

**Vacuum Pumps and Compressors for
Ethanol & Biodiesel Production**



NASH Vacuum Pumps and Compressors for Ethanol & Biodiesel Production

Biofuels: Renewable energy sources

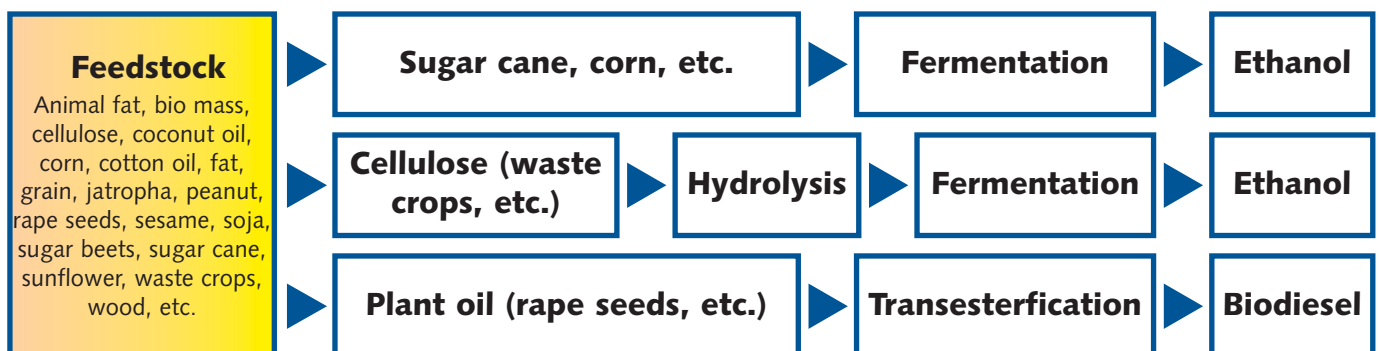
The energy requirements of our society are rising, but the supply of fossil fuels is limited. Therefore, the importance of finding alternative energy sources is increasing. Alternative fuels for combustion engines using renewable resources are very promising.

Technologically, processes and technologies for the production of fuels from renewable resources - biofuels in short - are well-engineered. These technologies, together with escalating costs of fossil fuels, make this alternative economically attractive. From an environmental point of view, biofuels have the advantage of burning "CO₂ neutral." And, last but not least, increasing political awareness creates the legal framework for the production and use of biofuels.

The term "biofuels" refers to the final products: Bio-Ethanol and Biodiesel. These end-products are manufactured by different processes: Usually, this is a fermentation process for the production of Bioethanol (using sugar-rich crops), a transesterification process for the production of biodiesel (using oil-rich materials), sometimes hydrolysis or other processes are used depending on the feedstock. Basically, almost all biological material can be used as a feedstock for biofuels. However, the suitability of these processes depends on biological characteristics like sugar or fat content.

Furthermore, geographic and climatic conditions play an important role in biofuel production: In South America, sugar cane is an important feedstock and the main source of material; in North America, it is corn; and in Europe, rape seed is the crop of choice.

Gardner Denver Nash is a pioneer in providing equipment and engineering for process facilities producing biofuels. Our vacuum and compressor systems are unmatched, working reliably worldwide in these applications for decades.



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Biofuels: Production processes

Vacuum and compressors are used in several biofuel production areas in both the fermentation and transesterification process.

Liquid carry-over can accidentally come into the vacuum system and NASH Liquid ring pumps are designed to handle liquid carry-over and keep on running reliably. They have the flexibility to use water, ethanol, or biodiesel as the seal liquid and are therefore the best choice for each process.

Vacuum and compressor systems in the fermentation process

In fermentation processes, biological materials are transformed into other substances through the use of bacteria cultures, cells or fungi, or by adding enzymes (fermenters). Bio-ethanol is then extracted by distillation. The distillation columns work under different levels of pressure and vacuum, to keep the evaporator and condenser in equilibrium.

Gardner Denver Nash liquid ring vacuum pumps are mainly used during distillation and rectification. Vacuum reduces energy consumption of the process and guarantees an economical production of the final product. During the dewatering process, a variety of separation and filter applications are used with vacuum, e.g. molecular sieves. Liquid ring pumps also work during mash liquefaction and the "distiller's wash" drying cycle. NASH compressors create a nitrogen layer over the fermentation process and guarantee an oxygen-free process. NASH liquid ring vacuum pumps and compressors also work in tank filling and emptying.

