

develop  
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biodiesel  
& retrofit

## RETROFIT REFERENCES

### Emden (Germany)

**Client:** Chevron

**Capacity:** 205,000t/y | 61mio. USgal/y

**Feedstock:** Vegetable oil, used cooking oil, POME

**Description:** Feedstock pretreatment, improvement of by-product quality from existing plants and generation of low-cost feedstock for existing plants

**BDI-Involvement:** Engineering, equipment, installation, commissioning

### Komárom (Hungary)

**Client:** Envien

**Capacity:** 33,000 t/y | 10mio. USgal/y

**Feedstock:** Crude glycerin, soapy water from by-product line

**Description:** Improvement of by-product quality, through new production line

**BDI-Involvement:** Engineering, equipment, installation, commissioning

### Volos (Greece)

**Client:** Elin Biofuels

**Capacity:** 33,000 t/y | 10mio. USgal/y

**Feedstock:** Vegetable oil, used cooking oil, animal fat

**Description:** Use of waste feedstock, improvement of biodiesel quality by installation of advanced esterification and eco distillation

**BDI-Involvement:** Engineering, equipment, installation, commissioning

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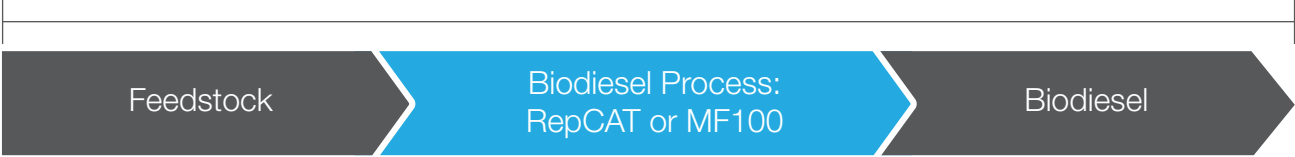
**We love developing technologies.  
Plant engineering is our true  
passion.**

Using our proprietary multi-feedstock technologies, we design and construct tailor-made biodiesel plants, enabling our customers to process a wide variety of feedstocks – from fresh vegetable oils to the lowest-grade waste fats. This grants them autonomy from the fluctuations of the feedstock market.

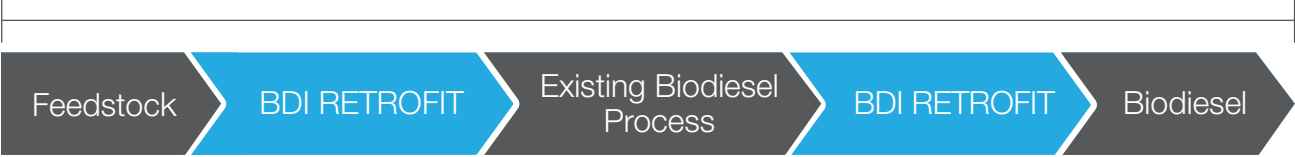
**Recycling and upcycling are in  
our DNA.**

From used cooking oil to split fatty acids from soap stock – we valorize waste streams, thus aiding our customers in the reduction of their carbon footprint. Additionally, our retrofit program brings biodiesel plants – regardless of whether they were constructed using BDI technologies or by our industry competitors – to the cutting edge of the latest advancements.

**Biodiesel Plant**



**Retrofit Concept**



01

**Status  
evaluation**

- Determination of customer requirements
- Technological evaluation of the existing plant
- Preparation of preliminary concepts
- Rough cost estimate
- Summary of results and recommendations

03

**Offer  
preparation**

- Definition of scope of supply
- Specification of the entire scope of supply
- Project and implementation plan
- Binding offer with detailed costing structure

05

**Engineering  
and delivery**

- Basic and detailed engineering
- Supplier management
- Efficient project management for short project times

07

**Hot & cold  
commissioning**

- Functional plant-testing and start-up
- Optimization of plant parameters and stabilization of processes
- Sustainable realization of guaranteed values
- Training of plant personnel
- Plant handover

02

**Pre-  
engineering**

- Preparation of concepts and planning of layout
- Feasibility study
- Integration into existing process
- Interface management
- Preparation of mass and energy balances

