Prevention of Pulsation and Vibration Problems in ethylene hypercompressor systems

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Abstract:

Safety and reliability are important aspects in the design of high-pressure pipe systems for polyethylene plants. The reciprocating hyper-compressors, applied in this kind of processes, often consist of booster, primary and secondary compressors delivering the ethylene to the reactor at pressures up to 3000 bar. Allowable pulsation levels at these conditions are beyond the scope of API 618, which specifies limits for allowable pulsations up to a pressure of 200 bar. Compressor manufacturers and operators often apply an allowable pulsation level of 10 % peak-to-peak, independent of line size or frequency. The API 618 further states that: 'for systems with a static pressure above this limit the corresponding cyclic stresses should be carefully evaluated'.

Normally a pulsation analysis is performed for the pipe systems concerned, though not always a mechanical response analysis is included. The analyses are performed by the compressor manufacturer or by an independent third party such as TNO TPD. PULSIM has also evaluated a number of these systems for operating companies *after* installation and commissioning

This paper highlights several cases in which pulsation and vibration measurements on site have been performed and compared to simulation data. In some cases solutions to solve or to prevent further pulsation and vibration problems in these systems are optimized by means of a detailed acoustical simulation and/or a mechanical response analysis. Measures to dampen pulsations and shift acoustic resonances are limited, as thick-walled pulsation dampers are not feasible at these high pressures. A number of alternative solutions will be discussed in this paper and will be illustrated via these cases.

A comparison between on-site measurements and simulations by PULSIM for a typical hypercompressor installation shows that the calculated pulsation levels are well in accordance with the actual levels. According to DSM experience vibration measurements show that sometimes the higher harmonics (over 20 times compressor speed) result in vibration levels, which deviate considerably from the levels calculated in the mechanical response study. For this reason it is also important that support details are included in the mechanical response analysis to prevent unrealistic assumptions of infinitely stiff supports for the frequencies concerned.

The DSM experience has shown that effective damping, also for higher harmonics, is necessary to prevent undesired high frequency vibrations.