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FlowCon Topic Letter

Insert Means Flexibility

Stable system performance, predictable commissioning, and fewer callbacks all depend on how well flow is controlled under changing conditions. Yet one important 'building block' is often misunderstood: **the insert**.

In practice, the value of an insert is not in the fact that it can be replaced. The real value lies in how it manages pressure variations and maintains the intended flow in the system. This directly affects energy efficiency, comfort, and the time spent on commissioning and troubleshooting. To understand this, it is useful to separate construction from functionality. The term **insert** simply describes the replaceable internal part of a valve. It does not define how the valve performs.

From a functionality standpoint, two main control principles dominate the HVAC market:

- A **spring-based solution**, where the insert continuously adjusts its opening as pressure changes and
- A **diaphragm-based solution**, where the insert maintains constant differential pressure across a defined control area.

Both approaches are designed to balance flow and FlowCon offers both insert solutions in the product range. The spring-based solution is the FlowCon stainless steel inserts (pre-set dynamic balancing), and the diaphragm-based solutions cover FlowCon Green and GreEQ (adjustable PICVs), FlowCon E-JUST and Composite (adjustable dynamic balancing) and FlowCon EDP, ADP and SDP (adjustable or pre-set DPCVs).

Why Insert-Based Solutions Deliver Flexibility from Start to Finish

Insert-based valve solutions are designed to support **flexibility across the entire project lifecycle**. From system design and phased delivery, to simplified installation, commissioning, service, and responsible end-of-life handling, the insert concept makes your HVAC project easier to handle, without compromising hydraulic performance or control accuracy - in fact, insert control accuracy is often superior to traditional built-up valves.

Flexibility during Design

From a system design perspective, the FlowCon valve concept imposes **no requirements for defined straight pipe lengths** before and after the valve. This allows the valve (both insert-based and one-unit solutions) to be positioned freely within the piping layout, close to elbows, tees, pumps, or other components, without loss of performance.

Flexibility during Delivery

The insert-based solution, where valve housings and inserts are supplied as separate components, allows **phased deliveries** in line with the overall project schedule and procurement strategy. This enables a natural separation of deliveries and costs across different project stages and craftsman disciplines.

Valve housings and flushing caps can be delivered early in the project and installed as part of the initial pipework installation phase, allowing mechanical

works to progress independently of final flow selection. Once the system has been flushed and is ready for commissioning, the inserts can be adjusted at ground level before being installed in the valve housing, which is typically mounted at high level above the ceiling, improving both accuracy and ease of installation.

By supplying components exactly when required on site, the insert-based solution supports **optimized logistics**, reduced site inventory, and improved coordination across the supply chain.

Flexibility during Flushing

An insert-based valve design **enables full flow, high velocity system flushing**, both forward and backwards, without the insert installed in the valve housing. During the flushing phase, the insert may be replaced by a dedicated flushing cap, allowing unrestricted flow through the valve housing. This approach is not mandatory as velocities can be reached if inserts are in maximum setting also, but supports effective removal of installation debris, construction residues, and contaminants prior to commissioning, thereby reducing the risk of blockage or performance deviation once the system is placed into operation. This process ensures that the valve operates under clean hydraulic conditions according to VDI2035 recommendations as the insert is installed.

By performing proper flushing as described above before activating daily operation, insert-based solutions support **best practice flushing procedures**, contribute to stable hydraulic performance, and promote long-term reliability and service life of the HVAC systems and its valves.

Flexibility during Installation

FlowCon's insert-based solutions can be installed in any orientation (**360° mounting**) with no negative impact on functionality. During installation of the valve housing, this design flexibility enables highly compact construction and efficient use of available space, particularly in confined plant rooms and retrofit applications. The absence of pipe layout constraints simplifies installation and reduces the need for additional pipework adaptations.

In addition, adjustable inserts can be set to the required maximum flow either before installation or after being placed in the valve housing. If flow requirements change, the setting can be re-adjusted easily while the system remains in operation, allowing the

flow capacity to follow original flow requirement and still be able to adapt to later system modifications. This makes the insert-based solution a very **flexible choice**.

