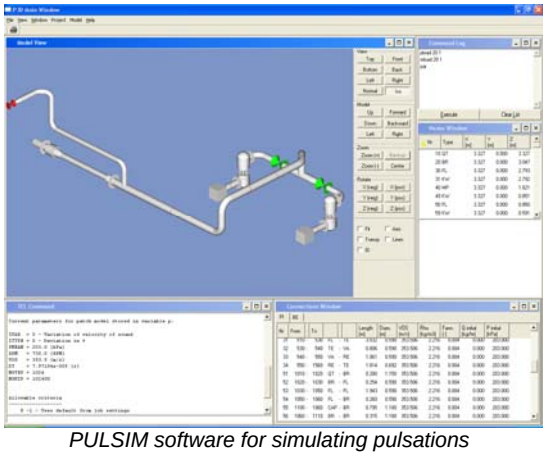
PULSATION ANALYSIS AND CONTROL

Introduction
Positive displacement pumps or compressors are frequently used in many different applications. They share however one common problem: due to their working principle so-called pulsations will be generated. The geometry of the connected piping and equipment can further amplify these pulsations due to acoustical resonances. These resonances may deteriorate the performance of equipment or, even worse, coincide with mechanical natural frequencies of parts, eventually leading to failure.

Although the principle of acoustical and mechanical resonances is simple, solutions undertaken may reveal unexpected increase of problems if one does not fully understand the interaction between pump or compressor and load cases, duties and operating cases.

Digital analysis
Our engineers use advanced (digital) analysis tools to demonstrate how to avoid critical (acoustical and mechanical) resonances but also to check the safety margin that is left in the design of pulsation dampeners, piping and process equipment.



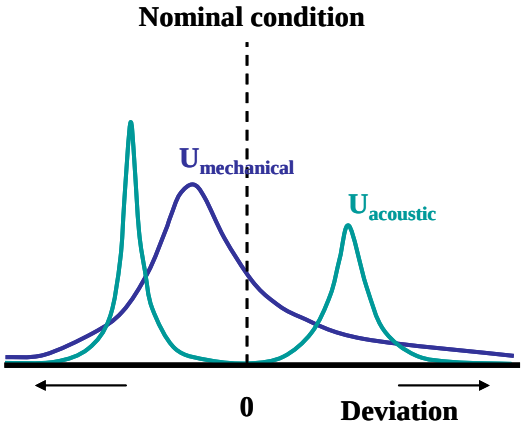
PULSIM software for simulating pulsations

The TNO PULSIM software allows us to model acoustical sources like reciprocating compressors, Roots blowers, pumps and screw compressors in detail.

For mechanical analysis the Finite Element programs ANSYS and FEMAP/NX NASTRAN are used (dynamic response) and Intergraph CAESAR II (pipe stress analysis).

Scope of analysis
Analysis can be performed for design and check of pulsation dampeners, but also for large and complex pipe systems.

The analysis will include all operating cases, load cases and (in case of multiple compressors) operating modes. In addition a sensitivity analysis will be performed to check the behaviour of the system when conditions are slightly off nominal design conditions (due to changes in temperature or gas composition for instance).



Possible coincidence of acoustical and mechanical resonances

The analysis includes study of pressure pulsations, but also pulsation induced vibration forces, since these tend to be even more important. Further attention is paid to flow pulsations (flow meters and non return valves are sensitive for these), gas flow velocities and pressure losses in the system.

Finally, our analysis tools include options to study special operating conditions such as under/over-compression at screw

compressors, reverse flow capacity control on reciprocating compressors, etc.

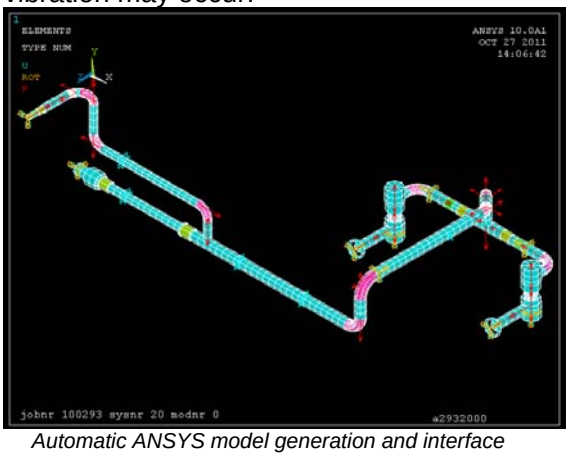
Approach
A proven 3-step approach is used for controlling pulsation and vibration:

1. performance check of the pulsation dampener at endless line conditions
2. acoustical (pulsation) analysis of the complete pipe system
3. mechanical (dynamic) analysis of the pipe system

Step 1 is intended to assure that the pulsation dampener shows adequate performance and that possible resonances in the connected pipe system can be solved in a simple way. This step should be carried out during the design stage of the project to avoid unnecessary (or often impossible) redesign.

Step 2 aims at calculation of pulsation levels and vibration forces in the connected pipe system for all possible operating conditions, compare these with an allowable level and provide measures in case limits are exceeded.

Step 3 will reveal the effect of gas pulsation forces on the mechanical construction. Natural frequencies are determined and relevant modes are excited with the vibration forces obtained through step 2. The resulting stress and vibration levels are compared against their limits. Worst case scenarios give insight in what to expect in real life. It should be noted here that even low forces can excite a pipe system such that unallowable vibration may occur.



Automatic ANSYS model generation and interface

This 3-step approach has also been taken up by the API Committee and implemented in the latest revision of the 618 Standard (5th edition).

Analysis results will be presented in clear, easy-to-read, reports. A discussion of results and recommended measures can be executed in English, German or Dutch language.

Full compliance with recognized standards
Depending upon the compressor type and on customer's preferences the way the analysis is carried out and results are compared with allowable limits, proven standards like the API 618, 619 and 674 are applied. Further, our engineers are fully trained and qualified for their tasks. And it will be no surprise to know that our company is ISO 9001:2008 certified.

Service
The products and services we deliver are most often backed up by a guarantee, which means that we continue to support you after the job has finished.
In the event of field problems we promise a quick response, even if causes are not yet found.

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