1 Process description

General description of the BioDiesel process

Used cooking oil (UCO), animal fat (AF) and other feedstock like Methyl ester phase (from High FFA esterification unit) represent a very high-grade source of energy (fuel for diesel engines) when they are chemically changed (transesterified). In chemical respect, fats and oils consist mainly of free fatty acids and triglycerides (i.e. three long-chain fatty acids are attached to a trihydric alcohol, the glycerine). These components can be transformed into BioDiesel, a fuel directly useable in diesel engines, fulfilling the worldwide stricted quality standard (EN14214).

The process can be divided in two main parts:

1. Esterification and transesterification of the raw material to BioDiesel
2. By-product preparation

The process technology for the production of BioDiesel has been developed thoroughly and is focused on the environmental compatibility, i.e. by-products represent valuable products which increase the economic output.

Chemical reactions, process parameters

In this plant, the reactions to produce BioDiesel take place at atmospheric pressure and at moderate temperature levels which is only possible due to the presence of catalysts. Only [redacted] The distillation of BioDiesel and the dewatering of glycerine take place under vacuum conditions.
The following reactions and reaction conditions can be characterized:

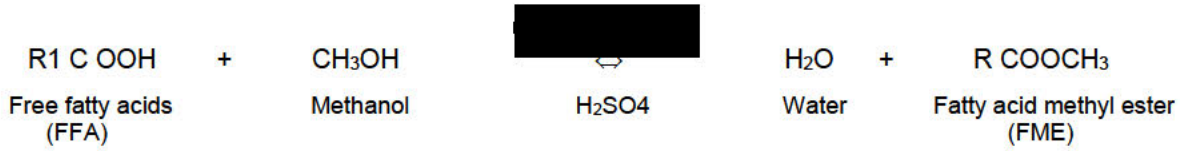
- **MEK preparation**

Potassium hydroxide (KOH) is used as catalyst for the transesterification. For a better dosing of the catalyst, [redacted]

[redacted]

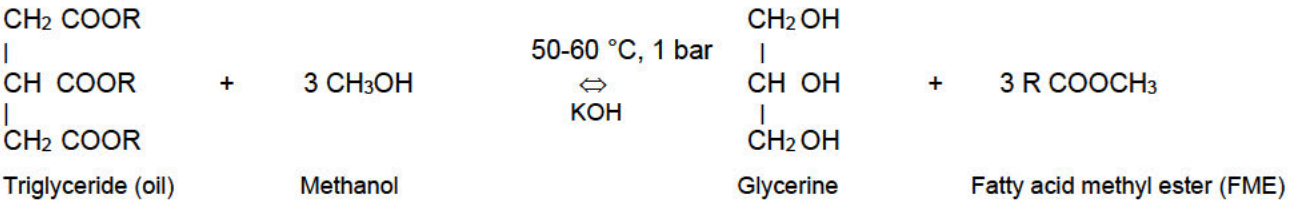
- **Esterification (with catalyst)**

The free fatty acids of the feedstock are esterified with methanol. Sulphuric acid is used as catalyst.