04

**Authorization  
procedure**

- Preparation of data required by the authorities
- Assistance throughout the authorization process
- Preparation of risk analyses (e.g. HAZOP studies)

06

**Equipment  
implementation**

- Technical on-site support during mechanical installation
- Shortest possible downtimes achieved by efficient process planning during installation phase

08

**Customer  
service**

- Regular maintenance support
- Spare part supply and service
- 24-hour technical service hotline
- Further training and workshops



# REPCAT

The BDI RepCAT technology was designed to offer producers maximum flexibility with feedstock selection, particularly concerning free fatty acid content. The use of a heterogeneous catalyst is the key to making the technology as efficient as possible. The catalyst is synthesized on-site and reused within the process. As the reuse of the catalyst is one of the main characteristics of the BDI RepCAT process, it is reflected in the process name.

## PRODUCT DESCRIPTION

### Application:

This highly innovative process allows all waste-based oil and fats (used cooking oil, animal fat, sewer or trap greases) containing up to 99% free fatty acids (FFA) to be processed and converted into biodiesel, adhering to the EN 14214 quality standard and other relevant biodiesel standards. In addition, the plant produces completely salt-free glycerin with a minimum of 95% content.

### Functional product characteristics:

In a continuous reactor, the esterification and transesterification with methanol take place simultaneously. The system operates at high pressure and high temperatures. Depending on the FFA content, a one- or two-step process can be established.

Once the biodiesel and glycerin have been distilled in a multi-stage high-end distillation unit, a phase separation follows. The bottom product from the distillation containing the catalyst is transferred back to the front end of the process. The excess methanol is purified and recycled back to the reactor stages.

### Add-ons:

- Fat pretreatment
- Feedstock and product tank farm
- Loading and unloading stations
- Utilities

### Installation mode:

- Stand-alone unit

## PRODUCT DATA

### Input specification:

- Free fatty acid content up to 99%
- Phosphor content up to 450ppm
- Sulfur content up to 100ppm
- Polyethylene type plastics content up to 50ppm
- Polymerized triglycerides content up to 10.0%

### Product quality:

- EN 14214
- ASTM D6751

### Unit capacities:

- 50,000t/y to 150,000t/y

## Biodiesel Plant

Feedstock

Biodiesel Process:  
RepCAT

Biodiesel



### BDI RepCAT plant, Ghent (Belgium)

**Client:** Cargill

**Capacity:** 115,000t/y | 35mio. USgal/y

**Feedstock:** High-FFA feedstock, waste oils and fats

**Technology:** RepCAT plant and pretreatment

**BDI-Involvement:** Engineering, equipment, installation, commissioning

### BDI RepCAT plant, Komárom (Hungary)

**Client:** Envien

**Capacity:** 50,000t/y | 15mio. USgal/y

**Feedstock:** High-FFA feedstock, waste oils and fats

**Technology:** RepCAT plant and pretreatment

**BDI-Involvement:** Engineering, equipment, installation, commissioning





# MF100

The BDI Multi-Feedstock process can turn a wide range of feedstock such as animal fats, used cooking oils, grease trap fats and vegetable oils into high-grade biodiesel that exceeds the highest quality standards, such as EN 14214.

PRODUCT  
DESCRIPTION

» Application:

All fat and oils with an FFA content of up to 20% can be processed into biodiesel with this technology. It offers unique flexibility in terms of feedstock input, high yield rates, high quality of the resulting biodiesel, low operational and maintenance costs as well as a high level of economic feasibility.

Functional product characteristics:

The plant consists of two main parts, the biodiesel production line and the by-product line. In the main production line, the process steps of esterification and transesterification take place. These process steps are fundamentally designed to be adaptable to changes in feedstock. The next process steps include FME washing/purification and a gentle distillation under vacuum conditions to ensure high quality.

In the by-product line, the glycerin phase is split into three further phases. Firstly, the recovered fatty acids are recycled and converted into biodiesel. The remaining glycerin is then demethanolized and dewatered, whereby the recovered methanol and water are recycled. Then the potassium sulfate is purified depending on customer requirements. Additionally, it is possible upon request to process the glycerin to meet customer quality specifications. Furthermore, the glycerin can also be processed in a way to fulfill customer quality requirements.

