

Neutral Alcohol



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Process Technology

VOGELBUSCH ALCOHOL PLANTS

WORLD CLASS TECHNOLOGY – WORLDWIDE SUCCESS

Vogelbusch is a major global player in the engineering and construction of alcohol plants, and has introduced many important improvements in alcohol process technology and design since 1921.

The Austrian company has long been a pacesetter in alcohol technology, and has breakthroughs such as the continuous fermentation process, energy saving multi-pressure distillation/rectification systems and the manufacture of neutral alcohol to its name.

A consistently innovative approach and environmentally sound engineering have played a large part in the success of Vogelbusch alcohol plants. Projects around the globe demonstrate that Vogelbusch plants consistently achieve world class performance. High-grade alcohol (ethanol) produced by Vogelbusch plants is used as beverages, chemical feedstock, fuel, or a base for pharmaceuticals and cosmetics.

MEASURABLE COMPETITIVE ADVANTAGES

Alcohol producers have to meet the challenge of the rising purity demands of their commercial customers whilst keeping raw material and energy costs under tight control. Vogelbusch plants are designed for outstanding performance in terms of product quality, process economics and environmental impacts.

We have extensive experience of a wide range of feedstocks and state-of-the-art proprietary technology for every stage of the alcohol production process. World-famous developments pioneered by Vogelbusch include:

Vogelbusch MULTICONT® continuous fermentation process

- | Low investment and operating costs
- | Outstanding yields, concentration and productivity
- | Reliable and stable operation for extended periods of time
- | Easy operation thanks to full automation

Vogelbusch multi-pressure column system

- | Superior product purity
- | Advanced column system operated at different pressure levels
- | Minimized energy demand – heat input reused several times
- | Integrated stillage preconcentration for reduced evaporation load

Vogelbusch evaporation systems

- | Multi-effect systems with heat input recycled up to nine times
- | Zero life steam demand for integrated grain processing plants
- | Optional reduction of thermal energy demand through mechanical vapor recompression

Continuous process improvement is carried on at our state-of-the-art in-house laboratories and pilot plants, and in cooperation with universities. An important aspect of our expertise is our mastery of distillation and evaporation process simulation using physical property sets derived from research and confirmed by numerous plants in operation.

Vogelbusch offers highly specialized custom solutions that optimize process economics for:

- | Manufacturing of combined or alternative products
- | Use of multiple feedstocks

- | Compliance with precise specifications for product quality, steam pressure, etc.
- | Local maintenance and construction conditions

