A ball valve is a simple and robust valve used in applications and industries across the spectrum. It consists of a ball with a hole through the center that can be rotated 90°.

The hole is either aligned with flow and open, or perpendicular to flow and closed. The straightforward, quarter-turn action is fast and simple to operate, and the position of the handle provides a clear indicator of whether the valve is open or closed.

Most ball valves are typically used as a shut-off valve. Many households likely use ball valves at some point in the water supply plumbing.

Not relegated to common plumbing, many industries use ball valves for critical control applications including aerospace and cryogenics. Their reliable operation and high-pressure handling ability make them an attractive solution for many specialty operations.

Seals Inside a Ball Valve

The seals inside the ball valve play an important role in their performance and reliability. There are two main seals in a common ball valve, which are referred to as seats.

The seats are typically machined or molded to match the diameter of the ball and are mechanically compressed against the ball face. Seat material varies by application needs, but virgin PTFE is frequently used for this application.

The Client’s Issue

The customer wanted a very specialized ball seat: utilizing a spring energizer in the seat. While easy to suggest, this would create a significant challenge in how the seal is manufactured.
The customer was looking for a sealing solution for a ball valve in their industrial gas processing plant. The ball valve would serve as a critical shut-off point in the system. The valve would be actuated by an electric motor, and could therefore be operated remotely.

The customer was looking for an improvement in the overall wear life of the ball seats, while still providing consistent and predictable actuation torque. Being motor activated, the torque required to move the ball open or closed was limited—so the friction generated by the ball seats would need to be carefully controlled.

Operating Conditions:

- Ball Valve Seat
- Ball Diameter: Ø2.500”
- Media: Petroleum Processing Gases
- Pressure: 100 PSI
- Temperature: -40° to 175°F

The Challenge

The typical PTFE ball seat can provide many years of service over many cycles and still retain positive sealing. Over time, unenergized PTFE will wear and leakage will eventually occur.

While there are valve designs that incorporate external springs to energize the seats, the customer was looking to retain a simple hardware design without adding mechanical components and increasing the physical size of the valve.

A spring energized seal would be the answer to this. Eclipse designs and manufactures thousands of spring energized seals every year, all which provide the sealing characteristics the customer wanted.

The concept, design, and functionality are nothing uncommon, but the packaging within the constraints of a typical ball seat would provide a challenge.

For the spring to function properly (as in a regular radial seal), the spring would need to be oriented at an angle that would match the contour of the ball. While contact could be made with the ball using a standard face or radial spring orientation, the effectiveness of the spring would be greatly reduced, since the compressive force would not be acting in the correct direction. Consequently, deflection range and therefore wear life would be compromised.

For the spring seal to function at its full potential, the angle at which its containment groove
is machined within the seal would need to match the angle of incident of the ball. This presented a manufacturing challenge as the necessary angle would certainly be non-standard to any available lathe tooling.

Luckily, Eclipse designs and fabricates all the necessary lathe tooling in-house. Grinding and sharpening tools is a normal and frequent operation, which allows Eclipse to machine complex or custom shapes and spring grooves. But in this case, the angle at which the spring groove tool would need to be made would be impossible to produce with conventional tool grinding equipment.

**The Eclipse Solution**

Eclipse turned to EDM (Electrical Discharge Machining). EDM allows geometries that would normally be impossible to grind such as nearly sharp inside corners and back angles.
The final step would be to fabricate a custom tool holder to mount the EDM tool. With that, the necessary steps to machine a spring groove at the unusual ball angle would be complete.

A simple seal design concept can take the efforts of multiple engineers, machinists, and manufacturing techniques to achieve.

Turning back to the seal design, Eclipse chose its EZ038: Graphite-filled, modified PTFE as seal material. The benefits of modified PTFE would greatly be utilized in this application.

Its improved resistance to cold-flow compared to conventional PTFE would help ensure long life. And its superior permeability resistance and the ability to achieve an excellent seal surface finish combined with the graphite filler, make it ideal for critical gas sealing.

**How It Performed**

The advantages and benefits of spring-energized PTFE seals are realized everyday in applications across the world. These are usually limited to either rod or piston seal configurations.
The spring energized ball seat was able to extend the wear life and service interval of the valve. The spring is able to keep constant energy on the sealing lip contacting the ball, even as the lip wears.

While extending the life of the seal, the spring energizer also facilitates predictable and consistent actuation torque by carefully controlling seal friction. The customer was ensured the remote motor actuation would always function as intended.

Gallagher Fluid Seals is a preferred distributor of Eclipse Engineering. Call us at 1-800-822-4063 for more information on Eclipse seals.

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