

■ Shown here is a three-stage configuration of the MSG Alpha integrally geared centrifugal compressor. It is available in one-, through six-stage configurations. Its multistage, integrally geared, inter-stage cooled, oil-free centrifugal design is capable of handling power up to 1250 hp (932 kW) and pressures up to 1200 psi (82 bar).

CENTRIFUGAL GAS COMPRESSOR FRAME INTRODUCED AT OTC

Under Its "Edge Is Innovation" Theme, Cooper Cameron Displayed Three New Products: Integrally Geared Centrifugal Gas Compressors, Full Line of Rotary Valve Actuators and DC-Powered Subsea Production System

By Joe Kane

This year's Offshore Technology Conference, held in Houston, Texas, U.S.A., during the first week of May, was bigger and better, both an education and experience with its vast array of exhibits. Though new and exciting products abounded at the show, by far, the most exciting for this publication was Cooper Compression's introduction of its new MSG Alpha process gas compressor during its scheduled press conference.

Cooper Compression is a division of Cooper Cameron and includes Cooper Energy Services and Cooper Turbocompressor. During the show, I had the opportunity to discuss Cooper Cameron's overall strategy in the selection of product development objectives with Sheldon R. Erikson, chairman, president and chief executive

officer. "The end targets of any development we undertake within the groups comprising Cooper Cameron," Erikson commented, "are that it brings efficiency, longevity and profitability to our customers operations. The degree that we can reach these targets determines the amount of effort we devote to product development. To determine the feasibility of any project, we apply the 6-Sigma concept of decision making to each project. This is a concept that I have found to be highly successful in overall project management.

"The collection of data," Erikson continued, "not only involved other divisions of Cooper Cameron, but also involved Cooper Compression customers to determine their needs and special requirements. Once we determine

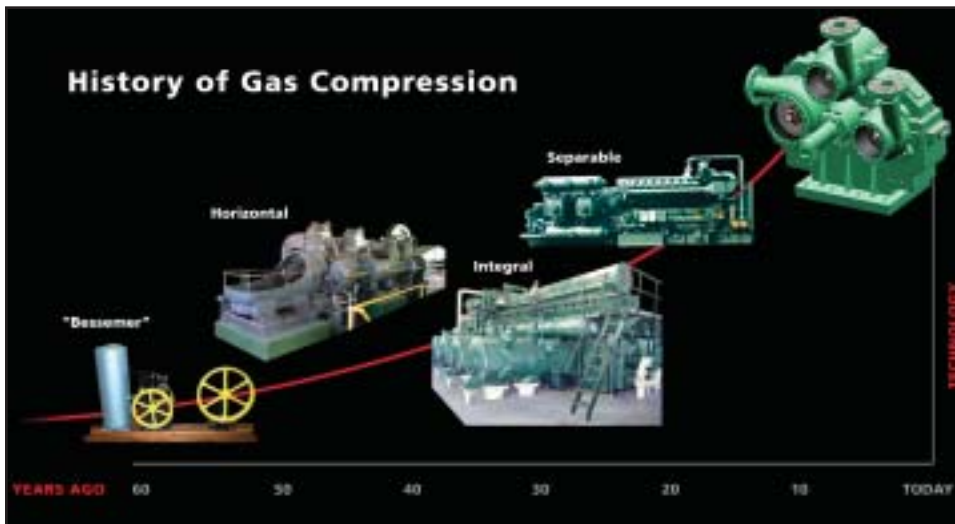
that our product development criteria have been met, we are willing to commit all the necessary resources at our disposal to complete each project. This is the philosophy we used when considering the three products introduced at OTC in early May."

According to John Bartos, vice president, engineering and new product development, the MSG Alpha is the most compact Cooper Compression frame available for gas service and one that offers more range in operating performance (higher flow capacity/high suction pressure capability) than flooded or oil-free rotary screw compressors. Significant to this compressor is its excellent efficiency, high reliability, low maintenance cost and traditional Cooper Compression quality. It is available in one-,

through six-stage configurations. Its multistage, integrally geared, interstage cooled, oil-free centrifugal design, combined with its ability to handle power up to 1250 hp (932 kW) and pressures up to 1200 psi (82 bar), its ability to accommodate high suction pressures and dual process capability, make the MSG Alpha an excellent choice for process gas and natural gas booster compression needs."

The MSG Alpha is a natural evolution of Cooper Compression's creation. In its consolidation with Cooper Energy Services, Cooper Turbocompressor became exposed to the natural gas products and markets of CES. As a consequence, centrifugal product solutions were evaluated in applications that once used largely recip.