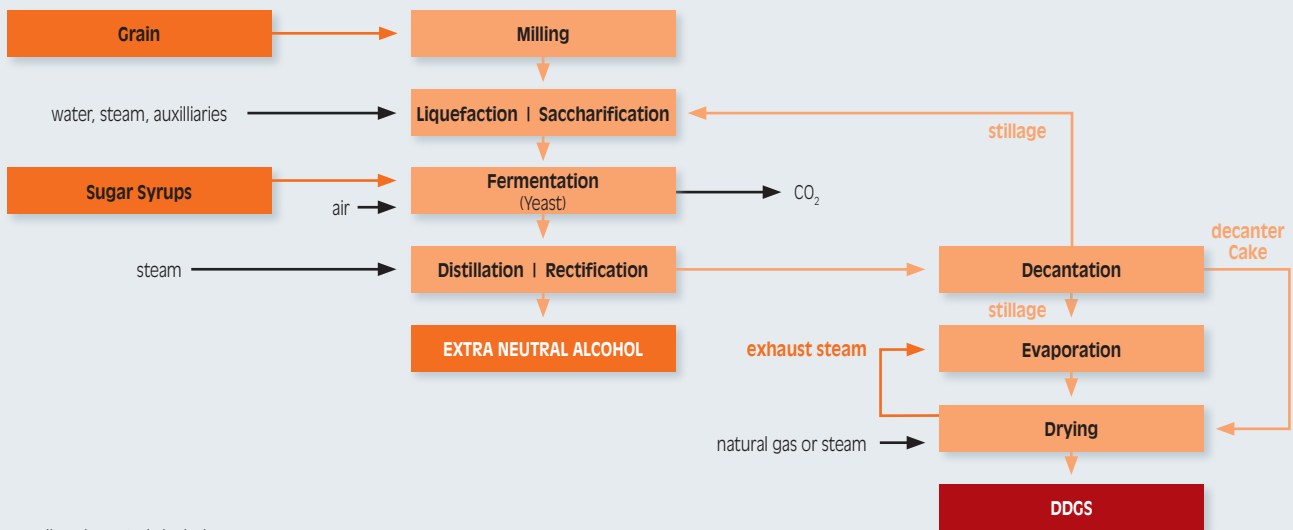
ALCOHOL QUALITY

We have the technology and experience to design processes for a wide range of applications and product specifications. They are individually tailored to comply with national ethyl alcohol standards, and pharmacopeia or producer specifications.

Neutral alcohol and extra neutral alcohol is highly concentrated and purified ethanol of agricultural origin. Depending on its quality it is suitable for a variety of applications:

- | Neutral alcohol is the base for flavored alcohol beverages, for vinegar, and is also used for a wide range of chemical and pharmaceutical products and processes.
- | Extra neutral alcohol has the highest purity and organoleptic quality, and should have as little bouquet, flavor and color as possible. It is used in the production of alcoholic beverages such as vodka.
- | In their dehydrated form, which is practically water free, both are used in chemicals, pharmaceuticals and cosmetics.





Vogelbusch neutral alcohol process

THE VOGELBUSCH NEUTRAL ALCOHOL PROCESS

Vogelbusch offers proprietary technology for every stage of alcohol production. Fermentation and subsequent purification by distillation/rectification are the core process groups. Raw material preparation, auxiliaries and by-product treatment are adjusted to the desired feedstock. Flexible design concepts and technology can be precisely adapted to specified substrates, capacity, available steam pressure and energy costs.

FEEDSTOCKS

Our key success factors include knowledge and field experience of input materials and the ability to analyze them precisely for bioprocess needs. Our equipment can process alcohol from a wide range of starch or sugar-containing substrates, even from cellulose conversion processes. These include wheat, corn, milo, barley, rye, potatoes, cassava, sweet potatoes and wet milling by-products, as well as sweet sorghum, sugar cane and sugar beet in the form of molasses, thick juice or syrups.

Vogelbusch has also supplied a number of stand-alone rectification plants designed to process raw (crude) alcohol, such as that obtained from small agricultural distilleries, or to act as a sidestream of bioethanol production into extra neutral alcohol.

RAW MATERIAL PREPARATION

Starch

Grains and tubers are milled before they are used in the process. Starch or by-products from wet milling plants do not require any special treatment and are fed directly to liquefaction. In the liquefaction (conversion) step, starch is liquefied by enzymes under the right temperature, pressure and pH conditions. Each parameter is optimized for the type of raw material used. At the saccharification stage, the liquefied substrate is partly transformed into glucose. The saccharified substance is cooled down and fed directly to the fermentation unit. Final conversion of the starch into glucose takes place simultaneously during fermentation. The Vogelbusch HOTMASH® process reuses heat from hot stillage, resulting in significant steam savings.

Sugar

Molasses and sugar syrups seldom require special treatment, and are normally fed straight to the fermentation unit. Where the substrate contains large amounts of inhibiting substances which would affect the fermentation pasteurization and/or stripping may be necessary. Occasionally, a sludge removal process may also be required.

FERMENTATION

At the fermentation stage yeast transforms monosaccharides into alcohol. The Vogelbusch MULTICONT® continuous fermentation process consists of a prefermenter and between four and seven main fermenters in series. Process conditions in the prefermenter are adjusted to promote yeast growth by adding nutrients and oxygen, while in the main fermentation tanks the alcohol increases in concentration as mash flows through the system. A constant flow of substrate enters the fermentation unit and the same volume of liquid leaves the system simultaneously. Final alcohol concentrations in the mash of over 12% vol are regularly achieved. The continuous process is widely regarded as the state-of-the-art alcohol fermentation technology. Conventional batch fermentation systems can be employed for particularly challenging raw materials.

