Operational life of diaphragms of metering pumps

Often asked but impossible to answer is the question about the operational life of metering pump diaphragms stated in hours, for example. In the following, we try to explain why this is practically impossible:

First of all some details on the diaphragm itself:
The operational life required from the diaphragm supplier is specified with > $5x10^7$ cycles at maximum stroke against 10 bar, using water of 20 °C.

The diaphragms mainly consist of fabric-reinforced EPDM which is chemically very resistant and mechanically resistant to repeated bending stresses. For assembly, an insertion part with a more or less large surface is vulcanized into the diaphragm. The liquid-end side is coated with an 0.25 mm thick PTFE layer mainly in order to be resistant to most media. Besides the adhesion of the media is reduced by far and the diaphragm is suited for food. Nevertheless there are media which can penetrate the PTFE layer (the PTFE layer is semipermeable for certain molecular sizes). One of them is chlorine dioxide. If it diffuses, the PTFE might come off of the EPDM. Metering is then reduced or stopped completely because the gas bubble produced between the EPDM surface and the PTFE layer acts like dead space. For these cases diaphragms without PTFE layer can be used. They fully consist of EPDM or Viton.

With a rising temperature of the metered medium the operating life is shortened as well. 80°C can be considered as the maximum operating temperature. The operating life might then be reduced by 30 %. For CIP applications or general sterilization 120°C are allowed for max. 10 minutes if the pump is not working (provided that the head is resistant accordingly).

When metering abrasive media, e.g. suspensions such as kieselguhr or lime milk, flush cleaning of the head must be provided which is switched on for some minutes after disconnection **and** before startup of the pump. Thus it can be avoided that hard sediments which are formed during standstill block the diaphragm in the lower section of the metering head and cause the diaphragm to rupture or the elastomere to tear off of the insertion part.

The maximally admissible pressure load of the diaphragm is 10 bar. Here it must be taken into account that the pressure losses of the fittings and the flow conditions must be added to the system pressure into which is metered. These are:

- opening pressure of the injection nozzle
- friction load of the piping
- friction load of the installed fittings
- acceleration pressure if no pulsation dampener is used on the discharge side of the pump

Backpressure valves should not be set to unnecessarily high values. For metering into open pressureless systems a setting of 1.1 to 1.5 bar is sufficient to avoid siphoning. If the backpressure valve is used to increase the accuracy by avoiding the influence of variable backpressure, the valve must be set to approx. 1 bar above the highest possible system pressure.

Without considering the chemical influences and the temperature, the maximum operational life of the diaphragms is reached - provided that the installation is perfect - if the total of operating pressure, friction load and acceleration pressure does not exceed 10 bar. The operational life ranges from a few months to several years.