7.2.2. Cryogenic technology

On the other hand, icing around the stuffing box at very low temperatures can create big problems and even cause malfunctions of the entire control valve. Simply extending the bonnet, however, doesn't yield the desired results if the following points are not carefully considered:

- Physical condition and specific heat of the medium
- Temperature difference between medium and environmental temperature
- Installation position (bonnet upright or bonnet downwards)
- Design details of the valve bonnet

Since the items mentioned first are usually predefined and cannot influenced by the valve manufacturer, the efforts of the designers are concentrated on a bonnet style which guarantees the desired results. Special attention should be given to the following details:

- Heat conduction of the bonnet should be minimized
- Heat convection has to be largely limited
- Loss of heat energy has to be kept to a minimum
- Radiant heat of the piping system should be shielded.

If one compares old bonnet constructions with modern control valve design the differences become obvious. Paying attention to the influencing parameters mentioned above, means that very compact valve bonnets with a max. length of approx. 350 mm for temperatures up to 450 °C and bonnets with a max. 600 mm length for low temperature applications down to -200 °C are possible.

There are special applications, for which a trouble-free function of the control valve is only guaranteed, if at all times a certain quantity of a **flushing liquid** is supplied. This is sometimes necessary, in order to prevent either a seizing of the valve stem in the guide bushing or an encrusting of stem and bushing. For this reason the bonnet is provided with a tapped hole entry which enables the supply of a suitable anti-sticking fluid.

Figure 7.2.2.-1: Cryogenic Globe Valve Type 3246-7

In cryogenic technology (e.g. for liquefaction of air) thick-wall cold boxes (Figure 7.2.2.-2) are frequently used. These are usually filled with ceramic insulating material. To cope with the considerably large wall thickness of the cold boxes, specially extended bonnets are needed. These bonnets are mostly provided with a special fastening flange, in order to be able to fasten the entire control valve, together with the actuator, onto the outer wall of the cold box.

A similar function is fulfilled using an extended bonnet with pipes which are completely insulated by a thick layer of rock wool or similar, for reasons of avoidance of energy losses. To allow access to the adjustable valve packing, usually a bonnet extension beyond the standard dimension is required. A PTFE packing is suitable if the temperature of the fluid is not higher than 220°C.

Since the stem sealing element of a control valve always remains a weak point, great efforts are made today, in order to avoid environment pollution. For this reason special bonnet styles have been developed. As an example, a "double" packing stuffing box with a lantern ring in the middle is sometimes used or packing with a lubricator, or a specially vented valve packing.

Figure 7.2.2.-2: The bellows seal on SAMSON's cryogenic valves keeps the cold in the cold box and reliably prevents the outside parts from icing over.

In the case of vented double packing, the packing is split into a lower and an upper section. Near the location of the lantern ring the bonnet has two tube connections arranged opposite each other. One of them feeds a neutral flash gas (e.g. air) into the packing box. The other vents, via a small tube, any leakage into the atmosphere, i.e. if leakage has already passed the lower packing section, then it will be mixed with the carrier flash gas, so that the gaseous fluid cannot overcome the upper packing area.

Since environmental protection is attracting a steadily increasing importance, bonnets with **bellows seal** (Figure 7.2.1.2.-1) are often applied, particularly for dangerous fluids such as chlorine gas or similar. Instead of a conventional packing, an elastic, metallic bellows seal is used to resist the internal pressure,. This bellows is tightly welded to the valve stem on one side and tightly connected, on the other side, to the bonnet. This makes leakage impossible as it could appear at a moving joint like a standard stuffing box.

One disadvantage of an extended bonnet with bellows seal is the fundamentally greater height of the control valve (and a higher price, which limits the application of this construction to special cases only. Another limitation is seen with very high process pressures and tough, sticky media or those which tend to polymerize and become solid within the bellows seal housing.