- **Transesterification (with catalyst)**

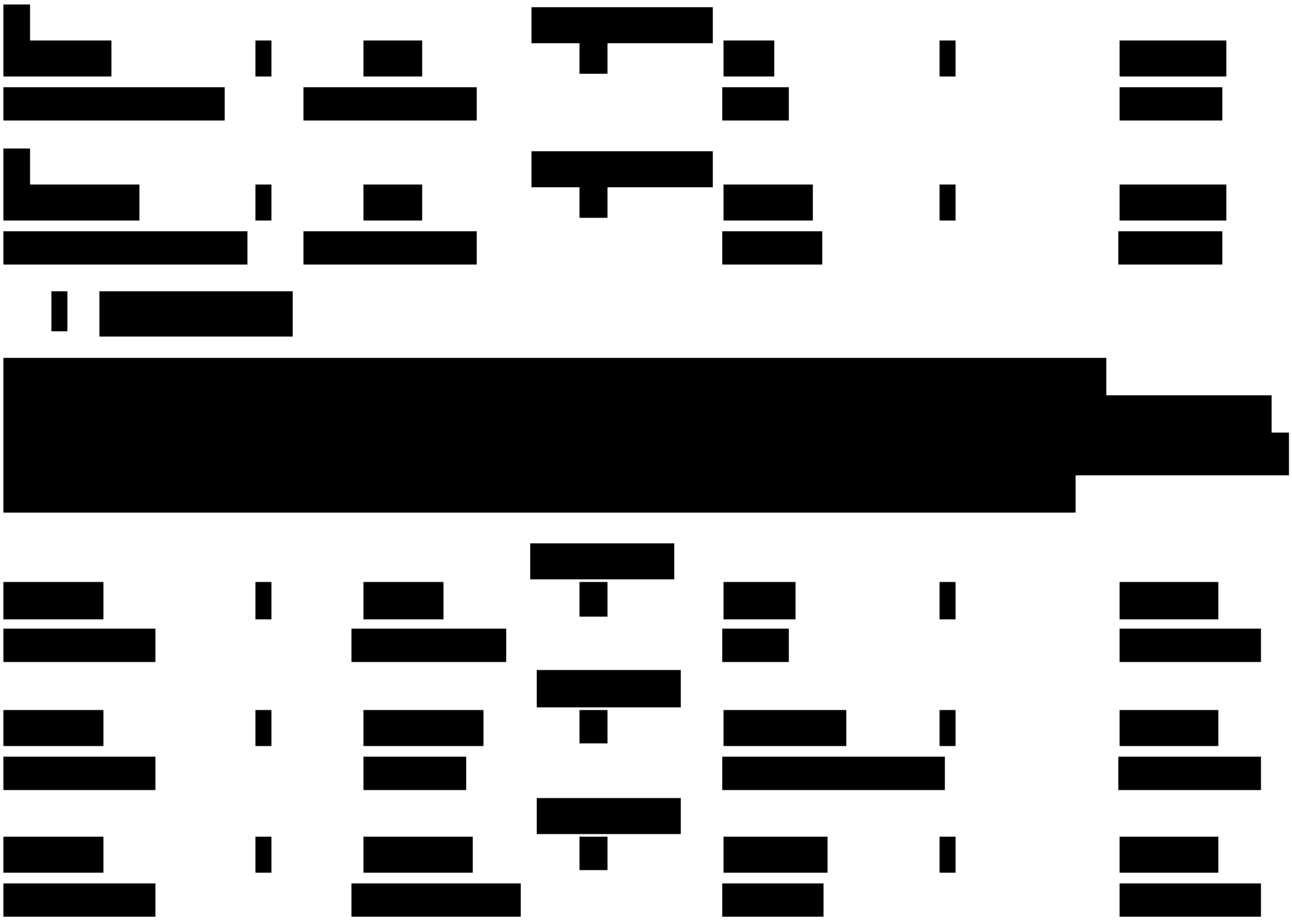
Oil (i.e. triglycerides, which is the main part of the feedstock) is transesterified to fatty acid methyl ester. Dissolved potassium hydroxide (KOH) is used as catalyst.



1 R=alkyl-radical

- **Side reactions**

Using potassium as a catalyst for the transesterification leads also to [redacted]



Detailed Process description

The BioDiesel plant of Argent Stanlow is designed for a production of [redacted]
In the esterification step, free fatty acid (FFA) which is part of the feedstock is esterified with methanol together with a recycle stream of the process under acidic conditions (sulphuric acid used as catalyst) and ambient pressure in a batch process (stirred and heated tank reactors). After reaction, an aqueous phase (water is a side product of the reaction) can be separated from the oil phase.
The oil phase (triglycerides and FME) is transferred to the transesterification tanks discontinuously. The transesterification requires a catalyst [redacted] The catalyst – [redacted] is prepared in a separate mixing station.
The transesterification process is realized as a [redacted] process to achieve a high FME yield. After dosing [redacted] the triglycerides are transformed to methyl ester and glycerine. Due to the density difference, the glycerine together with the catalyst and excess methanol separates from the FME and can be discharged to the by-product preparation line. The methyl ester phase of the first reaction step remains in the transesterification vessel [redacted]. The glycerine phase is again discharged to the by-product preparation line.

