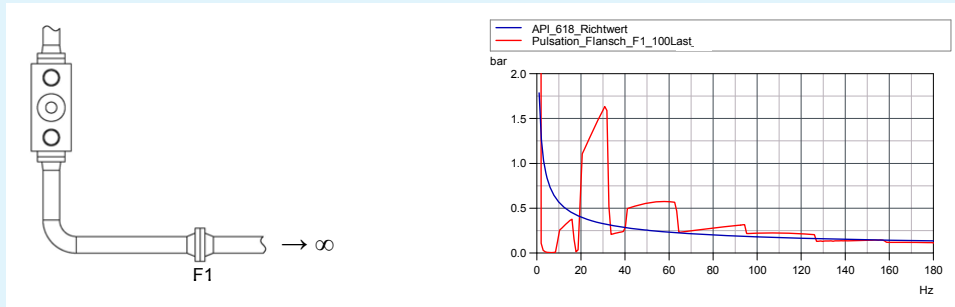


Design of pulsation dampers: What is possible – what is not?

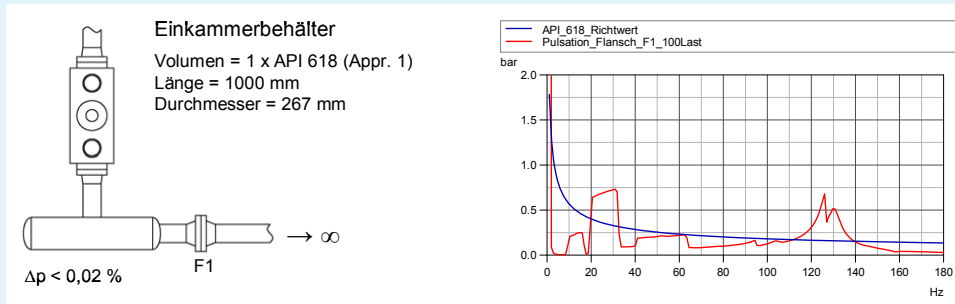
The operating conditions and requirements regarding the use of reciprocating compressors today are getting more and more complex. In order to avoid problematic vibrations for the connected pipeline system, acoustically pulsation dampers are necessary. The API Standard 618 gives different approaches for a proper acoustic design of the pulsation design of reciprocating compressor systems. According to Design Approach 1 the basic design of the pulsation dampers can be carried out based on the experience of the manufacturer for example with simple equations or rule of thumbs. API 618 provides some formulas for a first commercial setting of the dampers, this is used in some cases as initial design for optimization by means of complex numerical simulations. Design Approach II and III are based on a comprehensive acoustic model calculation.

In the following, the example of a typical speed-controlled natural gas compressor shows the different alignments and their effects. The figures 1 to 6 display the calculated pressure pulsations (peak-hold-spectrum) at the flanges F1 for a simulated speed run-up. The connected pipeline system is regarded as reflection-free. Figure 1 - reciprocating compressor without pulsation damper – shows significant pulsation exceedings of the API 618 guideline values (blue line) in the area of the double-rotational frequency (20 - 32 Hz) of the double-acting compressor. By use of an additional damping volume (Design Approach 1) the pressure pulsations of the 2nd order are dampened. However, they do not reach by far the required pulsation level (see figure 2). Furthermore, the use of the pulsation damper causes an acoustic resonance at about 130 Hz. In order to dampen this high frequent resonance, the use of a pulsation-damping-plate at the outlet flange of the cylinder is recommended (see figure 3). The calculations show that in this example a Design Approach I would not be sufficient. For a satisfying design the damping volume would have to be significantly extended or high pressure losses - e. g. due to the use of a baffle at the outlet of the damper, would have to be accepted. Another alternative for the design of dampers is shown in figure 4. There, an aligned two-chamber vessel with choke tube is illustrated. This is a so-called "acoustic filter" which dampens the pressure pulsations very well from a certain boundary-frequency on. In this way, a satisfying pulsation level can be obtained. But caution! By using an acoustic filter which is not aligned to the compressor, an unsatisfying damping behavior can appear in the lower frequencies, see figure 5. Another example of an acoustic filter is shown in figure 6. If, due to the reconstruction of a plant or the extension of a plant, a significantly lower pulsation level has to be reached, a system with very good damping characteristics can be obtained with the help of the existing damper, a pipeline link and a new damper.