With some substrates, yeast recycling can be used to improve yield and accelerate fermentation. Vogelbusch has designed plants that employ yeast recycling for non-fibrous raw materials such as molasses or starch milk.

DESIGN OPTION

Batch | Continuous Fermentation

Fermentation units can be implemented as batch, fed batch or continuous processes. Continuous systems are generally cheaper and easier to operate. Batch systems are often preferred for highly inhibiting substrates (e.g. low-grade molasses) or situations in which feedstocks must be frequently switched (e.g. molasses vs. grain).

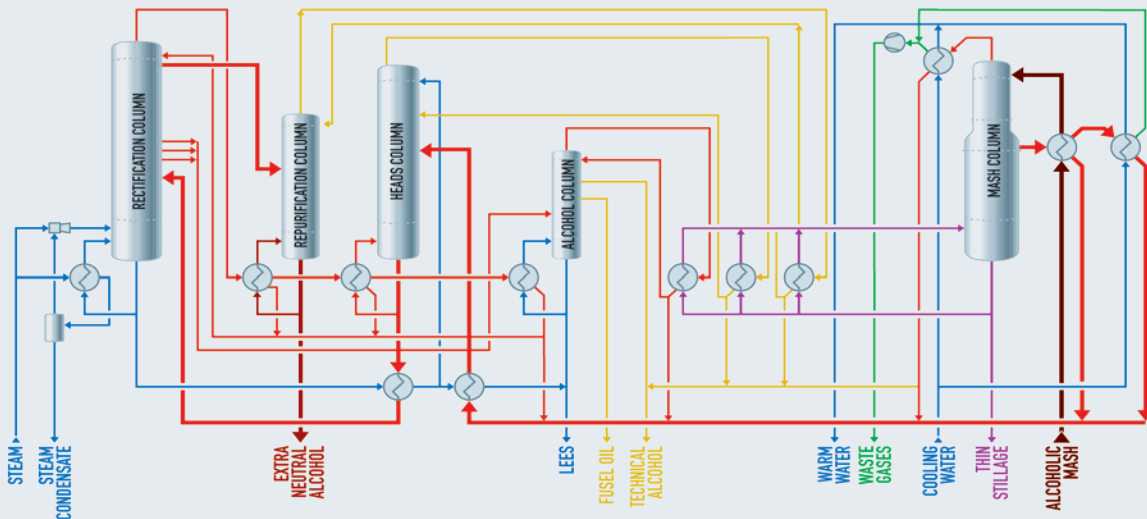
DISTILLATION AND RECTIFICATION

The alcoholic mash is fed to the distillation column where the crude alcohol is stripped from the mash, leaving behind an alcohol-free liquid, the stillage. The crude alcohol is purified and concentrated up to at least 96% vol in several process columns in series.

Vogelbusch process schemes for distillation/rectification are optimized for separation of impurities and avoidance of undesired chemical reactions. Ethanol yields from fermented mash to final product of 97.5% are typical.

The temperature range of the columns is selected for superior product quality. Vogelbusch column systems are individually tailored to the desired quality specifications, and analytical and organoleptic characteristics.

The Vogelbusch multi-pressure column system saves live steam. Thanks to advanced thermal integration techniques, the energy consumption of the distillation/rectification unit is kept to about 1950 kg steam / 1000 l neutral alcohol.



Example of a steam saving multi-pressure distillation | rectification unit for extra neutral alcohol.

DESIGN OPTION

Dehydration

A dehydration process is used to obtain super dry ethanol for pharmaceutical or industrial applications. Standard Vogelbusch technology employs a pressure swing adsorption (PSA) process using molecular sieves. The final water content can be reduced to 0.01% vol. On request entrainer dehydration can be employed instead.

EVAPORATION

In grain plants insoluble substances (fibers) in the stillage are removed by a decanter. Part of the decanted stillage is recycled to the liquefaction/saccharification unit which re-uses the latent heat and reduces the overall water demand of the plant. The other part of the stillage is pre-concentrated by the distillation unit reboilers, so as to reduce steam demand at the evaporation stage where it is concentrated.