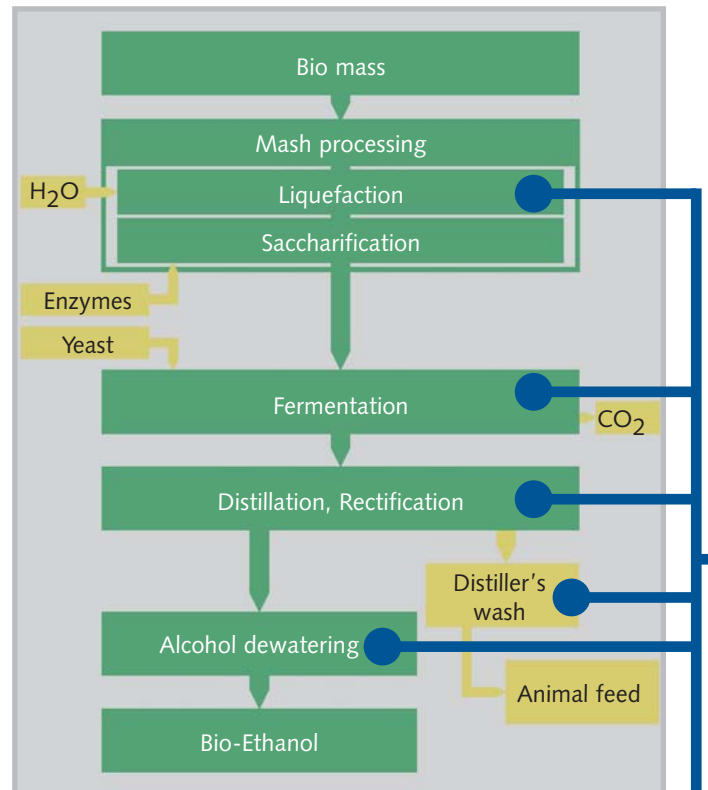
The future: using waste crops in the fermentation process

Due to economic reasons, today's fermentation processes depend mainly on sugar-rich crops as a feedstock. In the near future, using waste crops (e.g. corn stalks, straw or wood) will be another economic choice: Hydrolysis is used on the waste crop's cellulose to convert it to simple sugars, representing a new, large source of feedstock for fermentation processes.

Vacuum and compressor systems in the transesterification process

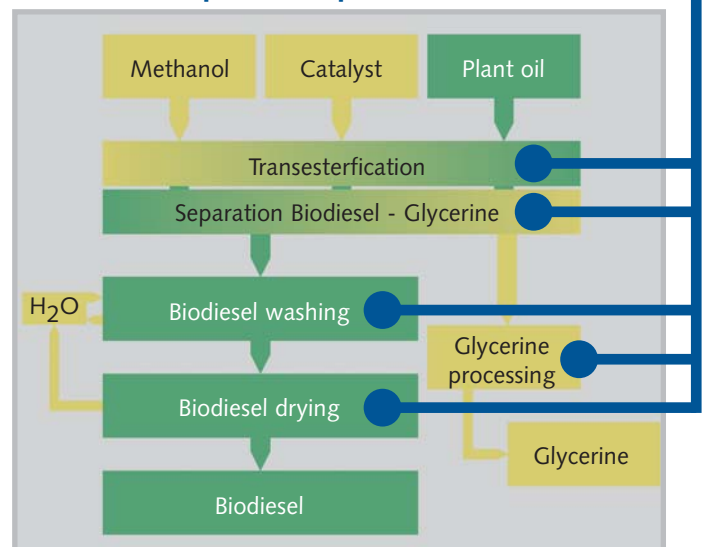
Prior to the transesterification process, plant oil was extracted by pressing and then purification (refinement). The refined plant oil is then transestered with methanol, creating methylester.

Liquid ring vacuum pumps and compressors from Gardner Denver Nash are used in the separation of biodiesel and glycerine, extracting wet and saturated gases with vacuum. They also work in tank filling and emptying, in Methanol recovery and Glycerine purifying. In the biodiesel washing and drying processes, several filter processes also operate under vacuum, which are supported by NASH liquid ring pumps.