Different circumstances and bonnet styles exist for special cryogenic bonnets Figure 7.2.2.-1 suitable for very low temperatures. In earlier days these bonnets were up to one meter high. Through more effective solutions the bonnet length could be considerably reduced without major disadvantages. A common problem at low temperatures is icing of the whole control valve body and bonnet. The humidity of the surrounding air condenses at the valve and bonnet surfaces and immediately freezes. This effect gradually forms an ice coat around the valve which finally prevents any valve movement (stroking). Modern bonnet constructions prevent the cold process fluid (e.g. liquefied nitrogen) from entering and filling the whole bonnet so that the bonnet wall temperature never falls far below zero. The improvement is achieved by a small stainless steel pipe surrounding the valve stem which separates the cold fluid from the bonnet wall. It is worthwhile mentioning that corresponding body and bonnet materials as well as suitable mounting positions of the control valve also play an important role in order to achieve the desired effect.

Cryogenic Engineers: Deal with temperatures between -150 °C (-238 °F) and absolute zero, -273.15 °C or -459.67 °F.

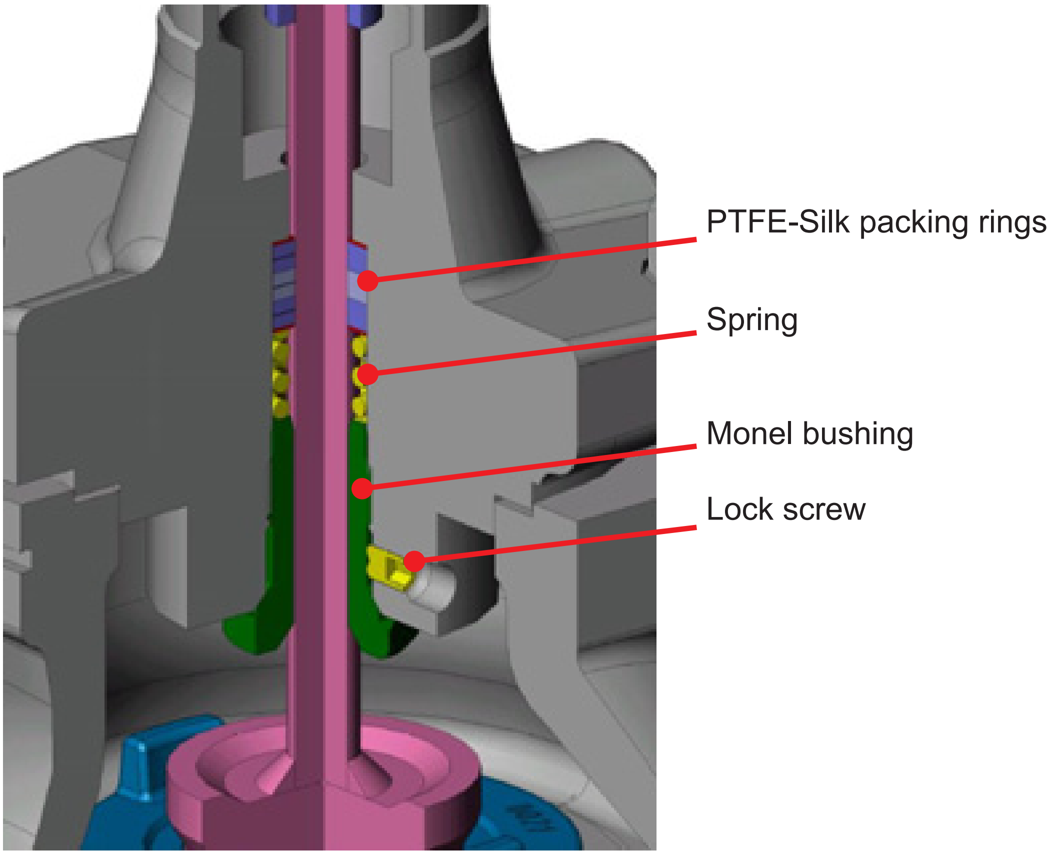

Figure 7.2.2.-3: SAMSON Type 3246 with ***Circulation Barrier***

Circulation barrier

A second packing prevents the liquefied gas entering to the insulating section.