Vogelbusch offers a wide range of proprietary evaporators including falling film, natural and forced circulation, and expansion designs. There is a choice of single or multiple effect evaporators, with or without thermal or mechanical vapor recompression. Our evaporation plants are optimized to energy costs and available steam pressure, as well as the availability of secondary process heat (e.g. from dryer vapor).

Stillage from beet or cane molasses is directly fed to the evaporation section. The concentrated molasses stillage (vinasses) can be sold as animal food additive or fertilizer, or incinerated to generate process steam.

GRAIN STILLAGE DRYING

While ethanol production consumes the grain's starch, the protein, minerals, fat and fiber are concentrated during the production process. Solids leaving the decanters are mixed with concentrated stillage from the evaporation section and dried. The dried product is sold as powdered or pelletized distillers' dried grains with solubles (DDGS) – a valuable animal feed. Alternatively, especially for smaller plants, stillage and the solids from decanter can be sold directly.

To minimize energy consumption, the drying vapors are reused in the evaporation section, and the residue vapors returned to the dryer. This closed loop principle also significantly reduces the atmospheric emissions.

DESIGN OPTION

Gas | Steam dryer

Decisions on dryer technologies are a matter of energy availability and cost. Where cheap steam is available indirect steam heated tube bundle dryers are used. Otherwise gas or light fuel oil fired dryers are employed, both ring and rotary drum dryers.

OUR SERVICES FOR NEUTRAL ALCOHOL PLANTS

Vogelbusch provides bioprocess engineering, consultancy and contracting services, and licenses technology. Our process design packages for alcohol plants include:

- | Pre-engineering
- | Basic process package:
Technology and process design, Supply of key equipment, Commissioning support and operator training
- | Detailed piping engineering
- | Turnkey supply of complete plants

Highly skilled experts are also available to upgrade or revamp existing plants to increase capacity, improve yield and/or product quality, and save energy and water.



AVERAGE CONSUMPTION FIGURES

RAW MATERIAL			UTILITIES								
		Quantity kg	Steam kg		Power kWh		Cooling water ³⁾ m ³		Process water ⁴⁾ m ³	Soft water m ³	
			DDGS drying or vinasses concentration								
			no	yes ²⁾	no	yes	no	yes			
Wheat	STARCH	58%	2630	2350	4800	135	285	105	185	4.6	0.4
Corn		65%	2350	2300	4100	130	240	100	175	5.0	0.4
Cassava chips		65%	2350	2350	-	150	-	100	-	4.8	0.4
Beet molasses	SUGAR ¹⁾	50%	3240	2250	3350	80	110	110	170	7.0	0.4
Cane molasses		50%	3270	2300	3450	80	110	120	180	7.7	0.4
Cane juice; Sweet sorghum		15%	10700	2050	3400	80	110	110	180	1.0	0.4

¹⁾ fermentable sugar as disaccharide

²⁾ natural gas can also be used as heat source for DDGS drying

³⁾ dT = 10K

⁴⁾ partly replaceable by treated condensates

Additionally minor amounts of chemicals are necessary, the consumption is dependent on the raw material quality. The amount of enzymes required in starch conversion depends on the producer.

ENERGY SAVING THROUGH THERMAL INTEGRATION

Vogelbusch designs include energy saving features at all process stages. Energy consumption at the raw material preparation stage is significantly reduced by recycling stillage, hot condensates and luter water. Further savings are achieved by the use of expansion vapors.

Another innovation in the distillation/rectification of potable alcohol, introduced by Vogelbusch in the 1990s and since continuously improved is the use of multi-pressure column systems in potable alcohol production processes. This cuts energy consumption without compromising product quality.

In the case of stillage processing at grain-based potable alcohol plants, multiple effect evaporation sections driven by waste heat from the DDGS dryers can be used to achieve additional energy savings. The configurations of proprietary Vogelbusch systems are selected according to investment and energy costs in each particular case.





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