

OLEOCHEMICALS

OPTIMIZED FOR THE HIGHEST
QUALITY OUTPUT



Air Liquide Group

The world leader in gases, technologies and services for Industry and Health

Air Liquide is present in 80 countries with approximately 65,000 employees and serves more than 3 million customers and patients. Oxygen, nitrogen and hydrogen are essential small molecules for life, matter and energy. They embody Air Liquide's scientific territory and have been at the core of the company's activities since its creation in 1902.

Air Liquide's ambition is to lead its industry, deliver long term performance and contribute to sustainability.

Air Liquide Engineering & Construction

A technology partner of choice

Air Liquide Engineering & Construction builds the Group's production units (mainly air gas separation and hydrogen production units) and provides external customers with efficient, sustainable, customized technology and process solutions.

Our core expertise in industrial gas, energy conversion and gas purification, enables customers to optimize natural resources.

We cover the entire project life-cycle:

license engineering services / proprietary equipment, high-end engineering & design capabilities, project management & execution services. In addition we also offer efficient customer services through our worldwide set-up.

As a technology partner, customers benefit from our research and development to achieve energy transition goals.

Our full suite of technologies

- Liquefied Natural Gas
- Cryogenics
- Hydrogen
- Syngas
- Petrochemicals
- Natural Gas Treatment
- Sulfur
- Standard Plants
- **Oleochemicals**

15

Engineering centers and front end offices

3

Manufacturing centers

60

Proprietary technologies

1,600

Patents

Pioneers in oleochemical technologies

Innovative design and expert execution

Air Liquide Engineering & Construction is the market leader in serving the world's oleochemical producers with advanced technologies. We design, engineer and manufacture the most reliable, efficient and cost-effective oleochemical plants and process units for the production of fatty acids, glycerin, fatty alcohols, methyl esters and biodiesel.

Our oleochemical portfolio is the outgrowth of decades of advanced Lurgi design and engineering of hydrolytic oil splitting, distillation and fractionation as well as batch and continuous hydrogenation. You can rely on the expertise of our project teams to design, plan and execute your project within the shortest possible time. In addition to providing consistently high quality end products our plants are automated for ease of operation, require little maintenance and are very energy efficient.

We offer complete systems, transforming feedstock into high grade final products and individual equipment units to convert natural oils to high-grade intermediate oleochemicals, including pharmaceutical-grade glycerin, with processes tailored for optimized output:

- Continuous oil splitting
- Glycerin water treatment and evaporation
- Glycerin distillation and bleaching
- Fractionation or distillation of Fats, Fatty Acids, Fatty Alcohols, Methyl Ester, Glycerin to tailored composites or pure fractions
- Hydrogenation (batch and continuous) of fatty acids and methyl esters
- Esterification
- Transesterification
- Hydrogenation of wax esters or methyl esters to fatty alcohols
- Carbonyl conversion
- Methanol recovery and rectification

