



Vacuum Systems and Heat Transfer Products



GRAHAM
ENGINEERING ANSWERS



Graham engineers analyze
your specific vacuum and
heat transfer requirements to
maximize the efficiency and
performance of your process.

Because it's not just about
engineering products, it's about
engineering answers.

Find Your Answer with Graham

Products

Our leadership position in vacuum systems and heat transfer equipment is based on decades of proven experience, and backed by thousands of units designed to maximize efficiency and to operate with trouble-free performance.

VACUUM SYSTEM PRODUCTS

Ejectors

- Steam jet ejectors
- Organic motivated ejectors
- Thermocompressors
- Steam vacuum refrigeration systems

Liquid Ring Pumps

- Vacuum
- Compressors
- Packaged vacuum systems
- Hybrid systems

Dry Vacuum Pumps

Process Vacuum Condensers

HEAT TRANSFER PRODUCTS

Steam Surface Condensers

- Turbine-generator condensers
- Mechanical drive condensers

Heliflow Heat Exchangers

- Cryogenic vaporizers and coolers
- Vent condensers
- Vaporizers
- Gas coolers
- Liquid to liquid
- Sample coolers
- Seal coolers

Plate Heat Exchangers

Micro-Mix II Instantaneous Hot Water Heaters

Clean Steam Generators

Desuperheaters

High Standards

All Graham equipment is built to the world's most exacting standards and codes, such as ASME Section VIII, Div. 1; TEMA C, B and R; Heat Exchange Institute; American Petroleum Institute; ISO 9001; and the Chinese Safety Quality License for Stationary Pressure Vessels.

Single-Unit Responsibility

Graham engineers and designs all work in-house to ensure performance and delivery you can rely on. This single-unit responsibility is unique, as we are one of the few manufacturers in the business that designs, manufactures, and tests our components in our own facilities.

Testing

To ensure efficient, trouble-free equipment, Graham can assemble and type-test certain products prior to shipment. Complementing our manufacturing capability is a separate research and development facility that is continually searching for better methods of designing and applying technology.

Responsive Service

Graham recognizes the need for fast and efficient responses to our customers' requirements. Our in-house capability ensures that equipment and drawings are delivered on schedule.

Expert Personnel

We have a complete staff of highly trained service engineers, available at a moment's notice, to be at a job site to offer technical assistance. Our sales representatives are factory trained engineers capable of discussing Graham's product lines in detail, conducting in-house seminars for customers, and offering technical assistance.

Something Extra

- *Application Appraisal* Our extensive experience in the process, power and marine industries makes us experts in applying Graham equipment to the overall process. A member of Graham's engineering or sales staff can survey your process to tell you how best to apply our equipment.
- *Personnel Training* In-house seminars conducted by our specialists teach customers how to operate, apply, maintain and service our products.
- *Facility Start-Up* Graham engineers are always available to supervise installation and start-up, and instruct your operating personnel.
- *Equipment Service* Graham service engineers will travel anywhere in the world to service Graham equipment.
- *Product Application Facilities* Graham's Research and Development department and Production Test Floor works closely with you on special projects requiring laboratory or prototype work.



Vacuum System Products

Steam Jet Ejectors: *Vacuum Performance Made Simple, Rugged, and Trouble-Free*

Graham pioneered the modern steam jet ejector system, and continues to improve its efficiency and performance. We are the only steam jet ejector manufacturer that designs and manufactures all major components of the system. This single-unit responsibility allows us to guarantee unmatched ejector performance.



Graham makes all types of multi-stage ejector systems, and has supplied the majority of the world's refinery vacuum distillation tower ejector systems.

Steam jet ejectors are simple, rugged devices that produce vacuum without moving parts. Vibration, as well as high electricity costs and bearing or seal problems, are eliminated. Our ejectors are explosion-proof, can be installed indoors or outdoors, and are noted for their long life, low noise levels, and minimal maintenance requirements.



