

Generating clean and sustainable energy

Biodiesel Technologies & Plants



Desmet Ballestra : The right partner

Desmet Ballestra is an engineering group operating all over the world in oils & fats industry, crushing, refinery, oleochemicals, soaps, detergents and surfactants, chemicals and biofuels.

In this field Desmet Ballestra holds the leading position with over 6.000 plants supplied in more than 148 countries and for clients ranging from small producers to large multinational companies.

Desmet Ballestra started the development of the Methylester Technology in the early eighties through an intensive R&D program in the field of the methylester production, mainly finalized to the production of convenient raw materials for surfactant production as alternative to LAB and fatty alcohol.

As a logical consequence of the deep experience acquired in the esterification of surfactants intermediate products, Desmet Ballestra has developed a continuous transesterification process to produce Diesel-Fuel Substitutes (BIODIESEL) starting from a wide range of vegetable oils of various purity (crude/neutral/refined), including exhaust and "fried" oils from edible/food applications without the need for a full refining step-up stream.

This flexibility allows to use raw material cheaper than traditional processes based only on refined oils.

Desmet Ballestra is nowadays in a position to design and to supply multiple feedstock Biodiesel production plants sized in a wide range of production capacities (from 50.000 up to 500.000 T/y), coping with the most stringent international standard specifications.

Optional units such as (upstream) Oil Refining and (downstream) Glycerine Upgrading can be added, based on the most updated and cost effective proprietary know-how.

The first continuous process biodiesel plant of 30.000 T/y has been installed at the Estereco factory in Umbertide in 1993. Since then Desmet Ballestra has been involved in many new projects all over the world.

In the last years, DSB Oleo has been awarded over 85 biodiesel plants with a total capacity exceeding 12.000.000 T/y in all major markets including Western (Italy, France, UK, Netherlands, Austria, Spain, Portugal and Greece) and Eastern (Czech Republic, Poland, Estonia, Romania and Bulgaria), North America (USA) and South America (Brazil, Argentina, Colombia, Peru), India and South East Asia (Malaysia, Indonesia and Singapore) and with all feedstocks (crude and refined vegetable oils, tallow and fried oils, etc...).

Oils & Fats
Oleochemicals

desmet ballestra

Science behind Technology

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.... for your Biodiesel Project

Technology

The Desmet Ballestra Technology is based on a 3-step Continuous Transesterification Unit that allows to operate under mild operating conditions with constant quality and minimised specific consumption of raw materials and energy.

The plant design is targeted also to reduce to a negligible extent the process effluents with consequent virtual elimination of pollutant and process wastes.



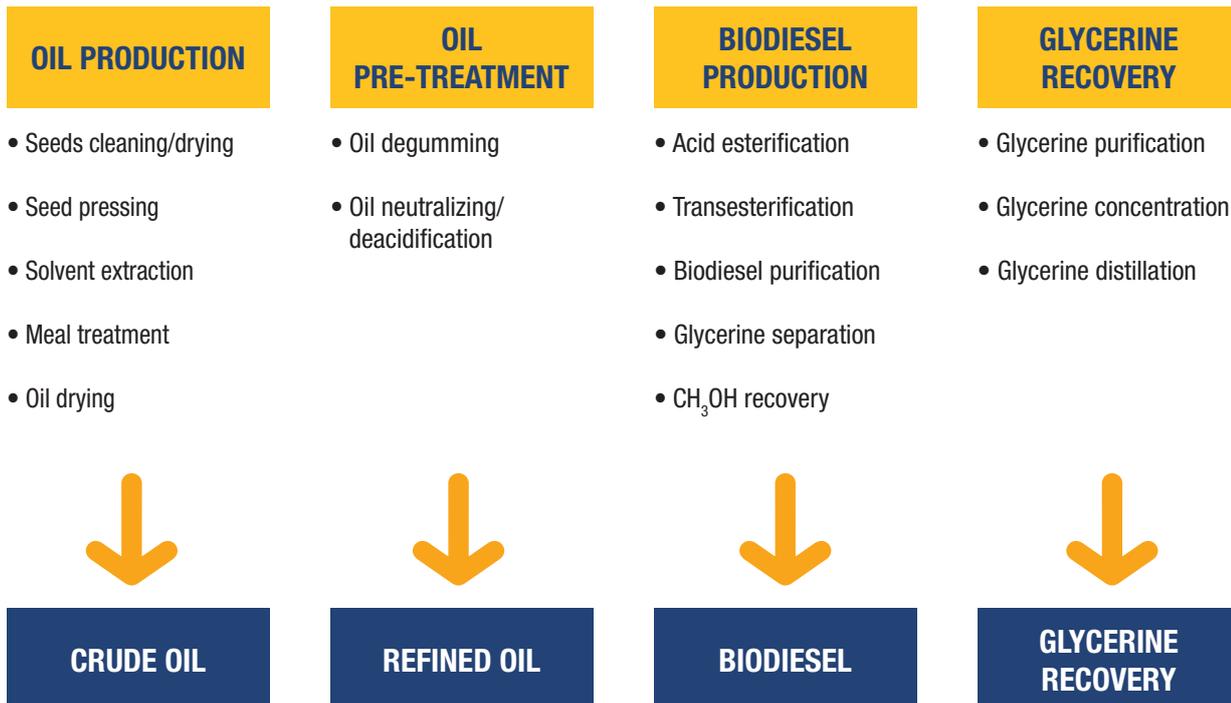
Overall scheme

The overall technology scheme offered by Ballestra for the production of Biodiesel and Glycerine starting from seeds and/or crude/neutral and/or refined vegetable oils and fats, mainly:

- rapeseed oil
 - sunflower oil
 - soybean oil
 - palm oil
 - recovered fried oil
 - animal fats
 - high acidity oils & fats
- is summarized here below.