Produce high quality products and maximize your profits

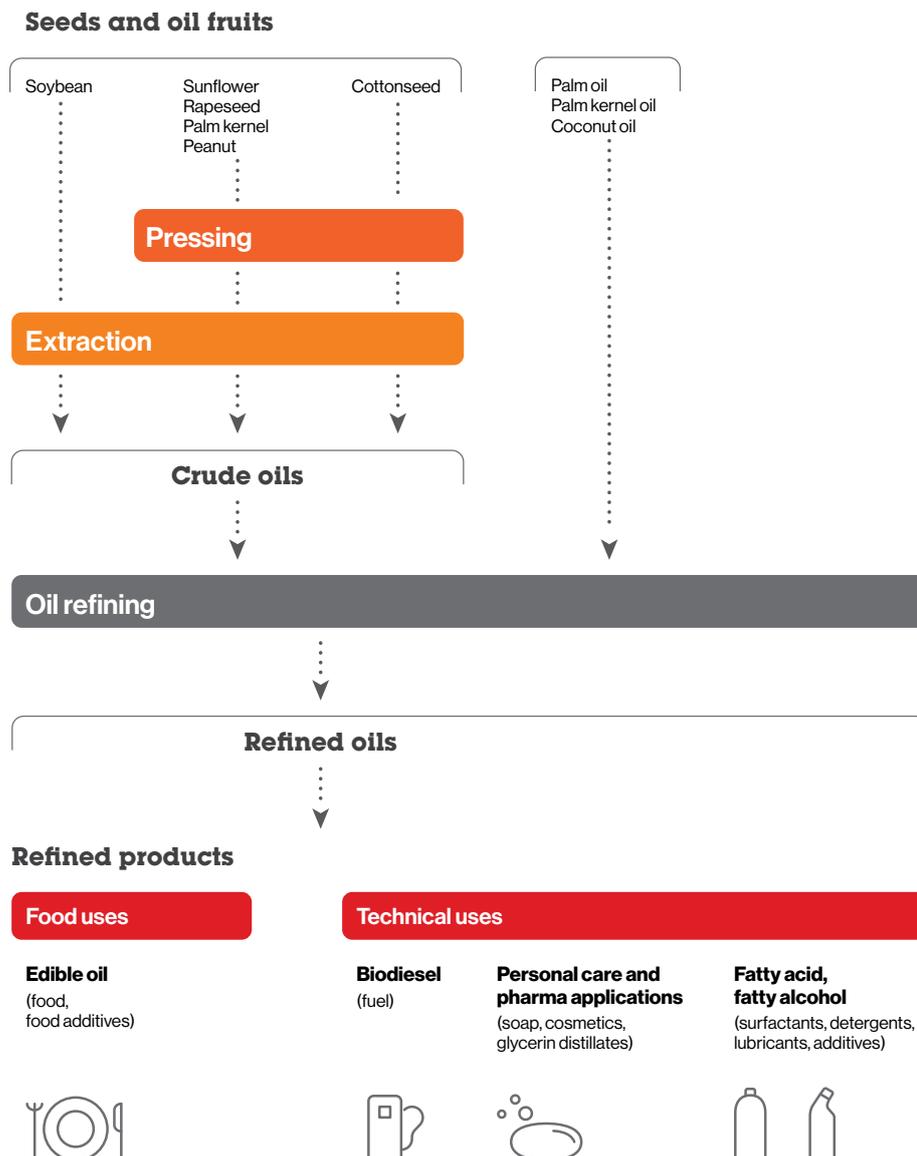
In 2007, Air Liquide acquired Lurgi Group and with it decades of development in oil and fats processing technologies. This is reflected in our extensive portfolio of proprietary technologies known for their efficiency and reliability.

Complete technologies for diverse feedstocks

Covering every stage of production

We cover every stage of the processing from natural oils to fatty acids, alcohols and glycerin

Our leading edge technologies provide complete system processing, from seed crushing and oil extraction to oil refining for a wide range of downstream applications. Air Liquide Engineering & Construction oleochemical technologies create value for the food, cosmetics, detergents, surfactants and pharmaceutical industries through our comprehensive offering.





Benefits



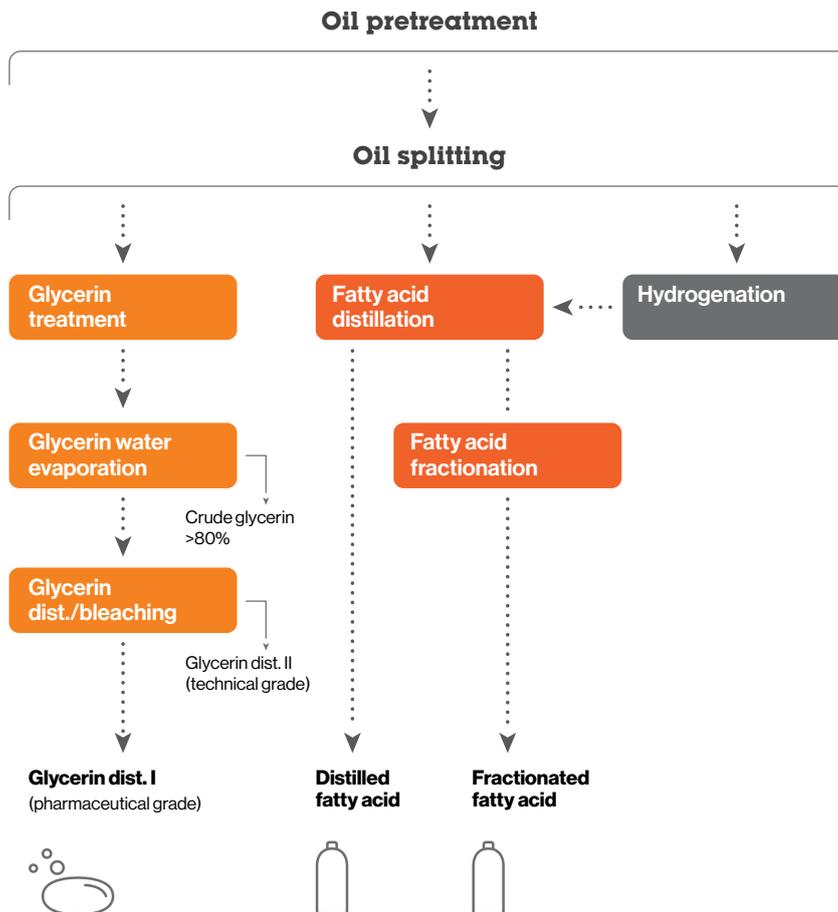
Optimized plant design ensures minimum waste and reduced energy consumption

