
3. 65 mm (2.559″) / 75 mm (2.953″) / 12 mm (0.427″).

Please note, that some intermediate sizes are also available.

The **maximum ambient temperature** is limited by the thermal class of the winding insulation, which is currently "F" (155ºC / 311ºF), therefore, for the current design, we indicate the ambient temperature of 105ºC / 221ºF, if required we can investigate possibility of increasing the temperature to 125ºC / 257ºF.

3. Electronics

Electronic control system for the SHUKOS valve, used in cooking applications, comprises of two main system components: a power supply and a control unit. For a single valve unit a 7W power supply is sufficient. For multiple control units in a single system a larger power supply option can be utilised. The sizing of the power supply is dependent on the number of individual valves in a system. The control system unit has a wide variety of possible options based on the user interface input control. Currently we are working on encoder and touch based interfaces.
We are developing our own electronic system and in the future will be offering it together with the valve, but in spite of this, at present time we would supply just the valve and on request, assist our customers to develop their own, whether open or close loop, systems.

4. Standards Approval.

All parts and materials of the valve as well as controlling electronics are **ROHS** compliant.

Because of the novelty of this devise there is no any standard which would directly relate to the product. However there are several ways of dealing with it:

A) Approve the valve as "Automatic Shut-off Valve", per **BS 161,** or **AS 4629**, or other similar standards. The test conditions of these standards are much harsher than a burner control operation, but we are prepared to apply for such standards for a dedicated customer. Obtaining quotes from Australian Gas Association (AGA), we have learned that testing one standard costs approximately $15,000, plus another $2,000 for issuing the certificate and as soon as any changes made to the valve, even just minor fitting changes, it needs to be retested. Therefore we prefer to customise the product as much as possible, securing customer dedication and then apply for the standard's certification.

B) We also have been offered by the Standard's Authorities to **develop a new standard**, covering the valve. This is obviously more expensive and time consuming option and probably is worth pursuing in a case of long production of large quantities.

C) Use the valve together with an **approved shut-off valve.** Apparently this is a more expensive option, but can be considered for a single valve application such as ovens, fire places, water heaters, etc. In this case the SHUKOS valve does not require any certification.

5. Other questions

5.1. Can the valve get stuck open?

Compared with a traditional solenoid valve, the SHUKOS valve has some features in common. In both types of valves the shut-off sealing is provided by a spring action when the coil is de-energized. But due to the very small air gap in the magnetic circuit of the SHUKOS valve, the spring force is greater than in conventional valves and the total linear travel of the moving parts is around 1.0 mm or even less. Therefore the probability of a failure event still exists, but it is significantly smaller than in traditional solenoid valves.

5.2. Do you provide samples?

Yes, we do provide samples for testing. But first we would like to know about the requirements for your application, which will enable us to develop a tailored engineering solution to meet your needs. And we require a payment for the samples, so please inquire when you wish to place an order.

5.3. How to specify the flow requirements?

We appreciate the fact that in different countries there are different types of combustible gases, even if they are called by the same names NG or LPG. So to specify the minimum and maximum flow requirements we recommend to our costumers to use **dry air**, preferably from compressed air cylinders, but a reasonably dry air supplied by compressor, can be used as well. To specify **air** flow is a common practice among gas valve manufactures such as Sabaf®, Defendi® and others.

There are several simple steps that we recommend to follow:

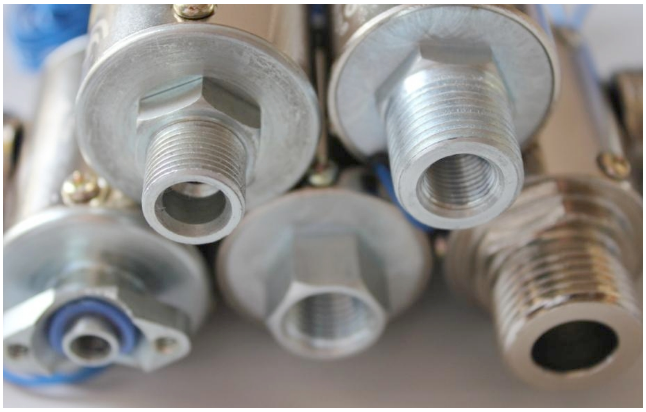
- Connect a burner to a desired gas supply (Gas Type and Pressure) via a manual rotational (set) valve. We recommend for better accuracy to use a needle valve with several rotations of the shaft.
- Ignite the burner and set desired minimum or maximum flame level, not forgetting to maintain a required pressure at the valve inlet. If satisfied with the output then fix position of the set valve shaft.

- Shut-off the flame by another means (e. g. solenoid valve) between the gas source and the set valve.
- Remove the set valve from the gas circuit (not disturbing its shaft position) and connect its inlet to an air supply with a flow meter and a pressure gauge (installed before the set valve).
- Leave the outlet of the set valve open to atmosphere.
- Set the air pressure relatively close to the gas pressure and record the flow.
- These minimum and maximum air flow values at known pressure will be sufficient design requirements which you will be providing to us.
- If you are planning to use the same valve for a range of burners, then it is acceptable to determine the minimum flow on the smallest burner and the maximum on the biggest.

Even if you could not provide the air flow ratings we will proceed with the design based on the power and diameter of the burner jet (injector), but this approach may compromise accuracy and range efficiency of the valve performance.

5.4. What can be customised?

- Electrical parameters, voltage and current, but the power level should remain the same and it mainly depends on the coil dimensions, unless the customer wants to change them.
- Inlet pressure, minimum and maximum flow.
- Fittings including manifold option and electrical termination.



Examples of different fittings.

5.5. Other Advantages of the SHUKOS valve

Apart from the main selling point, which is electronic control of the flame, it gives other benefits for designers and manufacturers such as:

- Independence of the valve location in the product from the customer interface, allowing to choose an optimal position of the manifold and shorten the inlet and outlet tubing, electrical connections, as well as easing appliance assembly procedures and reducing their time;
- Smaller holes in the glass for encoders or no holes at all for the touch interfaces which converts to reduction of reject rates for glass manufacturers and cost reduction;
- Completely solving alignment issues between valves' shafts assembled on the manifold, knobs and graphic on the glass or front panel of the appliance. Removing jigs, fixtures and reducing assembly time required for the cosmetic alignment. No more problems with a stuck valve shafts for push-to-turn action and uneven and different from burner to burner rotational torque.
- In case of the "Domino" cooking arrangement (when gas burners and electric elements are used together creating a common cooking surface) the SHUKOS valves deliver **a)** an implementation possibility of the same type of customer interface for controlling both gas and electric output and **b)** an advantage of electronic control of all "Domino" units from one interface of the master unit.

If you have any comments or would like further information then please contact us.

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