Add-ons:

- Fat pretreatment
- High-FFA esterification
- Advanced esterification
- Glycerin distillation
- Feedstock and product tank farm
- Loading and unloading stations
- Utilities

Installation mode:

- Stand-alone unit

PRODUCT  
DATA

» Input specification:

- Free fatty acid content up to 20%
- Water content up to 0.5% mass
- Phosphor content up to 200ppm
- Sulfur content up to 100ppm
- Polyethylene type plastics content up to 50ppm
- Polymerized triglycerides content up to 10.0%

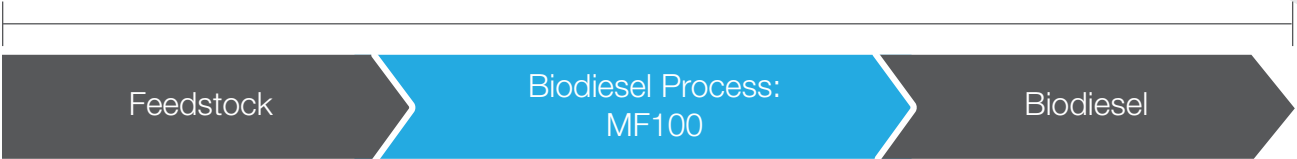
Product quality:

- EN 14214
- ASTM D6751

Unit capacities:

- 25,000t/y to 150,000t/y

## Biodiesel Plant



Multi-Feedstock+ plant, Amsterdam (Netherlands)

Client: Argent Energy

Capacity: 100,000t/y | 30mio. USgal/y

Feedstock: Used cooking oil, animal fat (Cat.1), fatty acid distillate

Technology: Multi-Feedstock+ plant and pretreatment

BDI-Involvement: Engineering, equipment, installation, commissioning

Multi-Feedstock+ plant Stanlow (United Kingdom)

Client: Argent Energy

Capacity: 75,000t/y | 22.5mio. USgal/y

Feedstock: High-FFA feedstock, animal fat (Cat.1), trap grease

Technology: Multi-Feedstock+ plant and pretreatment

BDI-Involvement: Engineering, equipment, installation, commissioning





# FAT PRETREATMENT PLANT

## Retrofit Concept



This unit is specialized to improve the quality of animal fats, used cooking oils, trap greases and other impure oils to ensure smooth operation and further use in biodiesel production plants.

### PRODUCT DESCRIPTION

#### Application:

In comparison to vegetable feedstock oils, low-quality feedstock like waste fats and oils need to be pre-treated to elevate their quality prior to further processing or selling.

#### Functional product characteristics:

To increase the oil quality, a centrifuge removes impurities like water and solids which are unfavorable for further processing in biodiesel production. Impurities that are water-soluble (e.g., polar substances, short chain acids) are washed out with the water. By adding special washing agents, an additional reduction in metals, phosphor and sulfur content is achieved. Finally, a column removes residual water.

#### Add-ons:

- Special washing agent dosing line and feed homogenization
- Wastewater handling
- Utilities

#### Installation mode:

- Stand-alone unit
- Container installed
- Mounted on a skid
- Integration into existing installation

### PRODUCT DATA

#### Input specification:

- Water content up to 10.0%
- Solids content up to 5%
- Phosphor content up to 450 ppm
- Sulfur content up to 200 ppm
- Metals content group 1 up to 1,000 ppm
- Metals content group 2 up to 500 ppm

#### Reduction potential:

- Water reduction up to 99%
- Solids reduction up to 99%
- Phosphor reduction up to 80%
- Sulfur reduction up to 50%
- Metals reduction group 1 up to 98%
- Metals reduction group 2 up to 90%