Combination vacuum systems, commonly called hybrid systems, combine our steam jet ejectors, condensers, and liquid ring pumps for enhanced efficiency and performance.

Graham ejector systems are designed to use steam or organic vapors as the motive fluid, and are available in a wide range of metals and non-metallic, corrosion- and erosion-resistant materials. Our most popular sized models have pre-engineered components, however, we work with customers to custom design ejector systems of any size.



With more than 65 years of experience, Graham Corporation continues to lead the world in the manufacturing of ejector systems.

Our steam jet ejectors are used successfully for many applications, including filtration, distillation, impregnation, drying, degassing, deodorizing, deaerating, evaporation, desalination and crystallization.

Vacuum System Products

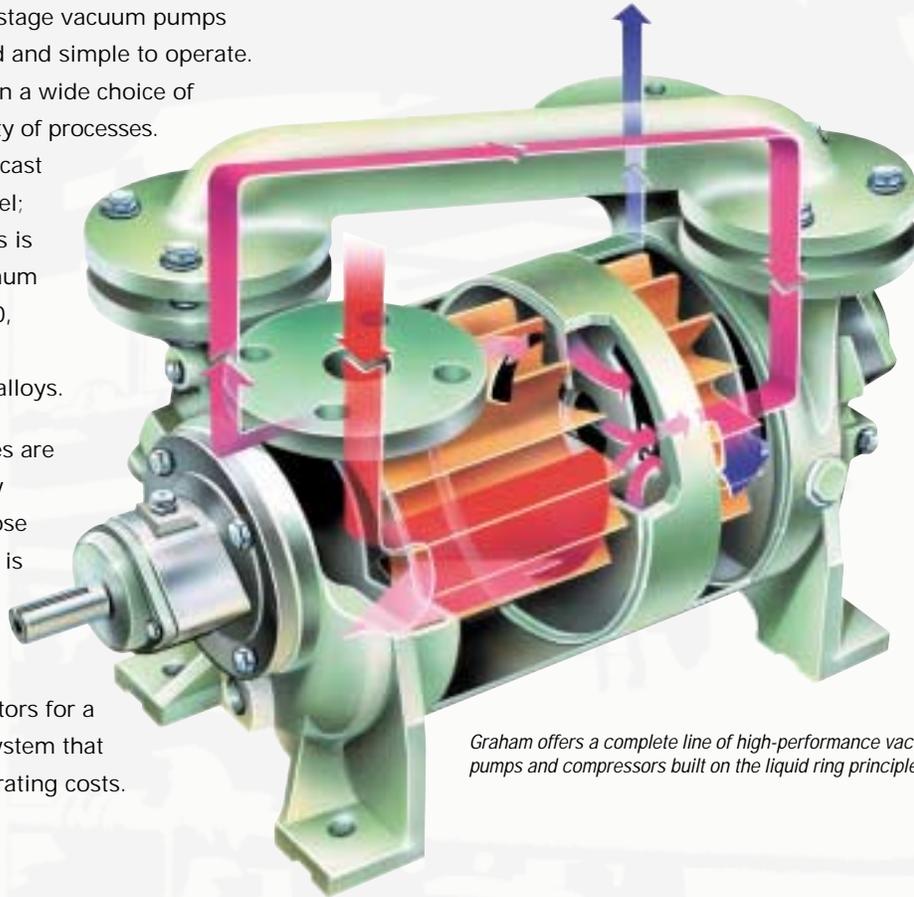
Liquid Ring Vacuum Pumps and Compressors: *A robust machine that keeps getting better*

Graham's single and two-stage vacuum pumps are designed to be rugged and simple to operate.

The pumps are available in a wide choice of materials to match a variety of processes.

Standard pumps come in cast iron, steel or stainless steel; while the Cor-Resist series is available in nickel, aluminum bronze, Hastelloy, Alloy 20, Ni-resist, titanium, duplex stainless steel, and other alloys.