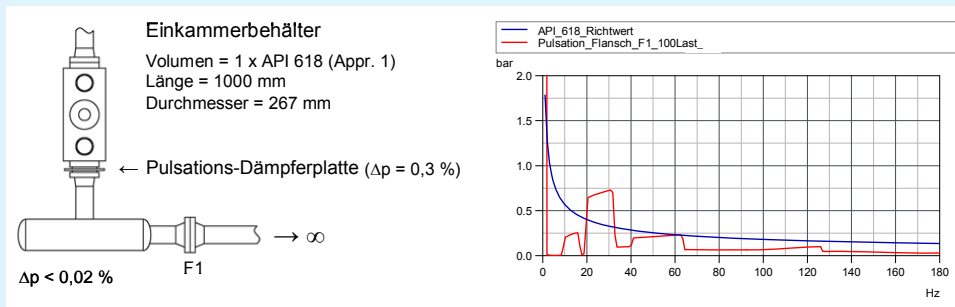
PULSATION STUDIES



Without pulsation damping

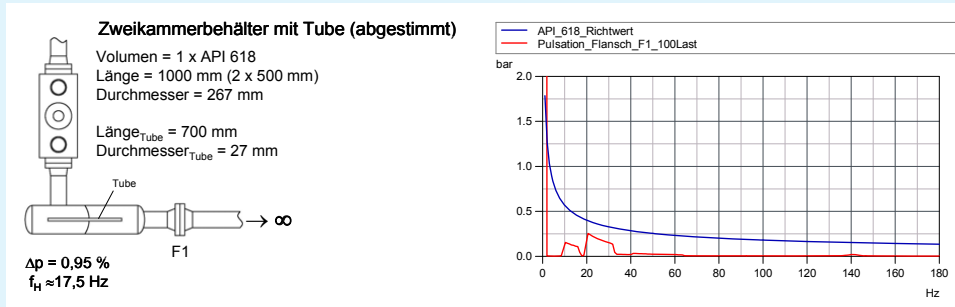


Pulsation damper according to Design Approach 1

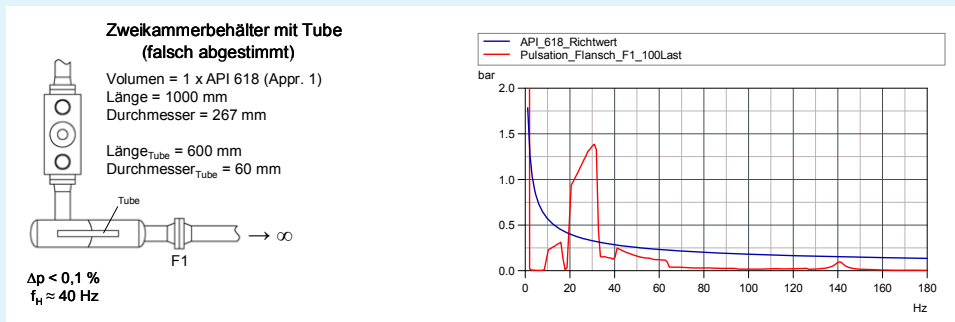


Pulsation damper according to Design Approach 1 and pulsation-damping-plate

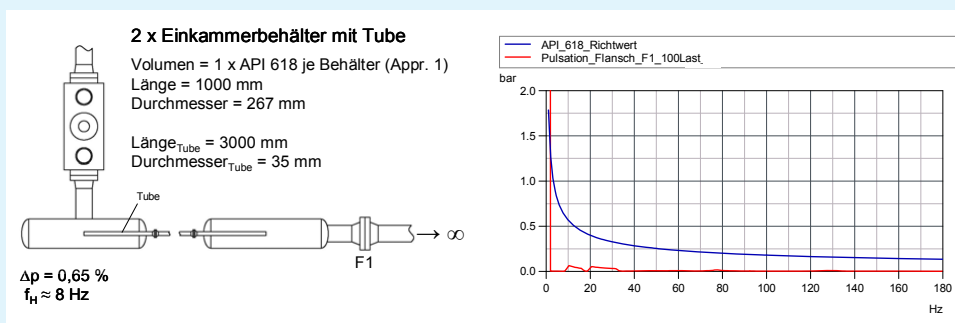
PULSATION STUDIES



Aligned two-chamber vessel



Incorrect aligned vessel installations



Acoustic filter by means of an additional vessel



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