### TECHNICAL DATA

#### Unit capacities:

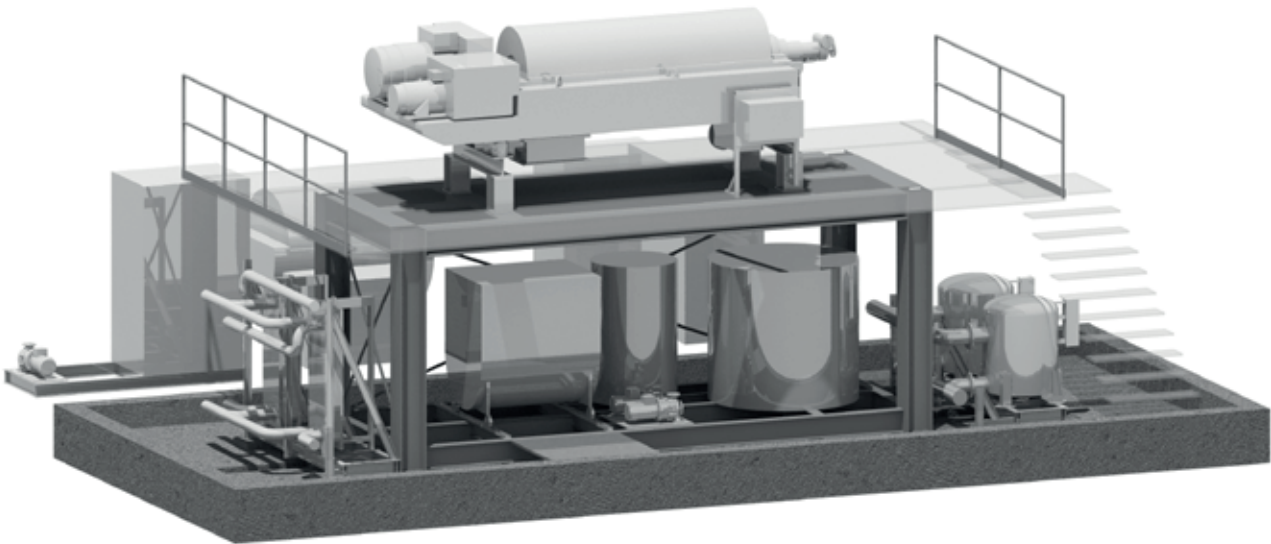
- 25,000t/y to 200,000t/y

#### Space requirement/Loads:

- 60 to 120m<sup>2</sup>
- max. 50kN/m<sup>2</sup> or max. 250kN point load

#### Electrical power demand:

- 60kW to 200kW





# ADVANCED ESTERIFICATION

## Retrofit Concept



This unit is designed for the conversion of free fatty acid (FFA) of animal fats, used cooking oils and other oils with high-FFA content to fatty acid methyl ester (FAME).

### PRODUCT DESCRIPTION



#### Application:

The process is designed for the conversion of feedstock, with an FFA content of up to 70%, into FAME, in a continuous esterification unit by means of an acidic catalyst and methanol. The goal is to reach an FFA content that is suitable for further processing at an existing biodiesel plant.

#### Functional product characteristics:

With a mixer, the feedstock is combined with acid and methanol and then heated up to reaction temperature. The esterification reaction takes place in a continuous reactor under specific conditions. After the reaction, volatile substances like methanol and water are separated in a column. The excess methanol is recovered and fully recycled in the process. Following this, a settler separates the oil from water and glycerin.

#### Add-ons:

- Fat pretreatment
- Oil neutralization
- Side stream handling of methanol, watery phase and glycerin
- Utilities

#### Unit design:

- One-stage process
- Two-stage process (depending on feedstock FFA content)