These versatile workhorses are designed to excel in many processes, particularly those where condensable vapor is present. Graham vacuum systems can include both liquid ring vacuum pumps and steam jet ejectors for a highly efficient vacuum system that optimizes capital and operating costs.



Graham offers a complete line of high-performance vacuum pumps and compressors built on the liquid ring principle.



Designed to meet the needs of many industries, Graham liquid ring vacuum pumps and compressors are available in cast iron, steel, stainless steel, bronze, and many other corrosion-resistant materials.



Our liquid ring vacuum pump packages are engineered from the ground up based on the premise "Keep it simple, build it tough."

Vacuum System Products

DRYFLO Dry Vacuum Pumps:

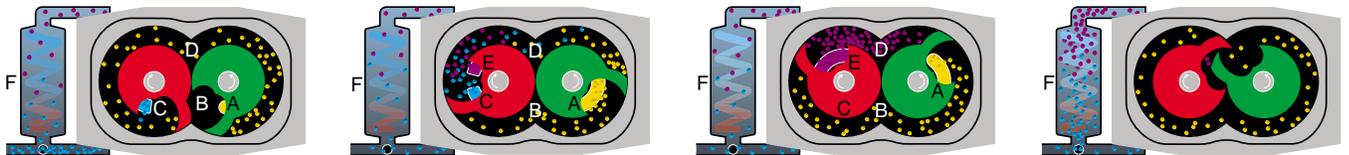
Ready to Meet Your Needs Today, and Expand with Them Tomorrow

Graham DRYFLO dry vacuum pumps run without working fluids such as steam or water. As a result, they run clean, eliminating environmental worries and the cost of disposing contaminants. DRYFLO pumps operate either hot or cool depending on customers' process requirements, and because they feature a modular design, Graham can custom build a DRYFLO model to meet specific application requirements.

DRYFLO's modular design makes it easy to convert and configure, and additional components can be easily added to build a tough, environmentally friendly vacuum system fitted specifically to meet customers' processing needs. Only Graham DRYFLO pumps offer this kind of flexibility.



Graham DRYFLO pumps run cooler and more efficiently than other pumps because they use cooled process gas to create compression rather than hot exhaust gas or by mechanically reducing chamber volumes.



As the hook-and-claw rotors in the Graham DRYFLO type ALLEX pump turn, gases are moved through the pumping stages without internal compression.

Graham DRYFLO pumps are so remarkable because:

- They don't need lubricating or sealing fluids.
- The pump is easily disassembled for maintenance.
- They run clean with no contaminated liquid to dispose of.
- They don't require steam to produce vacuum.
- Their no-wear, hook-and-claw design uses a direct gas cooling process that keeps the pump's internal temperature low, reducing chances of overheating.
- Their modular design allows them to be easily upgraded with additional condensers and mechanical boosters to meet various demands.

Vacuum System Products

Process Vacuum Condensers: *An Integral Part of the Vacuum System Design*

Graham has the experience and proven design methods to build reliable, problem-free condensers, which when used as precondensers, permit reclamation of high-value product, and reduce operating costs when applied as intercondensers. Both pre and intercondensers support the total vacuum system to achieve optimum efficiency and maximum performance.

