

DFT[®]

Severe Service Control Valves

HI-100 PRODUCT FEATURES BASIC DESIGN, ANALYSIS AND OPERATING DATA

The HI-100 product line features an in-line, through-ported, venturi flow shape. The seating element, a ball, is contained by a cage that positions it relative to the downstream seat by means of linear stem travel. There are no close clearances between the moving parts (i.e. cage, ball, and seat). These basic features enable the valve design to operate smoothly and efficiently at high or low temperature, and/or with fluids containing foreign matter such as slurries.

In the full open position (see figure 1), the flow is straight through and operates as a true venturi with the inherent high flow and high pressure recovery characteristics. The cage straddles the flow stream and supports the ball on four incline pads holding it on the edge of the stream. The force holding the ball firmly against the cage is caused by the pressure differential created by the high velocity fluid in the flow stream, compared to the relatively static state of fluid in the valve body. This dynamic characteristic is commonly referred to as the Vena-Contracta effect. The presence of a pressure differential at full open, and during all positions of the cage and ball, prevents suspended particles in the stream from settling out in the body, thereby keeping the valve clean and free of any material deposits. Also, in the full open position, any suspended particles flowing through this venturi configuration tend to concentrate in the center of the diverging cone and through the orifice. This obviously helps in lessening the erosive action of the fluid on the valve surfaces, in particular the seat face.

In the throttling position (see figure 2), the ball is supported in a three-point suspension by the two forward incline pads on the cage and one on the bevel of the seat face (see figure 3). The seat bevel acts as a ball bearing surface, permitting the ball to roll back and forward, and into the seat. This three-point suspension with the ever present pressure differential, keeps the ball in a very solid and stable condition during all positions of control. This same three-point suspension also permits extremely close control even at minute openings of the valve, down to only a few thousandths of an inch (see figure 4).

It should be noted that the ball is the only part that ever enters into the flow stream. Due to the unique three-point suspension, every small movement causes the ball to move ever so slightly and therefore presents a different face to the seat in the flow stream. This action results in extremely accurate rangeability and flow characteristics (see figure 5). Also, since the ball is the only part in the flow stream, the fluid, as it flows over the spherical surface, has a tendency to adhere to the surface and break away at a point close to the center of the downstream orifice. Therefore, any suspended particles will mostly miss the surfaces of the orifice and the new ones that do impinge will contact at a shallow angle, thus reducing wear.

In the closed position, (see figure 6), the ball sits freely on a conical seating surface and is held there by the pressure during system operation. The line contact between the ball and the seat yields a high unit loading for exceptionally tight closure. Due to the ball seating with pressure, the higher the pressure, the higher the closing or seating force. This high seating force, along with slight rotation of the ball during the initial opening travel, results in a new seating surface contacting the seat each time the valve is closed, thereby helping to extend the effective tight closure life of the valve.

It should also be noted that all valves have a guide pin. This pin is used only to position the ball for closing when there is insufficient flow to create an adequate pressure differential. When the valve is operating with a sufficient differential across the valve, the guide pin has no function.

Key design features to remember:

- **HIGH FLOW CAPACITY**
- **STRAIGHT THROUGH NON-TURBULENT FLOW**
- **TIGHT SHUT-OFF**
- **WIDE RANGEABILITY**
- **LESS SUSCEPTIBLE TO EROSION AND ABRASIVE WEAR**
- **HIGH PRESSURE-TEMPERATURE CAPABILITIES**
- **LOW OPERATING THRUST**

We have just reviewed the various operating positions from open to closed. Also presented was a simple analysis of the major operating characteristics of the product design, and why it can operate in the most severe applications without serious and detrimental effects. Additional operating features and characteristics, more applicable to a specific HI-100 valve design are available upon request. If you should require additional technical assistance, contact DFT at 800-206-4013 or 610-363-8903.