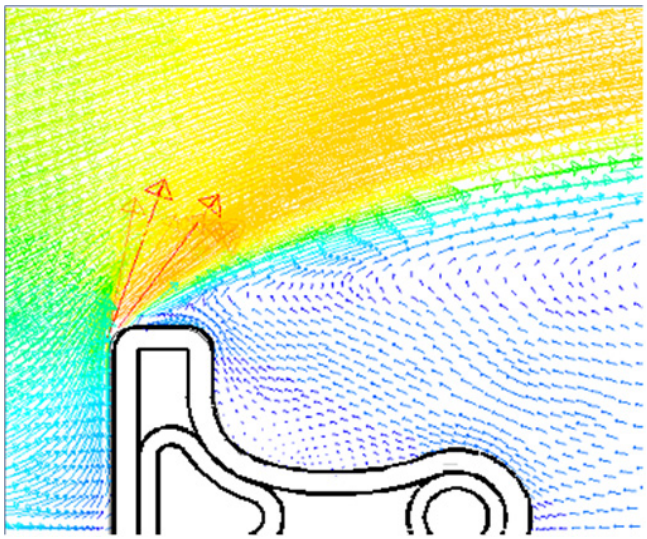
Technical Note
00840-0900-4809, Rev AA
March 2012

Surface Roughening on the Rosemount 485 Annubar Sensor®

The accuracy of an averaging pitot tube type flowmeter depends primarily on the accuracy of the flow coefficient supplied by the manufacturer. As fluid flows past the Annubar, the fluid separates from the sides of the Annubar shape. The location where this occurs is called the separation point. Figure 1 shows the separation point of the Rosemount 485 Annubar.

Figure 1. Separation point of Rosemount 485 Annubar



The flow coefficient of the Annubar averaging pitot tube is dependent on the constancy of the location of the separation point. If the separation point does not remain fixed throughout the flowmeter's operating range, the flow coefficient will change, degrading the accuracy of the flow measurement.

For low Reynolds Number applications, the separation point remains constant throughout the flowmeter's range by keeping the surface of the sensor smooth. Figure 2 shows the smooth front of the 485 Annubar.

Figure 2. Smooth front of 485 Annubar

As flow rates increase and the fluid directly adjacent to the Annubar surface (the boundary layer) transitions from laminar to turbulent, the separation point with a smooth sensor surface will change, causing a shift in the flow coefficient. For high Reynold's Number applications (exceeding 1 million), a textured surface finish is applied to the front surface of the Rosemount 485 Annubar. Roughening the 485 Annubar's surface forces the flow in the boundary layer to remain turbulent throughout the operating range and keeps the separation point constant. Figure 3 shows the roughened front surface of the 485 Annubar. Liquid applications are generally low Reynold's Numbers and gas and steam are generally high Reynold's Numbers.

Rosemount 485 Annubar

Figure 3. Roughened front surface of 485 Annubar

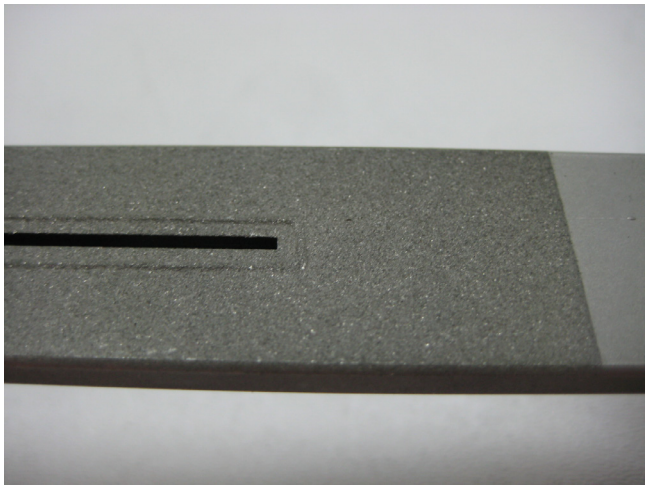
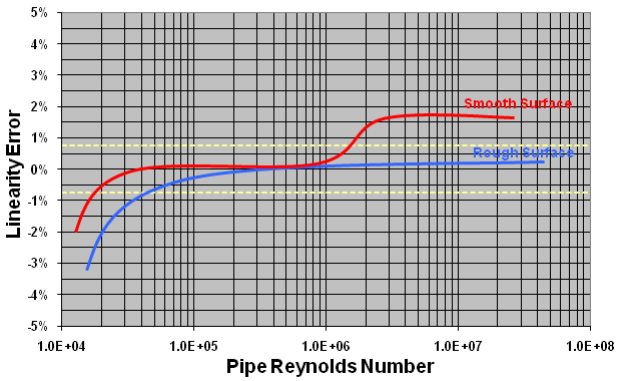


Figure 4. Flow coefficient of Rosemount 485 Annubar



Either surface texture gives a full 10:1 flow turndown with no shift in flow coefficient from a change in flow rates. The result is a consistent, stable separation point, and therefore an accurate flow measurement over a wide flow range. Figure 4 shows the linearity Error versus Pipe Reynold's Number for two 485 Annubars with roughened and smooth front surfaces. From the graph, we can see that the smooth surface remains linear at lower Reynold's Numbers and the roughened surface remains linear at the higher Reynold's Numbers creating a completely linear flow coefficient for the Rosemount 485 Annubar.

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