■ **The multi-service hydrogen compressor SSL320hs: three different processes, lubricated and non-lubricated on a single frame with insulated and heat traced pressure vessels, gas piping, oil system, cylinder lubricator, purge panel, instrumentation, conduit, tubing and all piping supports and motor.**

NEA REFINERY COMPRESSORS IN API 618 DESIGN WITH MEDIUM SPEED AND HIGH POWER

Neuman & Esser has Brought over 50 Units into the API 618 Reciprocating Compressor Market

By Roberto Chellini

Neuman & Esser Group (NEA) celebrated its 175th anniversary in 2005 but the development of the 320hs compressor clearly shows that this family-owned company is still dynamic and driven to improve the API 618 reciprocating compressor technology whenever possible.

The first customers for this frame were energy companies that were looking for a reliable piece of equipment to store natural gas in large salt domes or caverns during the summer time when prices are lower, and sell it during the winter when prices and demand are higher. Due to the remote location of these installations that are unmanned for several days and sometime weeks, reliability of the equipment was one of the most important factors.

NEA's 320hs medium-speed compressor combines the compact size of an API 11P compressor with the features of an API 618 machine. If required, cylinder liners, water-cooled cylinders, non-lubricated cylinders and double compartment distance pieces are available on request, but features such as hydraulic bolting, rolled threads, forged crankshaft and connecting rods are always standard.

Within a short period of time, Neuman & Esser successfully commissioned several two- and four-crank compressors with speeds up to 1000 rpm and a final discharge pressure of up to 5500 psi (350 bar).

In 2002, the first European refinery showed interest in this compressor type. The customer had to replace two reciprocating hydrogen compressors in an existing plant due to changed process conditions. In a lot of these cases, available real estate is very limited, time is of the essence and approval of the new plant can be an important issue. Neuman & Esser proposed replacing the old compressors with new API 618 compliant 320hs compressors. The units are rated 2011 hp (1500 kW) at 600 rpm (11.48 ft./s [3.5 m/s] piston speed). Each compressor is a single-stage, two-cylinder, double-acting machine with valve unloading-lubricated service, double-distance piece. The suction pressure is 507 psi (35 bar). The discharge pressure is 1334 psi (92 bar). The flow is 26,100 Nm^3/h.

Since the compressor building could not be changed, Neuman & Esser removed the first existing compressor, modified the foundation and installed the first new 1SZL 320hs compressor including new main motor and vessels, while the plant was still in operation. The second compressor followed right after the shutdown, minimizing the downtime of the plant significantly.

This approach allowed the customer to avoid a new approval process, minimized downtime and allowed them to use as much existing equipment as possible.

Both machines are running very successfully ever since. Due to the

The medium-speed six-crank SSL320hs compressor.

materials chosen by Neuman & Esser for the wear parts, no excessive wear can be seen and the average time between replacements of these parts is exceeding 16,000 hrs.

In 2002, the first U.S. customer showed interest in the same type of compressor for a hydrogen application and in 2003, NEA U.S.A., the sales and application center for the North American, Mexican and Caribbean market, supplied the first two type 4 crank 1 TVL 320hs compressors into the U.S. market. These single-stage compressors have four double-acting cylinders. It is rated 400 hp (289 kW) at 720 rpm (690 ft./min [210 m/min] piston speed). The suction pressure is 390 psi (26.8 bar). The discharge pressure is 675 psi (46.5 bar). The flow is 77,000 scfm (45,000 Nm^3/h).

Encouraged by the successful operation, NEA U.S.A. has supplied several other 320hs frames for hydrogen application.

Neuman & Esser has succeeded in placing the first three six-crank process gas compressors on the market, thanks in part to the unit's high flexibility with multi-service applications; smaller, less expensive driving mechanism; and high flexibility of flow control by mere suction valve unloading.

From a technical point of view, special attention must be paid to the crankshaft since all other components are dimensioned accordingly to rod and gas forces, respectively. Thus, even if there are additional cranks, the situation remains the same as for the four-crank design. The torsional vibration behavior of these longer and slimmer crankshafts must be analyzed in detail. For maximally four-crank compressors, the second natural torsional frequency is usually above the tenth harmonic of the speed.

Since there is usually no resonance with these high frequencies — due to overload of the crankshaft from strong damping and the small exciting moments — here only the drivetrain must be optimized with regard to the first torsional natural frequency. However, this is strongly influenced by the coupling's rigidity and/or the flywheel's mass moment of inertia.

With six-crank compressors it is very probable that the second torsional natural frequency, too, is within the tenth harmonic of the speed. What makes the design for this natural frequency difficult is the fact that it is mainly defined by the rigidity and the mass distribution of the crankshaft. Thus, a variation of the coupling's rigidity or of the flywheel's mass moment of inertia is not necessarily helpful when optimizing the speed with regard to the second torsional critical. That possibility could also be in contradiction to the optimization of the first natural torsional frequency that must, of course, also be considered. Therefore, a second, much smaller flywheel mass is attached at the output ends of the crankshaft for optimizing the second torsional critical. Due to that measure, it becomes possible to optimize both torsional-critical natural frequencies by means of their control variables whose actions are almost independent.

In order to obtain additional safety, resonance freedom can also be checked metrologically when carrying out the start-up commissioning.

This procedure was implemented for a current application at a hydrogen plant in United States.

Strain gauges were applied on the crankshaft by means of which the dynamic torque curve could be measured.

A contactless telemetry transmitted the measurement signal via a receiver to a computer that displayed the torque curve in real time. Thus the NEA specialist was in a position to evaluate the measurement results forthwith on-site.

In the U.S. hydrogen plant, the resonance freedom previously determined by calculation was confirmed by the measuring. However, if resonance had been measured, this could simply be removed by replacing a small pulley at the crankshaft end.

This latest compressor is a multi-service compressor type 3SSL 320hs operating three different lubricated and non-lubricated services on one frame. All accessories are skid packaged on a single massive skid including vessels, gas and auxiliary piping, API 618 oil system, instrumentation, purge panel, heat tracing and insulation. The 4000 hp (2982 kW) main motor was mounted on a separate skid. The skid-mounted design allowed an installation and start-up in a record time by minimizing the required site activities and two more six-crank 320hs compressors are waiting right now for their successful start-up.

In a very short time Neuman & Esser was successfully able to bring over 50 units of a brand new product with a total shaft power of more than 60 MW into the API 618 reciprocating compressor market — "a real breakthrough of the medium-sized range," said Franz-Josef-Ritzen, CEO of the global NEA Sales & Application Centers. This product, whether in two-, four- or six-crank configuration being lubricated, non-lubricated or even a multi-service compressor in a refinery or any other application does show that a smart design addressing new requirements can be very successful. "More important is that this can be done without jeopardizing reliability," said Manfred Salgert, president of Neuman & Esser U.S.A. The newest medium speed frame size of the Neuman & Esser compressor line does fit perfectly in between his smaller and larger low-speed family members. And having a last word with regard to the six-crank row: with a new order from a petrochemical plant in Southeast Asia about several machines of type 500, Neuman & Esser extends the whole range of 16,092 hp (12,000 kW) compressors by the six-crank design, this time for low-speed design. ■

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