Process steps and technologies

Oil splitting

Our leadership in this area is based on decades of Lurgi advances in oleochemical science and engineering. Our modern continuous oil splitting process offers excellent raw material yield and reduces residue. A 99% splitting degree is achieved at approximately 55 bar and 250°C in countercurrent flow pattern.

Lurgi plants are designed for maximum thermal efficiency. The use of economizers and recovery of steam generated by flashing of glycerin water reduce energy consumption, lower cost and improve the overall environmental footprint.





Distillation and fractionation

Our expertise in low-vacuum processes allowed us to develop high-performance and flexible distillation and fractionation technologies. These can be configured to ensure optimal production of tailored composites or pure fractions perfectly aligned with your needs.

Moderate heating, gentle evaporation of feed materials and product condensation with optimized heat recovery satisfy market demands and ensure odorless, high quality end products.

Process steps and technologies

Fatty acid hydrogenation

We offer two types of hydrogenation: continuous and batch.

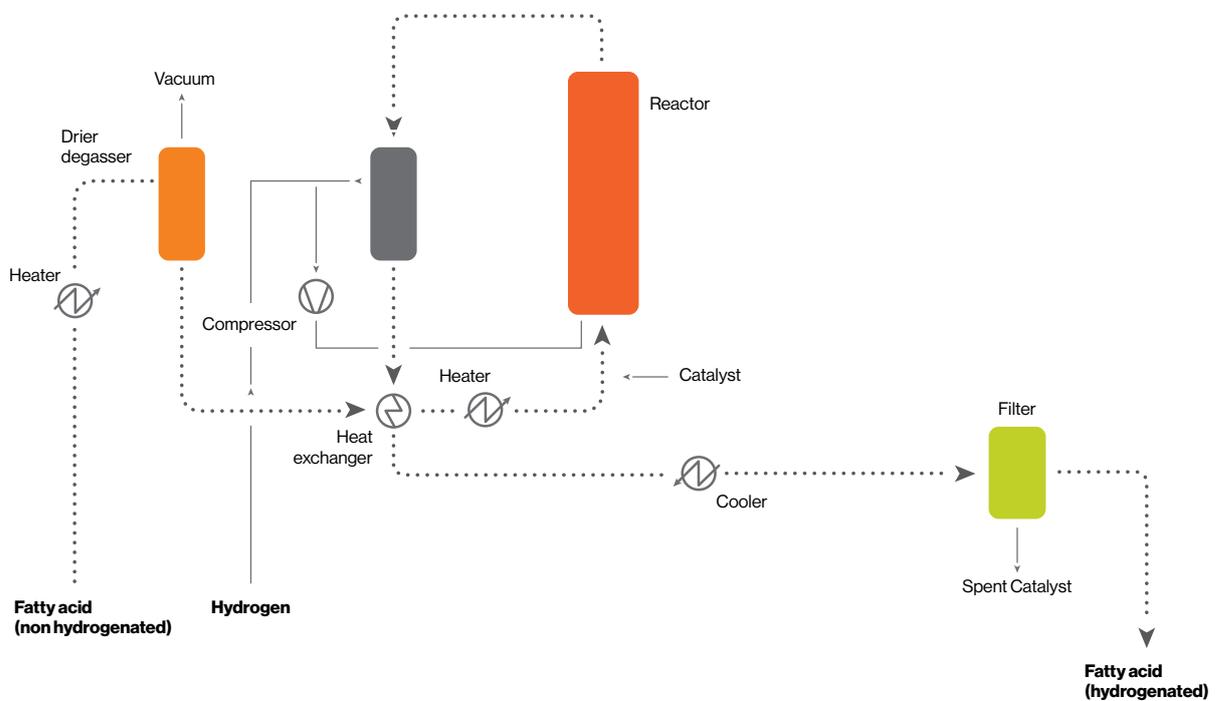
Both hydrogenation systems – batch and continuous plant – achieve targeted saturation of the oleochemical feed. For fully hydrogenated products from larger streams of single type feedstocks, the continuous multi-stage plug flow reactor is recommended. Where multiple feed is used in smaller volumes and variable degrees of hydrogenation, the highly efficient loop reactor system will be ideal.

