Further to one of my previous discussions regarding pneumatic part-turn actuators, in this issue I would like to take the opportunity to report on the best choice between the different technical solutions offered by pneumatic part-turn actuators.

By Günter Öxler

Figure 1

Figure 2

Figure 3

From any material to be used for the shaft – just think of the difference in machining stainless steel teeth and/or aluminium teeth on a shaft! Difficult if we look at hobbing and a pressure balanced shaft – so called floating shaft (see figure 2) – which makes the shaft blow out safely and reduces the wear & tear tremendously. The result is a wider material selection for the shaft, as only turning & drilling is necessary and a perfect solution with low wear and tear. All the used materials can be selected according to the operating conditions and can be hardened – just think on the cam disk in combination with the bearing pin in the piston (see figure 3). Frequently those actuators will reach a lifecycle time of millions of cycles. My experience shows an application with 50 Mio cycles within 6 months (glass bottle production line).

If we talk about wear & tear we should not underestimate the abrasion within the gear transmission. The aluminium particles, together with the oil / grease inside the actuator, form a grinding paste which results in a even faster damage of the actuator and, in the worst case, as well the abrasives infiltrate the compressed air system and damage upstream/downstream components such as solenoid valves; valve terminals etc.

Once again we have to consider that when using pressure dependant sealing rings and/or slide rings with graphite/Teflon compound material a lubrication of the air is no longer necessary so that the effect of having abrasives inside the actuator is less destructive as well as a reduction in the maintenance (refilling & draining of oil). The lever arrangement is responsible for the different output torque compared to a rack-and-pinion actuator (linear; constant torque curve) (see figure 4). The diagram shows the exact difference in effective output torque in both actuator systems. It is important to note that the scotch yoke actuator delivers a 20% higher break-away torque from the zero position – where any soft seated valve requires the highest available torque.
There are also, of course, limitations to the scotch-yoke system. If it is necessary to operate 3-way or 4-way valves which requires a turning angle of 180° it is not possible to use a scotch-yoke actuator as the lever arrangement does not allow turning > 95°. However, considering all the benefits of a Scotch-Yoke actuator, it is the best choice in automating valves with a 90° turning angle such as butterfly, ball and plug valves for ON-OFF as well as for control applications.

Why two different systems?
Most of the suppliers will define the two different actuator systems in a way that uses rack-and-pinion actuator for CONTROL purposes — because of its linearity, and the scotch-yoke actuator for ON-OFF applications as the scotch-yoke actuator is unable to hold intermediate positions. If we look on a common torque curve of a butterfly or ball valve, (as seen in figure 5), we will see that these valves have a reduced torque demand during the travel — resulting from the balanced tendency to open or close initiated by the media stream and the circumstance that 75% of the torque requirement in a soft seated valve is generated by the seat. But please do not forget about the previously mentioned design criteria: “NO O-Ring sealing as a dynamic sealing!”. The best option is a pressure dependant lip sealing as it delivers the least possible leakage. Second best is a combination of an O-Ring with a graphite/PTFE slide ring which reduces the friction in a slip-stick effect (see figure 6). This gives the best possible result for smooth operation and precise use of valve-controllers.

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Meet Günter Öxler

Günter Öxler has a long history within the valve industry. He graduated in Process Engineering and Mechanical Engineering in Stuttgart, Germany, holds a MBA degree in VWA as well as a Controlling degree and is a REFA Specialist. For more than 25 years, Günter Öxler has worked for several companies in the valve business, companies such as J.M. Voith GmbH (Hydropower and Paper Machinery), Erhard GmbH (R+D Process Valves and project engineering), and Festo AG & Co. KG (Project Manager and Project Engineer Process Automation). He is also member of the IWA, ISA, and VDI German Engineer and he is multilingual as he speaks 5 languages, among which are German, English, French, Italian and Spanish. Günter can be contacted under: OEX@DE.FESTO.COM