Bio-Ethanol production process - Fermentation

Biodiesel production process - Transesterification



Gardner Denver Nash vacuum and compressor systems work reliably in all stages of biofuel production. They are extremely rugged, efficient and insensitive to liquid carry-over.

NASH Vacuum Pumps and Compressors for Ethanol & Biodiesel Production

For more than 100 years, Gardner Denver Nash has engineered liquid ring vacuum pumps, liquid ring compressors and tailor-made engineered systems for many different applications in the process industry.

NASH Vectra:
reliable performance under backpressure conditions



NASH TC/TCM:
low absolute vacuum levels



NASH 2BE3:
high suction capacity



NASH 2BV:
compact design for low volume rates



NASH pumps, compressors and engineered systems cover all vacuum requirements in the production of biofuels.

Vacuum and pressure range

The typical operating range of vacuum systems in biofuel production is between 0.1" HgA and 18" HgA (3 mbar abs and 600 mbar abs), depending on the process area and the raw material used.

Gardner Denver Nash supplies liquid ring pumps and systems, specially designed for each process section:

- Single stage vacuum pumps with a wide performance range of vacuum to 1" HgA (33 mbar abs)
- Two stage vacuum pumps with extended vacuum performance to 0.8" HgA (27 mbar abs)
- Vacuum pumps that also perform under backpressure
- Compressors for lower pressures to 33 PSIG (2.5 bar) or for high pressures to 200 PSIG (15 bar abs)
- Liquid ring vacuum pump & steam jet ejector hybrid systems for very low vacuum levels, to 0.01" HgA (0.3 mbar abs), and flexible applications, hybrid & dry systems for vacuum of 1 mbar absolute
- Oil sealed vacuum systems for very low vacuum levels, to 0.4" HgA (13 mbar abs)

Suction capacities

NASH liquid ring vacuum pumps cover a wide performance range from 118 to 23,000 CFM (200 to 39,000 m³/hr). Suction capacity of our liquid ring compressors is up to 3,237 CFM (5,500 m³/hr).

Materials

Vacuum and compressor systems from Gardner Denver Nash are available in many different materials. For the production of biofuels, stainless steel is the material of choice, however other materials are available depending on customer preference.

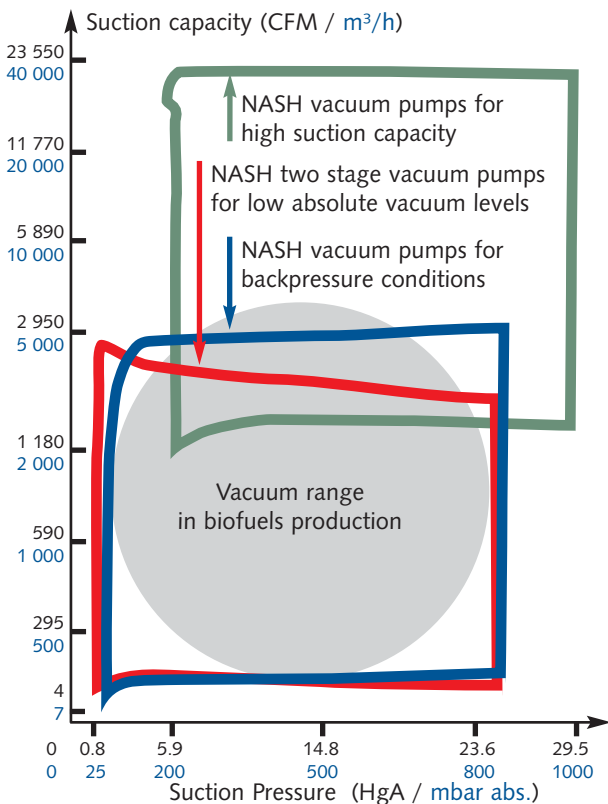
Typical systems come with explosion proof motors and accessories depending on the area classification in the plant. NASH systems are ATEX certified to meet this requirement.

Tailor-made engineered systems

Gardner Denver Nash designs and manufactures complete engineered systems, tailor-made for your application. Our engineers can find the best solution for your process requirements.

We also offer pre-engineered Vectrapaks: complete vacuum systems usually available in 2-3 weeks.

