KÖTTER CONSULTING ENGINEERS

MACHINE DYNAMICS

Compressor for ethylene kept quiet!

In a chemical plant a 2-stage compressor was operated (2-curve, 4 cylinders, double-acting, boxer arrangement) in the field of organic products for compressing ethylene. It was driven by a steam turbine over a planetary gear. The operator observed increased vibrations at the compressor system in the area of the pulsation damper and the process pipelines, especially at the discharge side, as well as at the operating platform. In the past, these vibrations led to alarming demolitions of piping fixtures.

KÖTTER Consulting Engineers was asked to detect the cause for the observed piping vibrations. For a safe operation of the plant, effective measures had to be determined. Therefore, a measurement with multichannel equipment was carried out, where the pressure pulsations within the pipeline and the structure vibrations (pipelines and steel construction) close to the compressor were registered synchronously.

The measurement results showed that the guideline values for pulsations according to API standard 618 were only slightly exceeded in the area of the discharge side of the pipeline when the rotational speed exceeded 374 1/min. However, in the piping system of the interstage the pulsations reached the 6-fold of the permitted values due to acoustic resonances.

In several areas, the structural mechanical pipeline vibrations (vibration velocities) at the suction side and at the interstage of the compressor significantly exceeded the permitted values. On the one hand, this was due to an excitement of structural mechanical natural frequencies (resonances) of the pipeline structure inclusive their mountings (see figure 1). On the other hand, the excitement by the high gas forces in the interstage – due to acoustic resonance – led by transmission on the relative flexible steel construction also to high vibrations at the suction piping, which was also fixed at the steel construction.

For an effective reduction of the gas pulsations in the interstage, a pulsation-damping-plate according to the "KÖTTER-principle" was installed at the optimised construction (based on the data taken from the acoustic simulation of the interstage).

In addition, a stiffening of the pipeline construction by massive pipeline supports was carried out. Suitable positions for the support structure were calculated before. The shift of the local mechanical natural frequencies out of the frequency range of the excited gas forces reduced the operational vibrations to a permitted level.

After implementation of the measures worked out by KÖTTER to calm down the compressor system, the operator calmed down as well and was satisfied with the new improved vibration situation.

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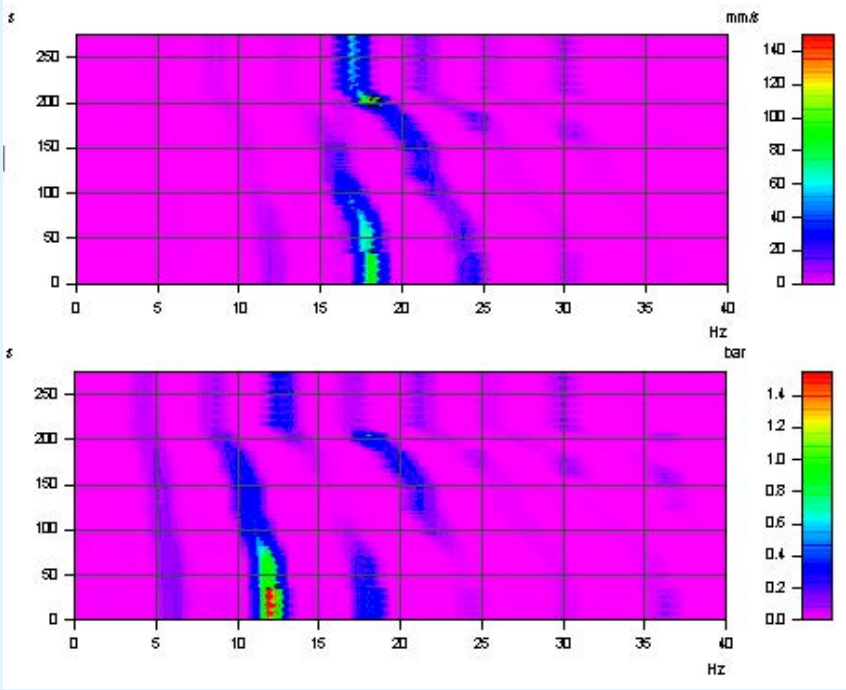

Time-frequency-amplitude spectrum at shutdown of compressor rotation speed from 374 1/min to 262 1/min, top: structural vibrations at the interstage of the pipe with local resonance at approx. 18 Hz, bottom: pulsations at the interstage pipeline

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