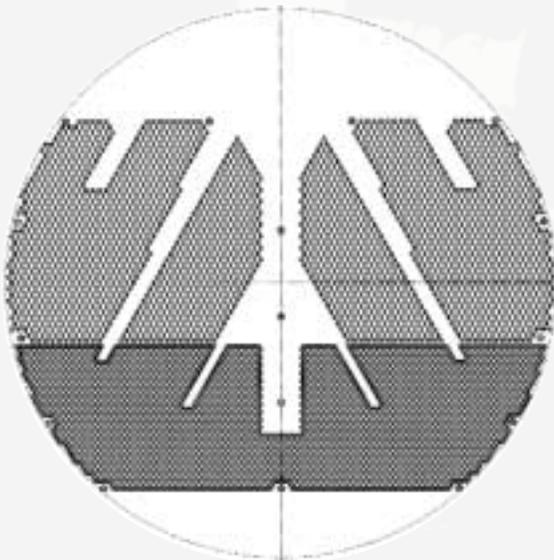
At Graham, we design with a systems approach, assessing appropriate layout and configuration of the entire vacuum system. And because proper installation of a vacuum condenser is as important to a smooth operation as its design, we work with customers to identify exactly where to position them — either ahead of, or into, their total vacuum system. We also work with customers to determine which model is best, and fully design, build and guarantee all of our vacuum systems. That's the Graham advantage.



Graham's condensers are designed to reclaim valuable product and minimize pressure drop to keep operating costs low and reduce environmental concerns.



Our freeze condensers trap and solidify product on heat transfer surfaces to improve reclamation and reduce carry-over into the downstream vacuum system.



Graham has the knowledge and experience to thermally and hydraulically design and build condensers capable of operating at pressures as low as 0.4 Torr. The above illustrates a tube field layout for a high vacuum process condenser in the production of nylon intermediates.

Graham: Engineering Answers

Vacuum System Products in Action



Four-stage vegetable oil deodorization vacuum system at a U.S., West Coast edible oil refinery.



Nickel-aluminum-bronze Cor-Resist liquid ring vacuum pumps for a salt water deaeration application



Mechanical booster combined with a DRYFLO type ALEX dry vacuum pump system for a drying application at



A combination mechanical booster and liquid ring vacuum pump system for a plastics and resins plant in Canada.



Vacuum preconditioner on a visbreaker at a South American lube oil refinery. Vacuum system supplied as unitized system,

Heat Transfer Products

Heliflow Heat Exchangers: *The Fit-Anywhere, Do-Anything, Gold Standard*

The Heliflow heat exchanger is invaluable as a heater, cooler, condenser, or vaporizer. It can transfer heat up to 40 percent more efficiently than equivalent straight-tube exchangers, and their spiral design eliminates baffles and maldistribution. For these reasons, and its many unique attributes, the Heliflow has replaced the straight tube heat exchanger in many applications.

Compact

With only three main components, Heliflow heat exchangers are compact, easy to disassemble and maintain. They do their job in a fraction of the space required by typical shell-and-tube exchangers. They can be mounted on columns, nozzles, walls and ceilings or in-line, and certain sizes require no support.

Standardized and Custom Built

Heliflow models are available in a wide range of sizes and materials. Graham builds hundreds of standard models, which can be delivered rapidly, and can custom build units for specialized applications. In either case, all models are built to fully comply with applicable codes.

Infinite Applications

The Heliflow is unmatched for many highly specialized applications and can be used as a high-pressure air or gas cooler, process cooler or heater, vent condenser, reflux or tower-top condenser, acid heater or cooler, feedwater and blowdown exchanger, jacket water cooler, freon or refrigerant cooler, hydraulic oil cooler, cryogenic exchanger, cooler for electroplating solutions, hot water heater, mechanical seal cooler, and sample cooler. The applications are countless.



Graham Heliflow heat exchangers are used as condensers, heaters, coolers and vaporizers, and are suitable for applications that use either liquids, vapors or gases as process fluids.



Heliflow heat exchangers come in standard sizes or units which can be custom-designed for each particular application.



The unique design of Heliflow heat exchangers makes them strong, compact, efficient, reliable, versatile and exceptionally easy to disassemble.

Heat Transfer Products

MicroMix II Instantaneous Steam-Fired Water Heater: *Fits Almost Anywhere for Instant, Unlimited Hot Water*

The MicroMix II uses Graham's proven Heliflow heat exchanger and a unique feed forward blending valve to provide hot water on demand, instantly and safely. The system senses demand requirements for hot water and provides blended hot water at a preset temperature throughout all rated flow capacities.