Our expert project teams will assess your current and projected needs in terms of raw material, capacity, space and energy to deliver the right unit for your business.

Distilled non-hydrogenated products

If your output is sold as bulk liquid after distillation and doesn't require hydrogenation, we can easily accommodate your needs.

Continuous hydrogenation



High-purity glycerin

Air Liquide Engineering & Construction's Lurgi technologies optimize the recovery of glycerin from natural oils. Glycerin water from oil splitting or methyl ester production is purified and fed to a continuous multi-stage evaporation unit to produce high quality crude glycerin, which can easily be distilled.

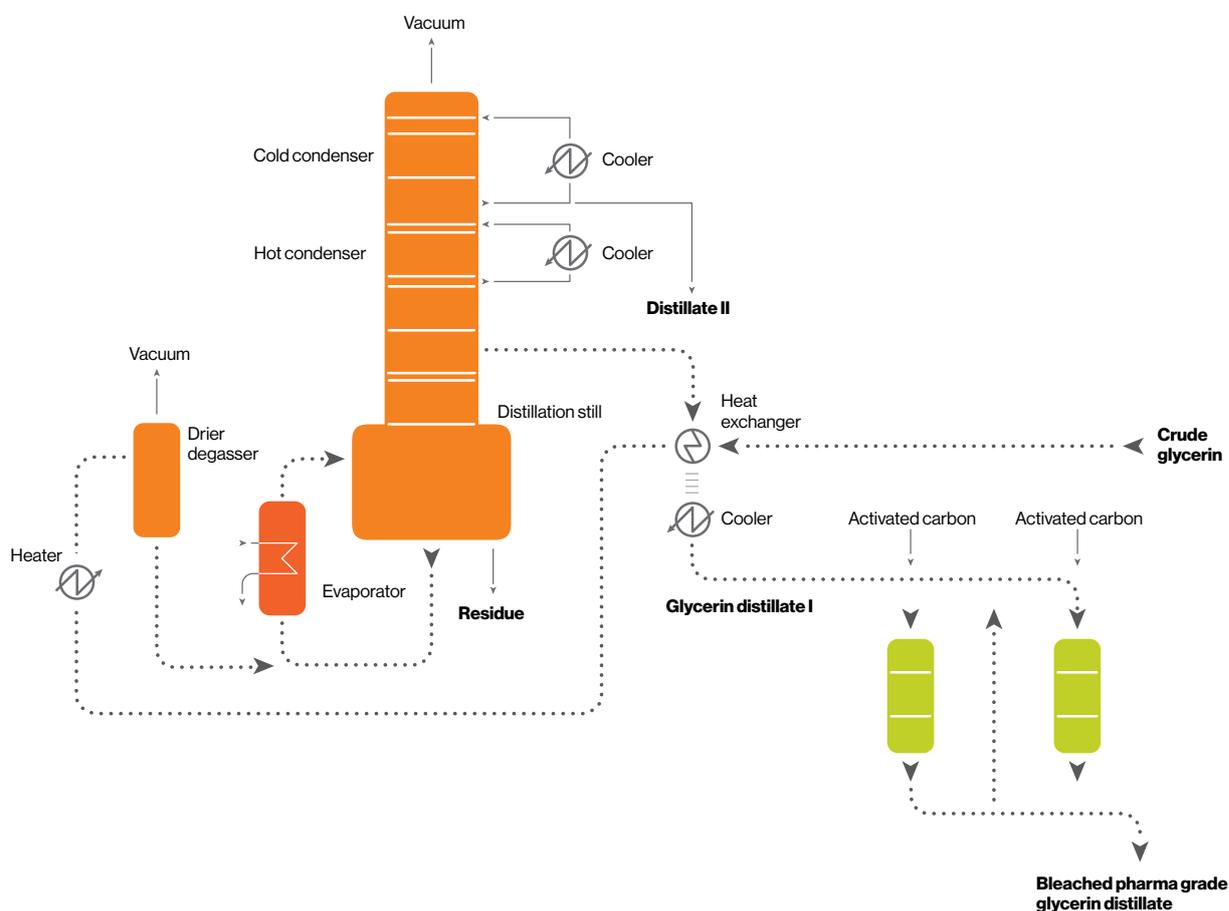
Here too, steam and chemicals consumption are optimized to lower operating cost and reduce environmental impact.