Whatever vacuum and compressor system you may need for biofuel production - there is a solution made by Gardner Denver Nash.



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Engineered systems by Gardner Denver Nash

Vacuum and compressor systems from Gardner Denver Nash are the perfect solution for biofuel production. We have the experience and the technology for your application.

Our experience

Gardner Denver Nash operates worldwide seamlessly between all locations. Our engineers have decades of experience with vacuum and compressor systems. In the production of biofuels, we worked right from the start - in the pioneer market of Brazil. Sophisticated software programs support us in dimensioning and evaluating the optimal pump size for your application. Due to our experience, we know the processes and can quickly develop the perfect solution fast. And, we supply turn-key vacuum and compressor systems including controls to integrate into your plants operation.

Our technology

Gardner Denver Nash liquid ring vacuum pumps and compressors are extremely rugged and reliable. They work for decades at low rotation "speed" and are LOW MAINTENANCE. NASH liquid ring pumps are ideal for the handling of wet processes. Since they use liquids as operating fluids, they are insensitive to liquid carry-over and dust carry-over. This makes liquid ring pumps superior to other technologies.

Gardner Denver Nash vacuum and compressor systems are the perfect solution for handling the wet and contaminated gases created during biofuel production. Please contact your local NASH office for more information.

Nash Experience	Benefits
Decades of experience in the biofuel pioneer markets and in the Sugar Industry	Reliable solutions
Process know-how	Speed to market
Turn-key solutions	All from one source
Sophisticated, specialized pump dimensioning software	Most efficient pump size
Over 100 years of vacuum and compressed gas experience	Peace of mind

Nash Technology Features	Benefits
Ability to handle carryover	Minimal process problems resulting in more uptime; intended for severe applications
Long design life of 40+ years	Highest reliability
No internal lubrication required	Less maintenance required; less downtime
No metal-to-metal contact	Constant wear-free performance
Cool Running, minimal temperature rise between inlet and discharge	Ideal for explosive gases and vapor recovery applications
Only one moving part	Simple and reliable operation
Direct drive speeds for 60 Hz & 50 Hz motors	Global product design
100% performance tested	Trouble-free start-up and operation
2 year warranty	Peace of mind

Other NASH Products

2BV Compact liquid ring vacuum pumps built for serious cost savings
Use up to 50 percent less water than other liquid ring pumps
Monoblock and pedestal designs available
Capacity of 4 to 350 CFM with vacuum to 29+'' HgV
Capacity of 7 to 595 m³/h with vacuum to 33 mbar abs



Vectra Liquid ring vacuum pumps and compressors
Available in feature rich budget designs (XL or GL)
Designed to handle high back pressure requirements
Capacity of 115 to 2,860 CFM with vacuum to 29'' HgV
Capacity of 195 to 4,860 m³/h with vacuum to 31 mbar abs



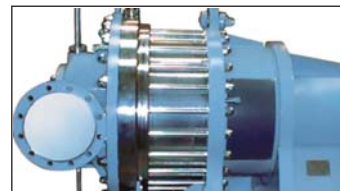
2BE3/P2620 Large liquid ring vacuum pumps with superior corrosion resistance
Top discharge capability which eliminates need for trench
Self-recirculating seal water, reducing need for external
seal water source
Capacity of 4,000 to 23,000 CFM with vacuum to 29+'' HgV
Capacity of 6,800 to 39,000 m³/h with vacuum to 31 mbar abs



TC/TCM Integral 2 stage liquid ring pumps with improved
performance at vacuum levels down to 0.8'' HgA / 27 mbar abs
Designed to handle large amounts of liquid
carryover without difficulty
Capacity of 100 to 2,200 CFM with vacuum to 0.8'' HgA
Capacity of 170 to 3,740 m³/h with vacuum to 27 mbar abs



Compressors Wide range of liquid ring compressors designed for many
applications. Rugged and reliable, they can handle highly
toxic, explosive and corrosive gases
Specifically developed for applications such as flare-gas,
Chlorine and Vinyl Chlorine Monomer (VCM) recovery
Capacity of 60 to 2,200 SCFM with pressure to 200 PSIG
Capacity of 100 to 3,740 m³/h with pressure to 15 bar abs
Single and two stage models available



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