Specification Review - Chrome Lined Flow Tubes

Summary

One of the most identifiable characteristics of the Flow Management Devices (FMD) prover is the precision machined flow tube. FMDs flow tube material of construction is either 304 SS or 316 SS with a chrome finished measurement section. This specification review will focus on the importance of the chrome finish within the flow tubes to maximize performance, service life, and durability over time as compared to non-lined stainless steel flow tubes.

Maximizing Flow Tube Performance

To offset potential tube damage caused by particulates and other hazardous contaminants, the best solution is a hardened material that is less impacted by scarring or other physical damage. As per the table below, chrome plating is significantly harder than stainless steel and much more durable. Also noted in the table below, chrome is significantly harder than stainless steel to the point where its hardness is commonly measured on a different scale more applicable to hard materials.

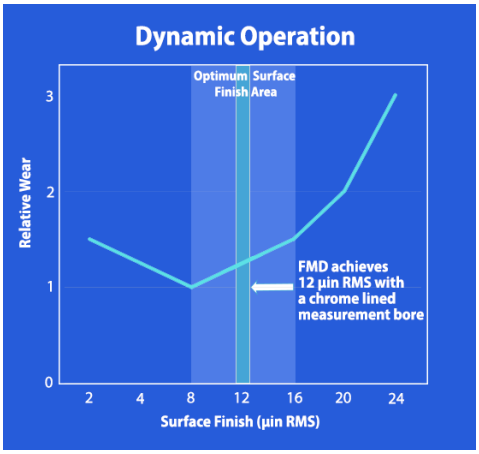
Material	Rockwell C Hardness (HRC)
304 SS	<20 HRC
316 SS	25-30 HRC
Chrome Plating	68-72 HRC

Note: Due to 304 SS and 316 SS being relatively soft metals, the HRC scale is not commonly used for them. HRB, BHN, or VHN are more commonly used for soft metals like 304 SS or 316 SS. HRC is more commonly used for hard materials like chrome. The HRC scale was used here to provide an appropriate comparison.

In addition to the data above, prior to finalizing the FMD flow tube design, FMD conducted flow tests on particulate laden petroleum fluids in chrome lined SST and non-chromed SST. It was noted that the softer materials were more impacted with scarring damage than lined provers. In fact, the lined provers showed virtually no impact of damage from particulates in the flowing stream.

Seal Compatibility

All compact provers require dynamic seals to be engaged with the flow tube. These seals have both hardness and surface finish requirements. Following the references from various seal manufacturers, a hardness of 40 HRC is recommended for non-pressurized applications and 55-65 HRC is recommended for pressurized applications. If these hardness recommendations are not met, not only will the seals fail but will also fail to the point where the flow tube damage is caused.



Seals also have surface finish requirements to reduce seal wear. The optimal surface finish is both achieved and maintained easier with the harder and more durable chrome finish as compared to polished stainless steel. The optimal range of surface finish recommendation varies by seal manufacture, but the range of 8 to 16 µin RMS is relatively deemed acceptable as noted in the various references associated with this specification and shown in the figure to the right. FMD easily achieves a surface finish in this range with a chrome lining.

Conclusion:

FMD recommends a chrome finished flow tube to prevent both premature seal and flow tube wear. This is supported by several seal manufactures and various hardness tests that all conclude a chrome finish is harder, more durable, and provides superior compatibility with dynamic seals in comparison to non-lined stainless steel flow tubes.

References:

"Chrome's hardness rates 68-72 on the Hardness Rockwell C (HRC) scale. **Chrome is the hardest metal that is commercially deposited from a bath." – Chrome Tech**

"For moderate linear, reciprocating motion and non-pressurized oil and rotary shaft seals, a minimum hardness of 40 Rockwell C or greater is recommended.

For pressurized rotary seals in PFTF/PTFE a hardness of 55 to 65 Rockwell C is recommended. **Harder surfaces allow the use of higher wear-resistant seal materials that will increase both the seal and hardware lives.** Softer surfaces require the use of lower wear-resistant seal materials that will not damage the mating hardware surface, but normally reduce seal life. A balance between seal material and hardware surface must be met for best overall sealing performance and to ensure that the seal is the sacrificial component." – **AHP Seals**

"For dynamic seals, the shaft or bore should have a surface finish between 8µin and 16µin RMS. This range of peaks and valleys on the hardware serves the purpose of holding the lubricant against the O-ring and ultimately minimize friction and wear damage.

Surface finishes above 20µin will cause abrasion on the O-ring surface, and no amount of lube will prevent the O-ring from wearing." – **Parker**

"Materials for the surface(s) over which moving O-rings slide should be chosen carefully. Those that give the maximum life to moving O-ring seals are: Cast iron or steel for bores, hardened steel for rods, or hard chrome plated surfaces.

Soft metals such as aluminum, brass, bronze, monel and some stainless steels should be avoided in most dynamic applications, although they may be used in low-pressure pneumatics. - **Parker**

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