



Elliott Compressors for World-Scale Ethylene Plants

Proven Turbomachinery Technology

■ OPTIMIZED PROFITS IN ETHYLENE PRODUCTION

The winning combination for profitable ethylene production is high-volume, low-cost operation and uninterrupted production runs. Compressor performance is critical for achieving these goals. For decades, leading ethylene producers throughout the world have turned to Elliott for efficient, reliable compressors and steam turbines.

For over 50 years, Elliott has been the world leader in centrifugal compressors for ethylene production. Elliott's strengths in refrigerant compression technology evolved from expertise developed when Elliott was a division of Carrier Corporation. Elliott equipment is operating today in approximately 50% of the world's ethylene plants, including most of the largest facilities with capacity of one million tons per annum (MTPA) or greater. With frame sizes designed for volumetric flow rates up to 320,000 ICFM (544,000 m³/hr), Elliott compressors deliver the efficient, reliable performance processors require for dependable, high-volume ethylene production.

Elliott's experience and achievements in the ethylene industry include:

- ♦ Installations in nearly 50% of the world's nameplate ethylene capacity
- ♦ Installations in over 40% of the ethylene plants that produce more than 500 KTA
- ♦ Installations in over 100 ethylene plants in more than 60 countries worldwide
- ♦ Installation of more than 700 compressors worldwide for ethylene service



Shell Chemical, Moerdijk, Netherlands.

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■ ENGINEERED FOR “MEGA” PLANTS

Crack gas, propylene, and ethylene compressor trains from Elliott are custom engineered to meet the high volume, high efficiency requirements of today's “mega” ethylene plants. As demands for production capacity grow, processing equipment and drivers must increase in size, throughput, and reliability.

Along with a history of engineering excellence and product innovation, Elliott stands apart in our ability to design and manufacture the large, reliable compressors and steam turbines required for the uninterrupted operation of these very large plants. Elliott's advanced modeling techniques and proven engineering experience result in machinery for refrigeration service custom designed for challenging applications such as efficient side-load mixing. Our steam turbines deliver the power required to drive the processing strings in high capacity ethylene plants. We offer a broad line of multi-stage, multi-valve turbines with horsepower ratings to 140,000 hp (104,398 kW) and speeds to 16,000 rpm.



88M6-4 refrigeration compressor with two side loads.



Multi-stage, multi-valve steam turbine assembly.

■ ENGINEERED SOLUTIONS FOR CHALLENGING APPLICATIONS

Refrigeration applications in ethylene production create extreme challenges in compressor design. These applications involve high molecular weights combined with low temperatures and variations in volume flow requirements. Large volume side-streams are common in the refrigeration process. Elliott's skill in designing compressors for these demanding conditions ensures an accurate fluid dynamic design with high efficiency performance, a broad operating range, and conservative mechanical characteristics. Computer modeling confirms that the flow streams merge at similar velocities for minimum pressure loss and maximum efficiency. Performance simulations incorporate the resultant data into the compressor selection. Verification of the aerodynamic design is proven during factory performance testing.

Crack gas service requires cooling to reduce the process temperature through the compressor stages. The compressor selection program calculates the amount of knockout and the resultant gas composition at each cooling point; this is especially helpful during feasibility studies for

ethylene plants. In addition to knockout calculations, the program can account for water injection into the process gas to help reduce the gas temperature and can calculate the effects water injection has on the compressor performance.

Our experience in crack gas applications allows flexibility in engineering compressor and driver configurations. Compressor strings can include two to four compressor bodies in addition to the specified driver. In typical crack gas applications, steam from the highest pressure header is used as the inlet for the steam turbine. Controlled extraction from the steam turbine typically feeds a medium or low pressure steam header to supply other steam turbines or plant services. A representative driver for a crack gas compression string is the Elliott 2SNV9 double-shell, controlled extraction, condensing steam turbine. This turbine is rated for 1500 psig (103 barg) at 900°F (482°C) and over 70,000 hp (52,199 kW).



Crack gas train – Elliott 2SNV9 steam turbine driver with 88M6I and 60M6I compressors.

■ SUPERIOR PROTECTION OF AERODYNAMIC COMPONENTS

Elliott's proprietary protective coatings provide excellent antifouling and corrosion resistance for the aerodynamic components of a compressor. Polymerization during the compression process can produce buildup that accumulates on aerodynamic surfaces and affects compressor performance. The buildup of these polymers can increase rotor vibration, constrict the gas flow path, decrease efficiency, and reduce throughput.