"This is where the 6 Sigma



■ Time line illustrating the evolution of Cooper compressors from their early inception to the present day.

and intensive customer interviews entered our process," Bartos said. "We accumulated a tremendous amount of data involving design, component and material requirements as well as field data to determine applications and demand. Cooper Compression's historical knowledge of the natural gas compression industry became a tremendous developmental asset. The formation of Cooper Compression allowed us to pool from the best technical talent within the divisions. The development of the MSG Alpha required the cooperative effort of a number of engineers from several locations, all working concurrently on the design.

"Development took place with input from our customers

via our "Voice of the Customer" approach," Bartos continued. "In effect, the customer wrote design specifications for the MSG Alpha compressor family. Consequently, we know that it fits the application requirements for our markets."

While meeting the market needs, the MSG Alpha also has strong product features. The MSG Alpha's centrifugal compression process is dynamic and results in no pulsation within the gas stream. Because the MSG Alpha uses dynamic compression (rather than positive displacement), the forces and moments imposed on the support structure are exceptionally low, as well as overall costs for foundation and support systems. It has a

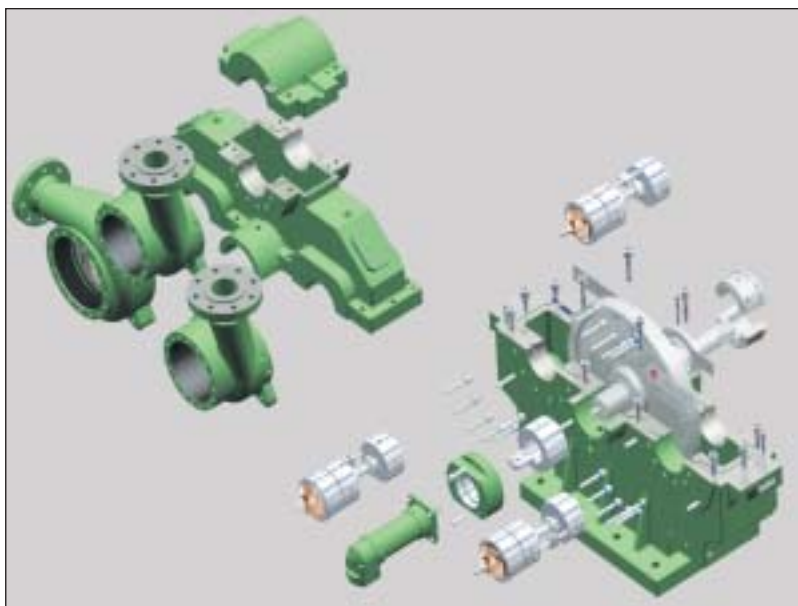
very small footprint.

Because the MSG Alpha compression process is "oil free," it isolates lube oil, thereby not contaminating the process gas with lube oil. The MSG Alpha evolved from years of proven centrifugal compressor technology where oil separators and oil treatment are not required. By design, the compression process in the MSG Alpha is isolated from the bearings and gearbox, eliminating the possibility of process gas and oil interaction. Downstream scrubbers are not necessary since the lube oil is not in contact with the process gas and does not become contaminated. The lube oil has much greater life and does not require costly reclamation.

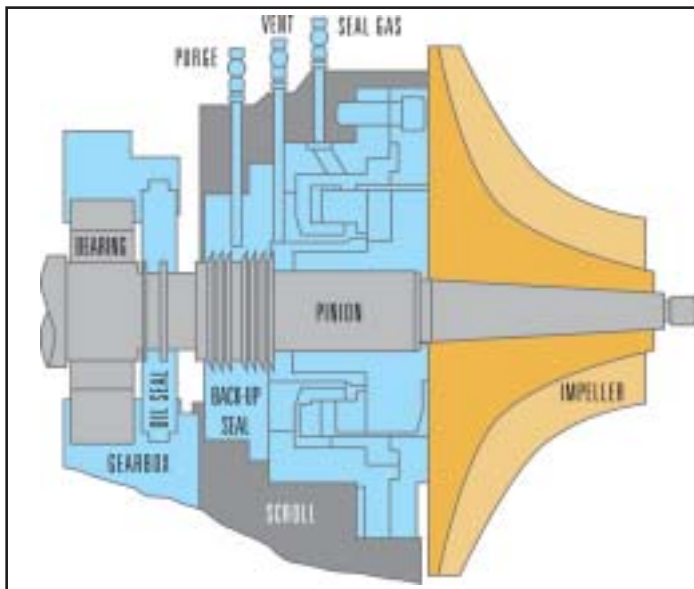
The MSG Alpha is designed to meet the compression applications in various markets: fuel gas booster, gas processing, landfill gas recovery, pipeline booster and syn gas recycle. It was designed and analyzed using the latest computational engineering techniques including rotor dynamic analysis, computational fluid dynamic (CFD) analysis, and finite element analysis (FEA) to maximize the performance and reliability of each design. Another unique computer design application is the use of parametric solid modeling for pre-engineered building blocks or modules.