Glycerin distillation and bleaching

Our technologies deliver superior pharma grade glycerine distillate. This is achieved as glycerin water is distilled and bleached over fixed bed activated carbon reactors. Natural or forced circulation evaporation systems, salt removal through decanter or wiped-film evaporator and design advances in the distillation column allow for purity greater than 99.8% with low energy consumption cost and high yield. The glycerine distillate conforms to or exceeds international pharmaceutical quality control standards.

Thermal efficiency is a feature of all our processes

Glycerin distillation and bleaching



Process steps and technologies

Fatty alcohol

We have developed two advanced processes for converting oleochemical intermediates into fatty alcohols widely used in detergents and non-ionic surfactants.

Wax ester route

Distilled fatty acids are esterified with a recycle stream of fatty alcohols without catalyst to wax esters and are then hydrogenated in one or two bed fixed reactors over a copper catalyst to fatty alcohols. Our innovation, the LP3 Process, allows for a reduction of operating pressure from 250 barg to a mere 70 barg for reduced investment and operating costs.

Methyl ester route

One or two fixed bed reactors are also used in this process over a copper catalyst at either 250 barg or using the LP3-Process. The methanol derived from methylester during hydrogenation can be recycled upstream into the transesterification generating feed methylesters.

Given the diversity of the market, we offer two technologies and can advise you on how best to integrate one or the other into your production seamlessly.

Breakthrough innovation readily available

Our newly developed LP3 is highly innovative process for the production of fatty oil

- **Liquid Phase**

LP3 keeps the feedstream in liquid state, facilitating trickle-bed conversion of feedstock in fixed-bed reactors. This allows for production of long chain fatty alcohols and reduces creation of impurities.