#### Installation mode:

- Container installed
- Skid mounted
- Integration into existing installation



### PRODUCT DATA



#### Input specification:

- Free fatty acid content up to 70%
- Water content up to 0.5%

#### Reduction potential:

- FFA conversion up to 95%

### TECHNICAL DATA



#### Unit capacities:

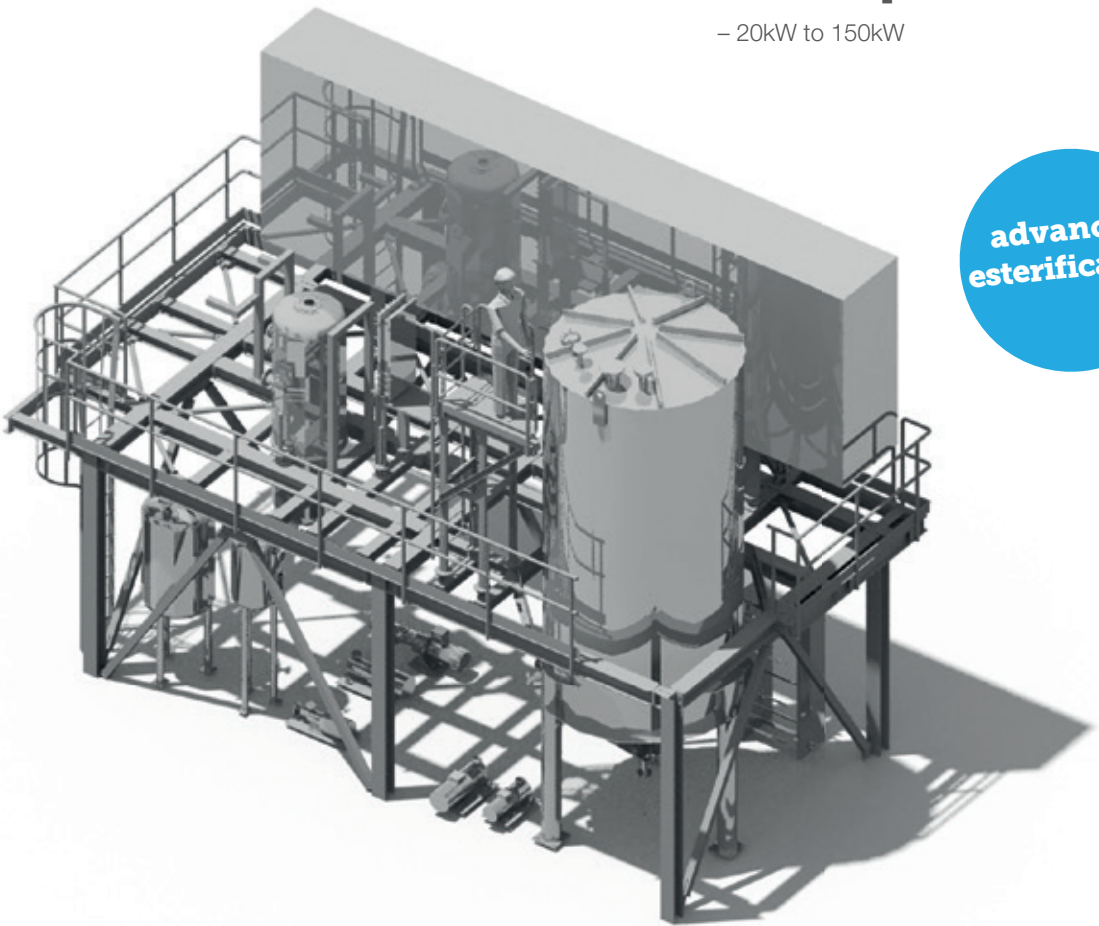
- 10,000t/y to 100,000t/y

#### Space requirement/Loads:

- 50 to 400m<sup>2</sup>
- max. 50kN/m<sup>2</sup> or max. 500kN point load

#### Electrical power demand:

- 20kW to 150kW





# HIGH-FFA ESTERIFICATION

## Retrofit Concept



This process is designed to convert free fatty acid (FFA) of high-FFA feedstock like distilled fatty acids, trap grease and other waste oils to fatty acid methyl ester (FAME).

### PRODUCT DESCRIPTION

#### Application:

For esterifying feedstock with an FFA content of up to 99% in a continuous esterification unit, by using only methanol and no additional catalyst.

#### Functional product characteristics:

The feedstock is mixed with methanol and heated up to reaction temperature. After increasing the pressure, the mixture is then fed to a continuous reactor where the esterification reaction of the FFA takes place, creating methyl ester. After the reaction, a column separates the volatile substances like methanol and water; methanol is recycled in the process. Finally, a settling vessel separates glycerin and solids from the product FAME.