Each MicroMix II water heater is a simple, compact, pre-piped package that can deliver hot water within +/- 4 degrees F of a preset temperature. Capacities are up to 120 GPM; units are available in standard materials, stainless steel for pharmaceutical applications and double wall construction. And each system requires less than six square-feet of floor space. Every MicroMix II unit is designed to ASME Section VIII, Division 1 and is fully certified.



Standard MicroMix packages are completely assembled as shown. There are four standard MicroMix II models, which include accessories and frames.

Clean Steam Generators: *Clean, chemical-free steam from plant steam*

Graham Clean Steam Generators are ideal for sterilization, clean-in-place applications, autoclaves, direct injection heating, food processing and humidification. They are available in standard sizes for quick delivery, or can be custom designed to fit specific requirements. Standard materials are copper heat transfer components, and stainless steel is available for improved corrosion protection and to minimize contamination of production steam.

Our Steam Generators are compact, highly efficient vertical units that consistently deliver clean chemical-free steam. All within a very small footprint.



Clean steam generator, including accessories for hospital humidification.

Heat Transfer Products

Graham Plate Heat Exchangers:

Designed to Seal Out Leaks and Lock in Performance

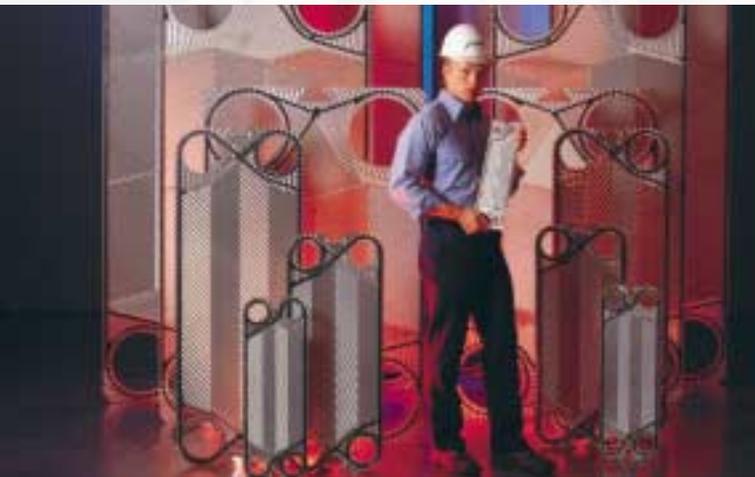
Graham Plate Heat Exchangers deliver extremely efficient heat transfer. Their asymmetrical channel design permits independent optimization of the hot and cold side fluids for top efficiency.

When plate bundles are clamped into the frame, our gasket system forms an extremely tight seal that virtually eliminates fluid leaks and reduces downtime.



Graham plate heat exchangers feature a unique gasket system that locks plates in place, eliminating leakage and providing high-thermal performance.

Graham Plate Heat Exchangers are available in stainless steel, titanium, and other corrosion-resistant metals. Graham provides a full range of plate and gasket materials for premium performance with your particular process fluids.



The unique patterns on our heat transfer plates promote high turbulence, discourage fouling and eliminate unwanted maldistribution.

Desuperheaters:

Reliable Steam Conditioning

Graham supplies three types of desuperheaters: Steam atomizing, double venturi and single venturi, all of which are capable of handling virtually any set of conditions when cooling steam or processing gas.

The superiority of Graham desuperheaters comes from our unequalled experience designing and applying the

venturi, which allows steam and gas to cool uniformly and efficiently by direct contact with water.



A typical double venturi desuperheater for removing undesirable superheat from steam.

Heat Transfer Products

Steam Surface Condensers: *Building Bigger, Better and Stronger*

Graham is one of the industry's leading manufacturers of shop-tubed steam surface condensers for mechanical drive turbines or power plant turbine-generator sets.