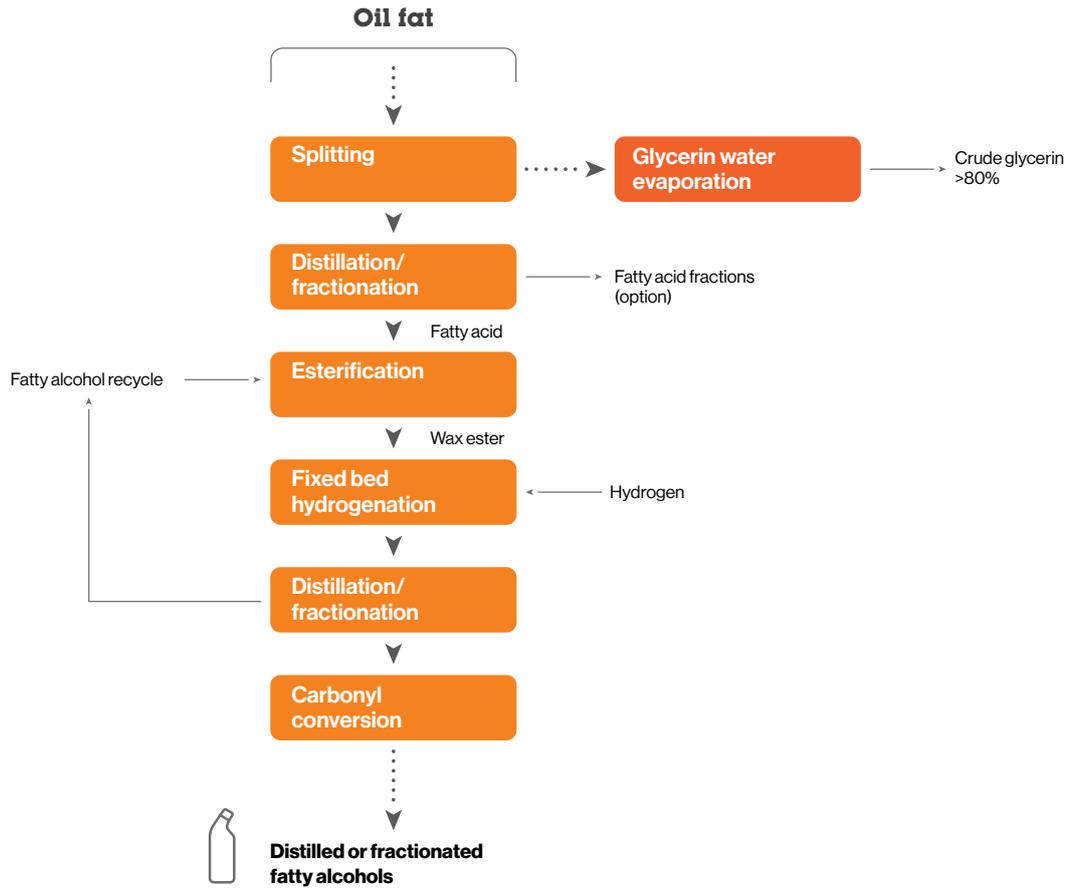
- **Low Pressure**

Performed at comparatively low pressure, LP3 reduces energy use and equipment design pressures keeping total cost of ownership down.