#### Add-ons:

- Fat pretreatment
- Biodiesel high-end or eco distillation
- Phase separation water/oil
- Utilities

#### Installation mode:

- Mounted on a skid
- Integration into existing installation

#### Unit design:

- One-stage process
- Two-stage process (depending on FFA content)

### PRODUCT DATA

#### Input specification:

- Free fatty acid content up to 99%
- Water content up to 1%

#### Reduction potential:

- FFA conversion up to 95%

### TECHNICAL DATA

#### Unit capacities:

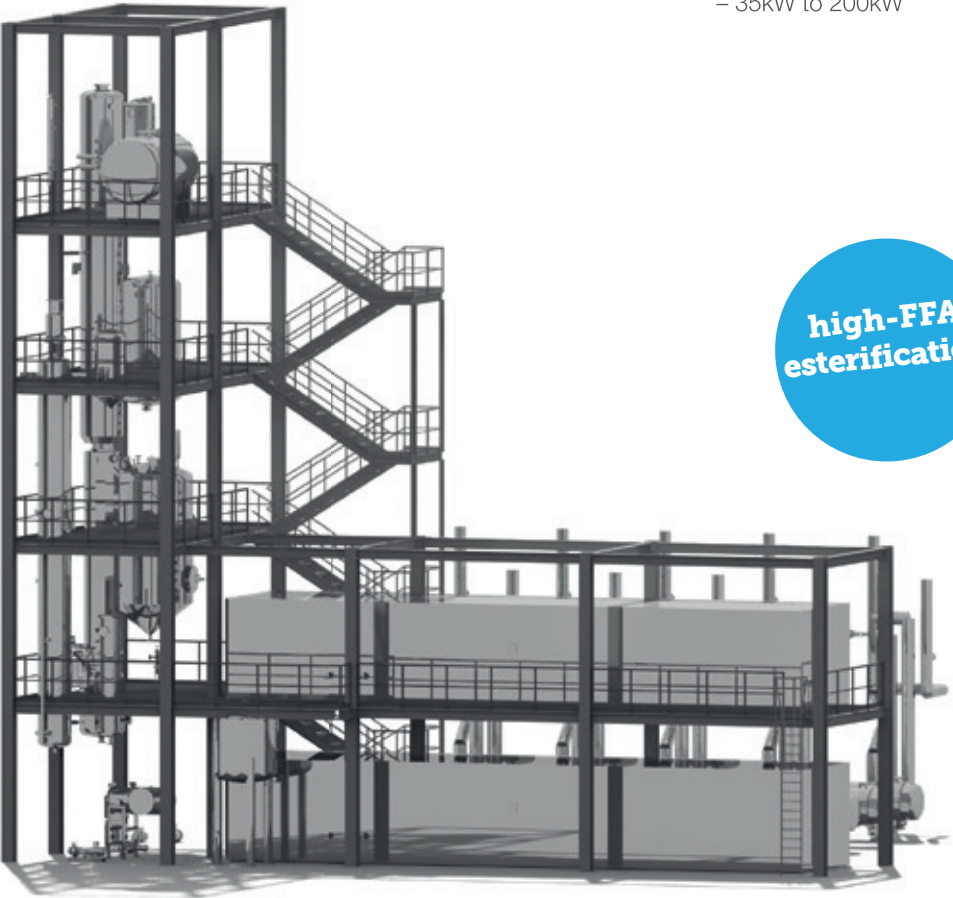
- 5,000t/y to 100,000t/y

#### Space requirement/Loads:

- 250 to 750m<sup>2</sup>
- max. 50kN/m<sup>2</sup> or max. 500kN point load

#### Electrical power demand:

- 35kW to 200kW



high-FFA  
esterification



# ECO DISTILLATION

## Retrofit Concept



The distillation unit is intended for quality improvement of biodiesel, based on vegetable oil blended with used cooking oils, animal fats or other waste oils, with special attention to economical energy use.

### PRODUCT DESCRIPTION

#### » Application:

Due to the use of a blend of vegetable oils, used cooking oils and other waste oils as feedstock, the produced biodiesel contains impurities, which lower the biodiesel's final quality. The so-called eco distillation increases the final product quality by reducing contaminations like steryl glycosides, while at the same time enhancing the methyl ester content, lowering other contaminants and decreasing monoglycerides. Thus, the finished biodiesel corresponds with the European standard EN14214.