The parametric assembly forms the core of a new product development process that links and integrates marketing, design engineering and manufacturing on a common platform for a unified and rapid design cycle. In addition, by using a solid model assembly, Cooper Compression is able to leverage a variety of resources from internal experts, outside design services and even local university talent familiar with the design tools to achieve a robust design.

According to Bob Kolodziej, Cooper Compression's director of new product development, "the use of a solid model assembly allows Cooper Compression personnel to identify design options while preparing for the manufacturing process



■ Exploded view of the MSG Alpha Compressor in its three-stage configuration.



■ Cutaway drawing of the impeller, shaft and seals of the MSG Alpha compressor.



■ High-efficiency, five-axis milled impeller.

weeks in advance. Additionally, the solid model assembly and parts allow Cooper Compression to share 3-D electronic data with suppliers and customers — which is vital to re-

ducing design cycle time and improving quality for both Cooper Compression and the end customer.”

The gearbox is a horizontally split design. This permits easy access to internal components for inspection and future upgrades. The central low-speed bullgear permits each pinion to operate at optimum speed to match the flow and peak efficiency characteristics of the impellers. The bullgear is connected directly to the compressor driver by a low-speed coupling.

Sleeve bearings are used to support the bullgear journals. The high-performance pinions are supported by hydrostatic bearings. The patented design of the squeeze film bearings

and viscous damper results in long life and virtually vibration-free operation. Thrust loads are absorbed using tapered “rider ring” thrust collars. The “rider rings” are a part of the pinion shaft and ride against the bullgear creating an oil wedge to carry the net thrust load where it is absorbed by a simple low-speed thrust bearing. Each rotor assembly consists of a pinion shaft to which one or two impellers are attached. The pinion gears are hardened and precision ground to AGMA 13 quality standards. Smooth, vibration-free operation is assured through precision component balancing of individual parts and then the final assembly. This design minimizes power loss and maximizes mechanical integrity. The MSG Alpha has no wearing parts requiring periodic changes or replacement of the compression elements.

Aerodynamic performance is the key to compression efficiency. To ensure the optimum performance for every application, the aerodynamic components are designed to meet each specific process’ needs. Three-dimensional computational fluid dynamic (CFD) analysis is used to optimize the compressible viscous flow through each stage resulting in a matched high-efficiency impeller and diffuser combination.

The solid models used in the design of the impellers are then transmitted electronically

to Cooper Compression’s impeller manufacturing cells. The cell’s CNC 5-axis milling machines ensure precise machining of the exact impeller and blade contours described by the aerodynamic engineers. The end result is matched impeller characteristics optimized for the process.

The MSG Alpha was designed with a “Modular” assembly philosophy. The result is an easy to assemble and maintain compressor package. Standard modules such as the structural base, lubrication system, bullgear assembly and bearings are first assembled. In sequence, the customer-specific aerodynamic components, gas seals, interconnecting piping, monitoring instrumentation, seal rack, and control system modules are added.

After assembly, each unit is given a complete aerodynamic and mechanical test in Cooper Compression’s ISO 9001, world class test facility. Testing is performed by experienced engineers and technicians following the guidelines set forth in the ASME PTC 10 test code.

Five individual test stands are available to test the units as complete packages at the customer specific design conditions. This includes design speed, gas properties, as well as inlet and intercooler water temperatures. Each stand is equipped with electronic variable frequency drive capable of supplying either 50 or 60 Hz and voltages ranging from 380 to 4160 Volts. The stands are also capable of achieving overspeed to ensure the mechanical integrity of the compressor. Closed loop package testing is also available. The end result is a quality product, meeting all the customer requirements, and ready for years of reliable service.

“Similar to the other Cooper Cameron new product launches at the OTC,” Bartos said, “the MSG Alpha is a product targeted to customer need and built by one of the longest serving compressor manufacturers in the industry. As we are, the MSG Alpha is an evolution in gas compression and a revolution in reliability.” ■



■ Phantom view of a three-stage MSG Alpha compressor showing the positioning of components.