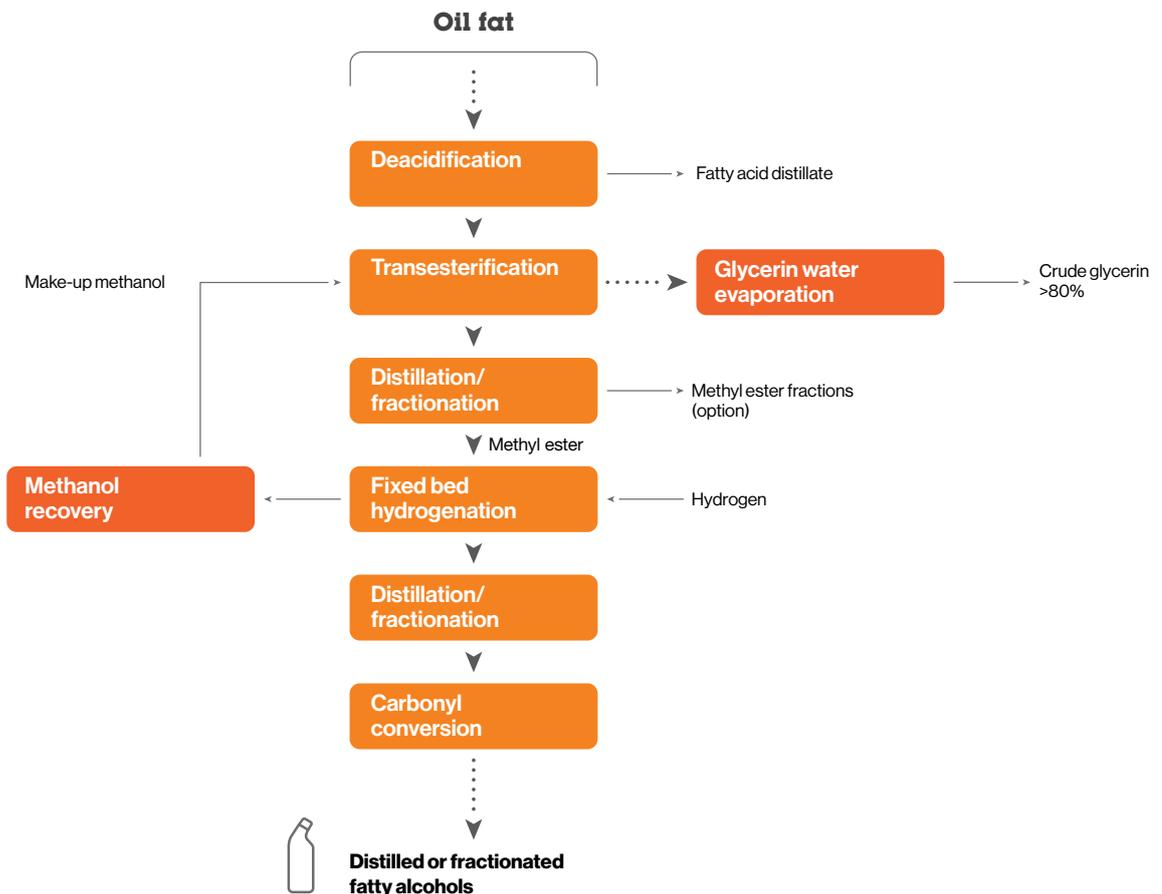
- **Long Performance**

A lead/lag double reactor system allows seamless catalyst changeovers allowing reactors to run continuously for extended periods. This facilitates improved and more efficient catalyst use lowering costs and creating more profitable lifecycles.

Wax ester route



Methyl ester route



Customer commitment

Evolving with you

Continually stepping up our game

Air Liquide Engineering & Construction provides you with a range of plant options designed to maximize efficiency, improve the quality of your product and help to minimize your operating costs.

All of the components of our plants are manufactured to the highest standards and are backed by the reliability of a firm with over a century of experience.

Our approach

- Continuous communication
- Enhanced offer
- Effective solutions

Our skills

- Up-to-date plants and units
- Quality control
- On-time delivery

Client satisfaction

Our commitment

- Production maximization
- Superior ROI
- Reliability
- Safety

You help make us smarter

Since acquiring Lurgi technologies in 2007, Air Liquide Engineering & Construction continues to build on the knowledge we gain from our customers.

We rely on the operational experience of our customers to guide us in our innovation. They help us find solutions through the research and development that we and the entire Air Liquide Group undertake.

The great strides we made in our oleochemical offering, notably our LP3-Process arose from a need for greater energy efficiency. Our expertise in design and engineering ensure that our offering meets or exceeds the most stringent environmental standards.



Execution capabilities

Thanks to our network of engineering and manufacturing centers, Air Liquide Engineering & Construction is able to offer effective project management and execution close to customers and vendors.

One of our key engineering centres specializing in Oleochemicals is headquartered in Kuala Lumpur, Malaysia. JJ-Lurgi Engineering is a joint venture between Air Liquide Engineering & Construction and Jebsen & Jessen. JJ-Lurgi boasts nearly 25 years of successful engineering and efficient implementation of edible oil, oleochemicals and biodiesel plants, especially in the Asia Pacific region.

More than 70 oleochemical plants were built over the last 15 years; all of which are still in operation. Among this impressive list, 16 are complete fatty acid plants with feed capacities of up to 600 tons per day. Our teams were also involved in plant expansion and upgrades as our customers grew. In addition to 12 fatty alcohol plants, 28 are glycerine recovery and pharma grade glycerin distillation plants, including the world's largest distillation unit of 600 tpd. We have also designed, engineered and delivered more than 75 Biodiesel plants worldwide and invite you to look at our offering in that area, as well.



Air Liquide Engineering & Construction, through its portfolio of technologies, leads the world in the most efficient and complete processing systems and individual process components. Our plants consistently deliver the highest quality fatty acids, fatty alcohols, glycerin and methyl esters.





● Engineering Centers and front-end offices ● Manufacturing centers



Contact us

leo@airliquide.com

www.engineering-airliquide.com