The methyl ester phase contains certain amounts of methanol, [redacted] and water. The impurities are removed from the methyl ester phase by [redacted] performed in [redacted] vessels. The washing water is partly recycled in the process.
A [redacted] is installed to perform the final washing step and removes an aqueous fraction from FME. After the separation step, [redacted] The volatile substances are removed [redacted] the high boiling substances are removed [redacted]. The [redacted] discharged (after adding oxidation stabilizer if required) to the BioDiesel quality tank resp. BioDiesel storage tank.

The volatile substances from [redacted] preparation line. The high boiling [redacted] discharged to a storage tank. It can be used [redacted]

The glycerine phase from transesterification and the aqueous phases from FME purification are processed continuously together with the aqueous phase [redacted] The potassium hydroxide and the [redacted] and fatty acid phase. The potassium sulphate is [redacted], the methyl ester together with the fatty acids forms the fatty acid phase, [redacted]

The [redacted] mixture can be separated by [redacted] (continuous operation). The fatty acid phase is [redacted] BioDiesel yield).
The generated potassium sulphate is washed [redacted].
It is then discharged as a side product (fertilizer) to big bags.

The acidic glycerine phase from the decanter is [redacted] in a neutralization tank. The hereby generated [redacted] is separated in a settler and recycled to the acidification tank.
The glycerine phase is [redacted] In the [redacted], CAP is dosed into the reboiler circuit for [redacted] glycerine.
Recovered [redacted] and [redacted] are recycled in the process. The crude glycerine [redacted] to a storage tank.

The BDI process for BioDiesel production consists of the following units:

Process Plant ***No.:***
Unit

[redacted]

Tank farm, loading/unloading
Unit *No.:*

[redacted]

Utilities:
Unit *No.:*

[redacted]

Unit No. 1: Esterification

Flow sheet: FL 4120 001

Basics:
Free fatty acids (FFA) which are part of the feedstock is esterified with methanol to methyl ester and water together with [redacted]. The reaction takes place at atmospheric pressure and at methanol boiling temperature [redacted] is used as catalyst.

Operation:
Oil [redacted] from the feedstock storage tanks through oil filters [redacted] to the [redacted] vessels [redacted]). According to the recipe, methanol, sulphuric acid and FFA from the by-product preparation process [redacted] are added. The content of the esterification vessel is heated up to reaction temperature by the installed heating coils [redacted] To keep the temperature constant, [redacted]. The evaporating components are [redacted] vessels.
After the reaction has finished, the [redacted]. After discharge of the settled water phase to the buffer vessel [redacted] temperature in heat exchanger [redacted] during transfer.

System data:
Mode of operation: [redacted]

[redacted]

Unit No 2: CAP Preparation

Flow sheet: [redacted]

[redacted] the neutralization of the by-product glycerine, a [redacted] used. The preparation of the catalyst is performed [redacted]

Operation:
Process water [redacted] after a required amount has been charged.
KOH is dosed from [redacted]

System data:
Mode of operation: [redacted]

Unit No. 2: Transesterification, FME-Purification

Flow sheet: [redacted]

Basics:
The transesterification is a [redacted]. After reaction, the formed methyl ester is purified with [redacted] steps. Glycerine and the heavy phases of the washing steps are [redacted] time.

Operation Transesterification:
The oil phase from the esterification vessels [redacted]).

According to a defined recipe [redacted]

Operation FME-Purification:
In the first purification step, [redacted] and can be discharged to the GLP collecting tank (B50100) by pump P21800.