For any of FlowCon's dynamic balancing- and PICV inserts, flow setting and selected differential pressure checks can then be carried out fast and efficiently as a final step as p/t ports are installed in the housing, minimizing on-site handling and avoiding time consuming commissioning.

Flexibility during Maintenance

An insert-based valve design provides **easy serviceability**. This modular approach allows **targeted maintenance activities** to be performed efficiently and directly on the insert, minimizing system downtime and eliminating the need for pipe disassembly or re-balancing. During maintenance, simply remove the insert for inspection, cleaning, or replacement as required, while the valve housing and pipework system remain untouched. Following maintenance, the insert can be re-installed or replaced, restoring the valve's flow balance and control functionality.

By decoupling insert maintenance from the pipework, insert-based solutions keep on supporting **easy serviceability** throughout the lifetime of the valve, contributing to predictable long-term system performance, and align with lifecycle-oriented maintenance strategies.

Flexibility at End-of-Life

Insert-based valve designs support a **lifecycle-oriented approach** by enabling physical separation of materials at end-of-life, in line with principles for Design for Disassembly and Design for Recycling as referenced in ISO 14040- and ISO 14044-based life cycle assessments.

At end-of-life, the insert can be removed independently of the valve housing, allowing differentiated handling of sub-components according to material composition. Valve housings are either all DZR brass or all AISI 316L stainless steel and can be re-used directly or recycled – this also goes for the assigned flushing caps mentioned under *Flexibility during Flushing*. Spring-based inserts are manufactured exclusively from stainless steel, facilitating direct allocation through established metal recycling streams with high material recovery rates. Diaphragm-based inserts are engineered for controlled disassembly with a simple twist by hand, enabling separation into distinct sub-components (composite

material, EPDM, brass and stainless steel), thereby supporting accurate material sorting and recycling in accordance with waste hierarchy principles.

By enabling disassembly and material separation at component level, insert-based solutions reduce end-of-life complexity, **improve re-useability and re-cyclability**, and support transparent lifecycle modelling. This contributes to improved data quality in LCA studies, facilitates more precise allocation of environmental impacts, and supports documentation requirements within ESG reporting frameworks and circularity strategies.

How Spring-Based Inserts Work

This insert solution is founded on the well-proven 'moving cup' technology, originally developed within the FlowCon Group in 1960. This mechanically simple yet robust principle forms the basis for a reliable, constant flow insert design with decades of field-proven performance.

Operating Principle

The insert functions as a pressure-independent maximum flow limiter, known as FlowCon's stainless steel insert range. Flow balance is governed by the fundamental relationship:

$$Q = \text{Area} \times \sqrt{\Delta P}$$

To maintain a constant flow (Q), the effective orifice area is continuously adjusted in response to changes in differential pressure (ΔP).

Functional Performance

Automatic flow balancing is achieved through the interaction between the internal spring and the moving cup. As differential pressure increases, the cup moves inward, reducing the orifice area. When pressure decreases, the cup moves outward, increasing the total opening. This dynamic response ensures a stable, pre-set max. flow control regardless of system pressure fluctuations.

As a single-flow, factory pre-set insert, the solution is fundamentally tamper-proof. A comprehensive insert-range enables simple selection across applications.

Materials and Design

The insert is manufactured entirely from stainless steel, ensuring high durability and corrosion resistance. Precision laser-cut orifices provide accurate flow control and exact flow balancing. In

combination with the spring mechanism, the laser-cut geometry creates a self-cleaning effect: any debris trapped in the orifices is removed through a knifing action as the cup moves.

The self-cleaning design minimizes clogging and supports long-term operational reliability with reduced maintenance. Combined with pressure compensating performance, robust materials, and tamper-proof pre-setting, the spring-based insert delivers consistent and dependable flow control throughout the system lifetime and makes it ideal for constant flow systems as a pre-set maximum flow limiter.

How Diaphragm-Based Inserts Work

The diaphragm-based solution is built on a rolling diaphragm principle that maintains a constant differential pressure across a defined effective area. This FlowCon signature-design was first introduced in the early 1990s, when FlowCon invented the PICV concept, and later evolved into the well-known **diaphragm-based insert concept**, with more than 25 years of proven field performance.