#### Functional product characteristics:

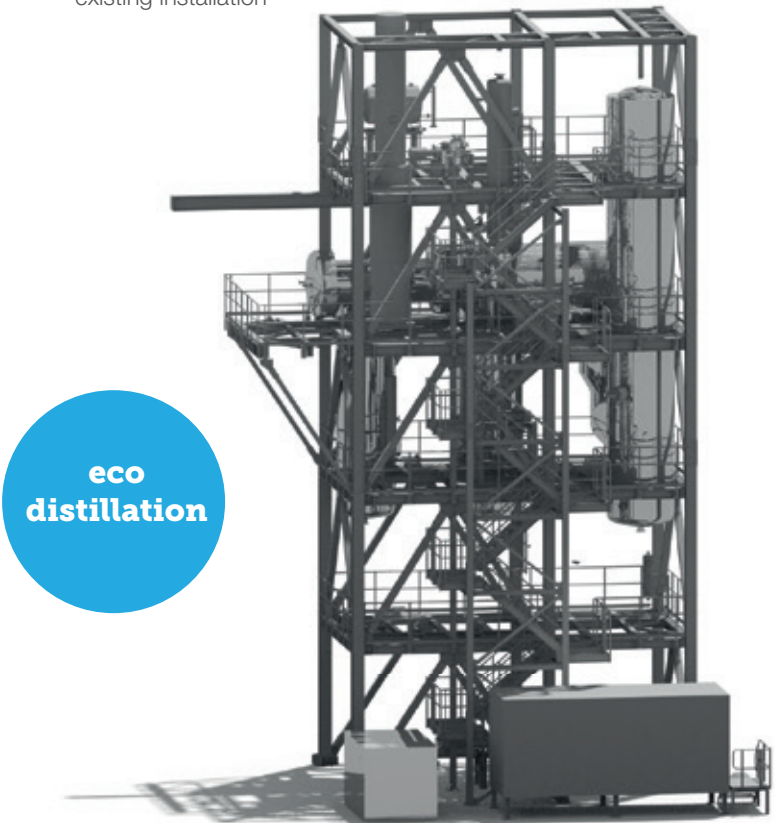
The eco distillation unit is a multi-stage distillation system. The degasser unit removes all less volatile components from the biodiesel before it gradually evaporates under vacuum conditions in the distillation unit. Through an integrated heat recovering system, the operation costs for the distillation system are minimized. The residual methyl ester content in the bottom product of the distillation unit is recovered in a specially designed evaporation unit to ensure highest possible yield. The installed vacuum system, in either a wet or dry design type, is specifically designed for methyl ester distillation.

#### Add-ons:

- Sulphur reduction unit
- Additive dosing
- Utilities

#### Installation mode:

- Stand-alone unit
- Mounted on a skid
- Integration into existing installation



### PRODUCT DATA

#### » Input specification:

- Methyl ester content higher than 88%
- Sulphur content up to 25ppm
- Water content up to 2%
- Methanol content up to 1%
- Total contamination up to 200ppm
- Monoglyceride content up to 1%
- Metals content up to 100ppm
- Phosphor content up to 10ppm
- Polymers content up to 10%

#### Reduction potential:

- Sulphur reduction up to 80%
- Water reduction up to 99%
- Methanol reduction up to 99%
- Total contamination reduction up to 98%
- Monoglyceride reduction up to 70%
- Metals reduction up to 99%
- Phosphor reduction up to 90%

### TECHNICAL DATA

#### » Unit capacities:

- 25,000t/y to 150,000t/y

#### Space requirement/Loads:

- 60 to 200m<sup>2</sup>
- max. 75kN/m<sup>2</sup> or max. 1,000kN point load

#### Electrical power demand:

- 25,000t/y to 100,000t/y
- 50kW to 130kW





# HIGH-END DISTILLATION

## Retrofit Concept



This unit is designed for quality improvement and reduction of impurities of Biodiesel produced from animal fats, used cooking oils, trap grease and other waste oils.

### PRODUCT DESCRIPTION

#### Application:

To use animal fat, used cooking oils and other waste oils as feedstock for biodiesel production, high-end distillation is necessary to increase the final product quality to surpass strictest quality standards (EN 14214).