[redacted]

System data:
Mode of operation: [redacted]

Unit No. 35: FME-Separation

Flow sheet: [redacted]

Basics:
To achieve a more effective separation of the water phase [redacted] This process step is designed either to [redacted]. Therefore, the separator can also be operated [redacted]

Operation:
The FME phase from the FME buffer vessel [redacted]

System data:
Mode of operation: [redacted]

Unit No 3 and 4: FME Distillation including [redacted]

Flow sheet: [redacted]

Basics:
After the last purification step, [redacted]

Operation:
The purified FME is [redacted] the main part of volatile components [redacted]. Additionally, the feed is stripped from remaining rests [redacted]. The top product is [redacted]

The FME leaving [redacted] After passing the quality check, the BioDiesel is transferred to the storage tanks. If quality standards are not met, the FME can be transferred back for reprocessing.

The [redacted] product of [redacted]

System data:
Mode of operation: [redacted] d

Unit No. 5: [redacted]

Flow sheet: [redacted]

Basics:
The formed glycerine phase mainly consists of glycerine [redacted] The amount of WPH depends on process conditions.
This reaction forms a [redacted] with a tricanter. The fatty acid phase is transferred [redacted]. The glycerine phase is fed into the glycerine [redacted]

Operation:
The glycerine phase from the transesterification and the aqueous phase from the purification steps are collected in [redacted]

[redacted]

[redacted]

[redacted] wash the solid fraction.

System data:
Mode of operation: [redacted]

Unit No. 6: GLP Neutralization [redacted]

Flow sheet: [redacted]

Basics:
The [redacted]
The fertilizer is purified [redacted] The purified fertilizer is then dried and discharged [redacted].

Operation- GLP Neutralization:
The pH-value of GLP in neutralization vessel [redacted]

Operation- [redacted]

[redacted]

System data:
Mode of operation: [redacted]

Unit No. 7: Glycerine [redacted]

Flow sheet: [redacted]

Basics:
The neutralized glycerine contains [redacted]

Operation:
The [redacted]

[redacted]

Operation mode A: [redacted]

The bottom product of dewatering [redacted].

Option B: [redacted]

System data:
Mode of operation: continuous, [redacted]

Unit No. 50: Ventilation system

Flow sheet: [redacted]

[redacted] ventilation [redacted] vessels during filling and draining. A slight overpressure in the system [redacted]) prevents the formation of explosive atmospheres in the system.
Excess gas is cleaned in a scrubber [redacted] before venting to the atmosphere.

Operation:
Most of the installed tanks and vessels in the plant are connected with each other by a ventilation system, which enables the exchange of ventilation gas during the filling and draining of the tanks and vessels. The ventilation system is fed [redacted]. Installed pressure control valves maintain the overpressure by dosing nitrogen if the system pressure falls, or by discharging gas in the case of rising pressure. The [redacted]

System data:
Mode of operation: [redacted]

Unit No. 56: Cooling system 1 (CWA1)

Flow sheet: FL 4120 005

The cooling system has [redacted]). The [redacted] operated in open mode, i.e. [redacted]

Unit No. 57: [redacted]

Flow sheet: [redacted]

[redacted] of about [redacted] is required for [redacted]

Unit No. 57: [redacted]

Flow sheet: [redacted]

The closed [redacted]

[redacted]

Flow sheet: FL [redacted]

The [redacted] process and side product treatment [redacted] maintain the products conveyable and to prevent freezing.

Unit No. 52: Compressed air (AIR1, AIR2)

Flow sheet: [redacted]

Instrument and working air are supplied by [redacted].

Unit No. 51: [redacted]

Flow sheet: [redacted]

The [redacted] fed to the [redacted] system and to [redacted] with [redacted] in case of emergency.

Unit No. 59: Water treatment plant (PWA1)

Flow sheet: [redacted]

The water treatment plant [redacted] for the process and the utilities.