Operating Principle

This diaphragm-based insert design is available as a range of automatic balancing inserts, ABV inserts (FlowCon E-JUST and Composite), a range of pressure independent control valve-inserts, PICV inserts (FlowCon Green and GreEQ) and a range of differential pressure control valve-inserts, DPCV inserts (FlowCon EDP, ADP and SDP). For the ABV- and PICV inserts, flow balance follows the fundamental relationship:

$$Q = \text{Area} \times \sqrt{\Delta P_{\text{constant}}}$$

To maintain a constant flow (Q), the differential pressure (ΔP) across the effective orifice area is kept constant, independent of changes in system differential pressure.

DPCV inserts, on the other hand, control a $\Delta P_{\text{circuit}}$ which is beyond the scope of this Topic Letter.

Functional Performance

Automatic flow balancing is achieved through the interaction between the internal spring and the rolling diaphragm. P1 (valve inlet) and P3 (valve outlet) represent the system pressures, with P1-P3 being the total pressure drop across the valve. The internal P2 is set by the diaphragm acting in reaction to P1, which is let to the upper diaphragm

chamber through an internal tube. As system differential pressure increases, the diaphragm rolls downward, reducing the outlet orifice area to maintain a constant ΔP (P1-P2). When pressure decreases, the diaphragm rolls upward again, increasing the openings and still maintaining ΔP (P1-P2) constant. This continuous mechanical response, i.e. the dynamic pressure independent balancing, ensures a constant and stable flow regardless of system pressure fluctuations.

The adjustable versions of diaphragm-based insert solutions allow precise setting of the required design flow. Both ABV- and PICV inserts (FlowCon E-JUST, Green and GreEQ) feature **stepless setting** across 41 defined setting positions through a multi-turn micrometer setting, covering the full range between lowest and highest settable maximum flow. This enables a clear and repeatable setting position matching design flow.

In addition, the PICV insert design ensures full control performance, delivering **100% valve authority** and **100% usable stroke**, independent of the selected flow setting. This is achieved by separating the adjustment and control functions: the flow setting is established through a horizontal rotational adjustment, while the actuator performs control through a vertical, linear movement. As a result, the actuator stroke remains fully effective across the entire flow range, ensuring accurate, stable, and proportional control at both partial load and full load.

Once the desired flow is set, the insert can be rendered tamper-proof by fitting a top cover (ABV inserts) or an actuator (PICV inserts), protecting the flow setting from unintended adjustment. A wide insert range for both ABV- and PICV variants ensures straightforward and reliable selection across a wide spectrum of applications.

Materials and Design

The three primary functional components are the essential patented rolling diaphragm made of EPDM, a stainless steel spring and the adjustment unit from glass-reinforced PPS, which together form the core regulating mechanism. The central head nut linking the setting scale with the dynamic regulating assembly is manufactured from brass. Other wetted composite parts of the insert are also produced from glass-reinforced PPS, ensuring high mechanical strength and long-term dimensional stability. Non-wetted components, including the scale and other external elements, are manufactured from ABS, PC, and POM. All materials are

specifically selected for durability and dimensional accuracy.

In summary, FlowCon's diaphragm-based insert design applies a mechanically simple yet highly precise pressure independent principle to ensure stable and repeatable flow control. By maintaining a constant differential pressure across a defined area, and by assigning flow adjustment and control modulation to two independent mechanical movements, the solution delivers full valve authority, long-term reliability, and consistent performance. Combined with high-performing materials, the diaphragm-based insert provides dependable operation throughout the system lifetime.

Conclusion

This Topic Letter has outlined the technical benefits when selecting insert-based solutions. By separating the valve housing from the dynamic balancing and pressure independent control function, inserts can offer advantages in terms of configurability, serviceability, and lifecycle flexibility - without compromising flow accuracy or control stability. Insert-based solutions will support precise hydraulic balancing, predictable control behavior, and efficient system operation. For further technical evaluation or application-specific guidance, FlowCon remains available to support you and your HVAC project.