Elliott POS-E-COAT® 523 provides excellent releasing properties for polymer build-up, corrosion resistance of the aerodynamic components, and the ability to withstand the harsh liquids or chemical injections typically used for cleaning compressors in crack gas service. Field experience demonstrates that POS-E-COAT 523 helps to maintain rotor dynamics and compressor efficiency under severe fouling conditions significantly longer than other industry coatings. Reducing polymer build-up on the aerodynamic components of a compressor also minimizes the downtime and the cost of materials required to clean the equipment.



Compressor rotor with POS-E-COAT 523.

■ INCREASED PRODUCTION THROUGH DESIGN OPTIMIZATION



110M6 compressor impeller.

Powerful design and modeling tools enable Elliott engineers to develop the highly efficient compressor and steam turbine designs required for high-volume ethylene production. Computational fluid dynamic (CFD) analysis, finite element analysis (FEA), and solids modeling provide full three-dimensional analyses of the aerodynamic flow path and the structural mechanics of compressor designs. We employ rotor dynamic analysis, compressor selection, and dynamic simulation programs to optimize multi-stage compressor applications. Compressor configurations we design with these tools include those with sidestreams, double flow, back-to-back, and intercooling. Typical steam turbine designs include multiple controlled and uncontrolled extractions, inductions, and double flow exhaust.

■ WORLD-CLASS MANUFACTURING AND TESTING CAPABILITIES

Elliott's manufacturing centers in Jeannette, Pennsylvania, USA and in Sodegaura, Chiba, Japan are fully equipped with the latest machine tools and test equipment. Both facilities produce the very large centrifugal compressors required for "mega-scale" ethylene production. These large compressors are designed for capacities up to 320,000 ICFM (544,000 m³/h).

One of Elliott's techniques to reduce cycle times for the fabrication of large compressor casings is to use a weldment positioner. The positioner allows for a continuous welding process by moving the weldment around the welder.

All Elliott compressors and turbines are thoroughly tested before shipment. The testing facilities in Jeannette and Sodegaura can accommodate multiple equipment test strings simultaneously. In Jeannette, a modern at-speed rotor balancing facility is one of only a few facilities equipped to handle large rotors up to 284 inches (7,213 mm) in length and 96 inches (2,438 mm) in diameter, with a maximum weight of up to 27,000 pounds (12,246 kg), and speeds up to 30,000 rpm.

Comprehensive Testing Facilities

Elliott's testing capabilities include:

- ♦ Testing to API requirements for:
 - API 612 (steam turbines)
 - API 614 (lube, control, and seal oil systems)
 - API 617 (axial and centrifugal compressors)
- ♦ Testing to ASME Power Test Code (PTC-10) requirements for compressors
- ♦ Part load and full load testing depending on application
- ♦ Full variable frequency drive (VFD) motor drive capabilities
- ♦ Customer specific testing requirements for ethylene process applications
- ♦ High speed balancing for Elliott and non-Elliott rotors



Multi-axis CNC casing machining center.



CNC machining and turning center.



Monitoring and data analysis during testing.

■ GLOBAL SERVICE AND SUPPORT

Service Parts Network

Our ISO 9001 registered Service Parts organization delivers the quality parts and rapid turnaround necessary to maintain the performance and reliability of all Elliott equipment. The Service Parts organization has an extensive finished parts inventory and machining centers allowing for quick manufacture and shipment of parts. Same day shipment is available on most stock items and emergency customer support is available 7 days a week. Elliott's knowledgeable customer service representatives and experienced service engineers are dedicated to addressing the specific needs of each individual customer. Service Parts programs include parts identification, inventory audits, upgrade assessments, and parts kit packages.

Field Support

From installation, commissioning, and start-up, through maintenance, overhauls, and repair, Elliott offers a complete range of turbomachinery service and support. Elliott maintains a global network of full-service repair facilities. We provide experienced on-site project management and skilled field service crews to job sites worldwide. Elliott Rerate Services enhances the performance and extends the life of critical rotating equipment from any manufacturer. Compressors can be modified and rerated in the field to increase reliability, efficiency, and capacity. Customized service programs range from routine preventative maintenance and emergency assistance, to comprehensive long-term service agreements.



Installation, commissioning, and start-up services.



Elliott Group is a global leader in the design, manufacture, and service of technically advanced centrifugal compressors, steam turbines, power recovery expanders, cryogenic pumps and expanders, and axial compressors used in the petrochemical, refining, oil & gas, liquefied gas, and process industries, as well as in power applications. Elliott Group is a wholly owned subsidiary of Ebara Corporation, a major industrial conglomerate headquartered in Tokyo, Japan.



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T H E W O R L D T U R N S T O E L L I O T T



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