Our condensers have substantial proven experience in ammonia, ethylene, refinery, and methanol plant surface condenser applications, and our steam surface condensers are preferred for mechanical drive turbine services. Graham also matches steam jet ejectors and liquid ring vacuum pumps to the condenser for a more efficient and reliable operation.



Graham surface condensers are available as stand alone or packaged units, in either circular or rectangular units, with surface areas exceeding 200,000 square feet.



A large rectangular condenser for a U.S., Gulf Coast merchant power plant.

For merchant and cogeneration power plants, where large rectangular condensers are required, Graham builds the largest units in modular components to be assembled on site. For applications involving aerated makeup water, Graham can integrate its DO2 system into the condenser and venting package design. The DO2 system guarantees that dissolved oxygen levels in condensate exiting the condenser hotwell are below 7ppb.



Graham has been designing and manufacturing condensers for more than 65 years.

Graham: Engineering Answers

Heat Transfer Products in Action



One of six large high-pressure Hellflow heat exchangers in a super-critical water treatment process.



Mechanical drive turbine exhaust condenser at a U.S., West Coast chemical company.



Plate heat exchangers ready for shipment.



One of two direct contact turbine exhaust condensers made for a Southeast Asian geothermal power plant



Graham MicroMix II hot water heater for hospital.



A cryogenically cooled vent condenser at a chemical storage facility that reclaims 98 percent of VOC vapors as condensate.



A large stainless steel condenser for a geothermal power plant on the U.S., West Coast

Engineering, Manufacturing, Research

Graham has complete engineering departments at their headquarters in Batavia, New York, U.S.A., and at Graham Precision Pumps Limited in Congleton, England. Each includes CAD, design and project engineers, who oversee every detail from a project's conception to the time the equipment is installed and operating successfully.



Solving Problems

After the equipment is installed, a full team of highly trained service engineers is available to respond to customers' calls for technical assistance.

Engineering Answers

Graham in Action

- All engineering is done "in-house."
- We performance-test our jet ejector systems and other units of new design or of unusual performance conditions.



- Quality control department works closely with our engineers, designers and manufacturing department to ensure that equipment is fabricated according to exact code requirements and specifications.
- Computer programs aid product design, engineering and performance.
- In-house training seminars keep Graham's engineering staff fully acquainted with the latest developments.

Manufacturing Facilities

Each of Graham's facilities is modern and fully equipped to manufacture equipment produced there. And, at both locations, our fundamental concern is the integration of fabrication, assembly, testing and quality control.



Engineering Answers

Our manufacturing capabilities include:

- Modern machine tools including three automatic drills with 37 and 23 spindles, automatic welding equipment, tape controlled drills and turret lathes.



- Non-destructive testing equipment.
- A complete line of calibrated precision measuring equipment and pressure gauges.
- Code welders qualified to domestic and international codes.
- More than 200,000 square feet in fabrication bays.
- Paint and sandblast.
- Quality control departments that coordinate closely with all engineering and fabricating departments.
- Production control departments that closely monitor workflow in the shop to meet required delivery schedules.
- Experienced shop and supervisory personnel, many of whom have been with Graham more than 30 years.

In-House Manufacturing

Modern facilities enable us to manufacture all equipment "in-house," eliminating the uncertainties that come with subcontracting and reducing the chance that components could be misaligned – which causes numerous delays and problems later on. Graham's emphasis on in-house design and manufacturing results in equipment that's fully integrated to your exacting requirements.

Research and Development

Graham's central research and development facility in Batavia, New York, U.S.A., is completely equipped to perform testing of steam jet ejectors, heat exchangers, liquid ring pumps, and other Graham products.

This modern laboratory develops and improves products and finds new applications for existing products. The facility also works closely with customers who have unique concerns that may require laboratory or prototype work.



A freeze condenser undergoing performance evaluation in the R&D facility.

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