#### Functional product characteristics:

The high-end distillation unit is a multi-stage distillation system. First, a degasser unit removes all volatile components from the biodiesel. In a thin film evaporator and the main distillation unit, the biodiesel evaporates gradually under vacuum conditions and separates from the impurities and high boiling components. The overall design of the high-end distillation is optimized to allow a maximum reduction of sulphur and mono-glycerides. By decreasing the loss of methyl ester in the bottom product, a specially designed evaporation unit recovers the biodiesel and ensures the highest possible yield. The vacuum system of the unit, in either a wet or dry design type, is especially designed for methyl ester distillation.

high-end  
distillation



#### Add-ons:

- Additive dosing
- Sulphur reduction unit
- Heat recovery system for low-pressure steam production
- Utilities

#### Installation mode:

- Stand-alone unit
- Integration into existing installation

### PRODUCT DATA

#### Input specification:

- Methyl ester content higher than 88%
- Sulphur content up to 140ppm
- Water content up to 2%
- Methanol content up to 1%
- Total contamination up to 200ppm
- Monoglyceride content up to 1%
- Metals content up to 100ppm
- Phosphor content up to 10ppm
- Polymers content up to 10%
- Unsaponifiable content up to 2%

#### Reduction potential:

- Sulphur reduction up to 95%
- Water reduction up to 99%
- Methanol reduction up to 99%
- Total contamination reduction up to 98%
- Monoglyceride reduction up to 95%
- Metals reduction up to 99%
- Phosphor reduction up to 90%

### TECHNICAL DATA

#### Unit capacities:

- 25,000t/y to 150,000t/y

#### Space requirement/Loads:

- 80 to 220m<sup>2</sup>
- max. 100kN/m<sup>2</sup> or max. 1,500kN point load

#### Electrical power demand:

- 100kW to 250kW





# SERVICES

## » Plant evaluations

- Project development and R&D support
- Authority engineering
- Pre-engineering
- Basic engineering
- Detail engineering

## Installation

- Mechanical and electrical installation
- Technical support of construction

## Commissioning

- Cold commissioning
- Hot commissioning
- Personnel training (operator and laboratory staff)

## Customer service

- Spare parts supply and service
- Regular maintenance support
- Production support
- 24/7 technical hotline
- Personnel training (operator and laboratory staff)
- Optimization of production plant regarding yield, energy and operation material consumption

# BASICS OF DESIGN

## » Equipment

Vessels, machinery and all other equipment are purchased from well-known and proven manufacturers and suppliers, to fulfill the required mechanical, technical and safety standards.

## Automatization

For the purpose of maximizing safety and uniform quality of the final product, the process is program-controlled. The basic automation system is designed as a stand-alone unit with PCS including PLC from a leading manufacturer.

Integration into existing systems like Siemens, Allen Bradley etc. is possible.

## Standards\*

- Directive 2006/42/EC ("Machinery directive")
- Directive 2014/68/EC ("Pressure equipment directive")
- Directive 2014/29/EC ("Simple pressure vessels directive")
- Directives 2014/34/EC and 1999/92/EG ("ATEX directives")
- Directive 2014/35/EC ("Low voltage directive")
- Directive 2014/30/EC ("EMC directive")
- Directive 98/24/EC ("Protection of the health and safety of workers from the risks related to chemical agents at work")
- Directive 2010/75/EU ("Industrial emissions directive")
- Eurocode 0-9 for Steel construction
- EN 13480 ("Piping standard")
- IEC/EN 60204 ("Safety of machinery")
- IEC/EN 60079 ("Electrical apparatus for explosive gas atmosphere")
- IEC/EN 60079-14 ("Electrical installations in hazardous areas")
- DIN VDE 0100 ("Erection of power installations with rated voltages up to 1000V")

\* Design according to specific national standards possible





## **BDI-BioEnergy International GmbH**

Parkring 18, 8074 Raaba-Grambach, Austria  
T +43 316 4009 100  
[sales@bdi-bioenergy.com](mailto:sales@bdi-bioenergy.com)  
[www.bdi-bioenergy.com](http://www.bdi-bioenergy.com)

