Modification and renewal of existing LDPE plants.

How can vibration-technical securing be successful if the data basis is unreliable?

The increase of capacity or the improvement of quality of LDPE (Low Density Polyethylenes) in existing production plants usually leads to larger conversion measures. The exchange of individual plant components, such as the inter- or aftercooler, once their service lives are reached can considerably impair vibration-technical behaviour of a plant.
Changed pipe lengths lead to sudden high pipe vibrations, caused by pulsations inside the piping system. These are mostly caused by the plant's core, the high-pressure reciprocating compressors (hyper compressor), which compresses the ethylene at up to approx. 3000 bar.

Therefore, a theoretical pulsation study is usually performed in the scope of the planning work for vibration-technical securing in the scope of the planning work. This means that acoustic and structure-mechanical simulation is applied to calculate the expected pulsation and vibration situation for the conversion condition (revamp).

Especially in older plants, however, there are often greater uncertainties regarding the input data that are needed for model formation, calculation of the study and evaluation of the results.

Find a few examples of this below:

- Technical documentation for the compressors (primary and secondary compressor or hyper compressor)
- Sectional drawings of the cylinders and compressor valves
- „As built" condition of the piping system
- Contamination status (e.g. wax deposits) within the cylinders, pipes, etc.
- Which orifice plates are installed in which position?
- When operating several compressors in parallel: Does the phase of the crank-shaft angle between the machines change?
- Is the pulsation level with a piping system in the current condition known, i.e. before the conversion?

There is a benefit of the legacy plants that you can use to close the knowledge gaps that become evident: They are already there. They are real! Therefore, it is possible to initially measure the real behaviour at operation of the system in the condition before conversion.

The measured data can be used to adjust and reconcile the uncertain model and calculation parameters. This finally provides a reliable tool, i.e. a computer model that permits reliable forecasts for the vibration-technical behaviour for the converted condition of the plant. In particular, necessary acoustic (pulsations) or structure-mechanical measures can be included in the plans and developed at the same time.

Depending on the task, the pulsations in the piping system in the low pressure area (primary compressor) and in the high-pressure area (interim stage and end pressure of secondary compressor) are measured in a first step in the scope of measuring-technical examination.

If the high-pressure lines do not contain the required pressure sensors, pulsation measurements can also take place indirectly via an application of strain gauges (DMS) coordinated by KÖTTER Consulting Engineers (KCE). The compression process of the hyper compressors (cylinder inner pressure of the secondary compressor) can also be recorded by DMS, e.g. at the expansion screws of the high-pressure cylinders.

The procedure recommended by KCE leads to six basic work steps (6-point approach):
1. Metrological registration of the current situation
2. Coordination of the model/parameter with the measurement results
3. Pulsation calculations
4. Structure-dynamic calculations
5. Review and design of reduction measures
6. Control measurement after recommissioning of the plant

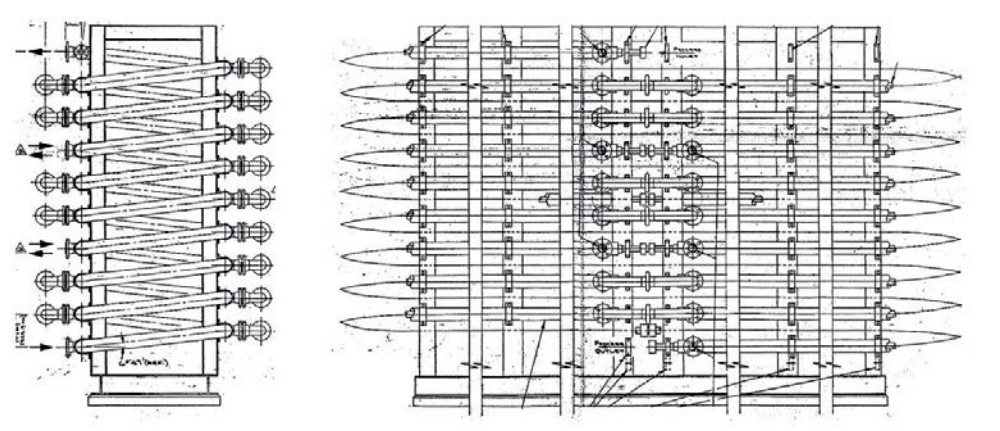
This procedure has proven to be successful multiple times in the past already. One example was an LDPE-plant in which frequent leaks occurred at the intercoolers of the hyper compressor water jackets.

The operator observed some strong mechanical vibrations in some areas of the coolers. Excessive pulsations were suspected as the cause. Solutions for this problem were to be developed with a theoretical study. KCE was able to convince the operator to first carry out a metrological investigation of the situation on site.

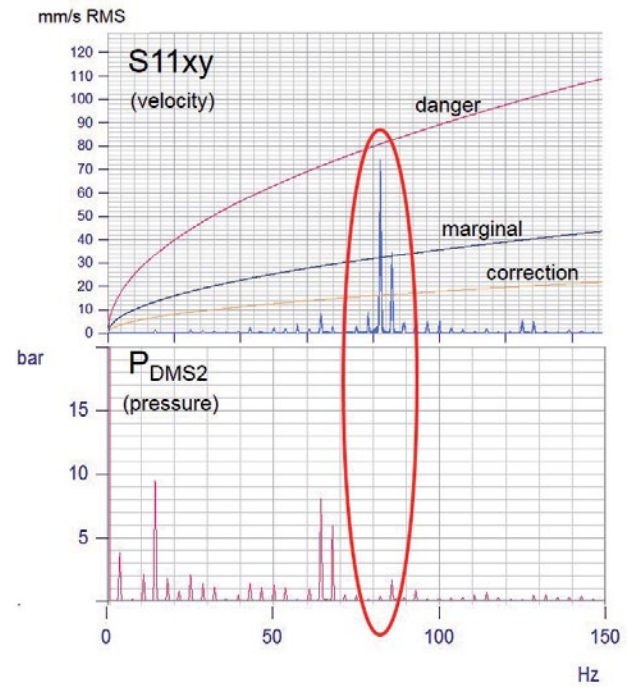
One essential result of the measurements was that the noticeable cooler vibrations were not due to excessive pulsations in the area of the intercoolers, see fig. 2. Instead, local structural-mechanical resonances at the cooler were causing the damage to the water jackets. The critical resonances were essentially due to aging of the cooler structure. Therefore, possible solutions were revision of the existing cooler structure or complete exchange of the coolers. The operator finally decided to replace the intercoolers. For the new coolers, the pulsation-technical effects and the structure-dynamical properties for the entire cooler setup were reviewed in the scope of a study. Since recommissioning, the plant has been running without any vibration problems.

This example shows that a solution can be found, especially in existing plants, if individual properties and interrelations of every plant are uncovered in the first step of the described 6-point approach – carrying out a metrological registration of the situation on site.

MACHINE DYNAMICS – PULSATION STUDIES



Schematic of the intercooler structure



Frequency ranges of the measurements, above: Vibration speed at a position on the pipe of the intercooler,below: Pulsation (dynamic pressure) before exiting from the cooler

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