Desmet Ballestra is in a position to adapt and design the process also based on other oils as well as using ethanol instead of methanol for the oil transesterification.

DESMET BALLESTRA BIODIESEL TECHNOLOGY



Operating Principles

How does it operate ?

The Biodiesel Production section, namely the Transesterification of Oils and the Biodiesel Purification step are characterised by unique features that with reference to the illustrated Process Block Diagram, are here below described :

The Transesterification reaction is accomplished in 3 steps with a methanol surplus with respect to the stoichiometric quantity, using an alkali methylate in anhydrous methanol solution as a catalyst.

Methanol and catalyst are dosed and recycled to the 3 reaction steps within prefixed rates.

Reaction temperatures are lower than 60°C and pressure is max. 0,5 bar(g). Overall residence time of the whole plant is 2 hours approx.

High yields

The yield of the continuous transesterification is 99,8% calculated as ratio of Neutral/Refined Oil fed to the transesterification versus the produced Biodiesel.

At the end of the transesterification process, two phases are accurately separated.

Purification of the upper methylester phase involves separation of unreacted methanol, washing with water solutions and final drying.

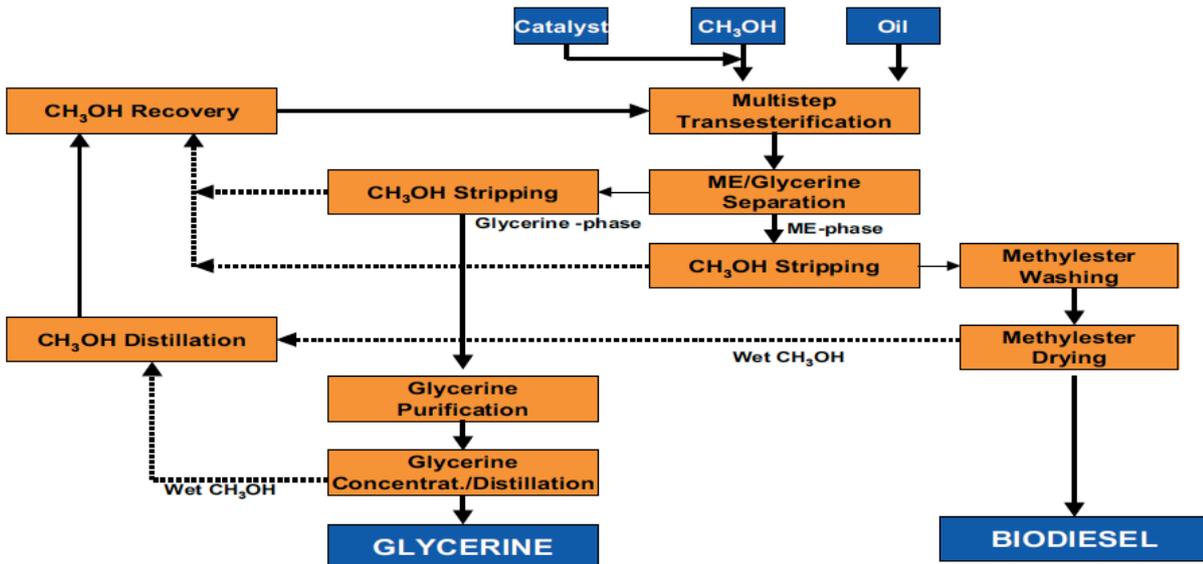
Purification of the upper methylester phase involves separation of unreacted methanol, washing with water solutions and final drying.

Purification of the lower glycerine phase involves: neutralisation, separation of unreacted methanol, dilution with wash liquid stream coming from methylester washing, splitting of soaps and final concentration up to 88-90%.

High Quality Glycerine

Partially refined glycerine can be delivered as such or sent to the upgrading-distillation section up to pharmaceutical grade meeting the most stringent pharmacopea specifications.

Biodiesel Production Diagram



Main advantages

These operations are performed by means of process sequence and characterised by :

- Mild operating conditions.
- Completely Computerised Process Control System.
- Simple mechanical design of the process equipment and negligible maintenance demand.
- Small overall dimensions of the units and equipment

In particular the Transesterification step entails these peculiarities:

- Continuous operation mode with multiple glycerine separation for each single step.
- Enhanced reactor Kinetics due to the “Solvation” effect of the excess Methanol vs. the quantity of oil to be reacted.
- Limited product hold-up.
- Operation flexibility deriving from the possibility to dose the reactants to the 3 steps in variable and specifically pre-set quantities.
- Possibility to process oils of widely variable quantity and origin.
- Easy and accurate control of the process key-parameters (temperatures, pressures and flow rates).

When accounting for the kinetic aspects of the transesterification reaction, a continuous process shows peculiar advantages with respect to the traditional batch process, as herebelow detailed:

The initial step of the reaction consists in the solvation of the oil molecules by the excess reactant (methanol); this step is slow due to the scarce affinity between the two reactants and is accelerated by the presence of methylester that, being a mutual solvent, acts as a “phase transfer agent”.

In a batch system, where no methylester is initially present in the reaction mixture, the transesterification reaction requires, therefore, a dwell time before appreciable amount of methylester are produced.

Conversely, in a continuous process, the two reactants are fed to a reaction mixture containing the steady state methylester amount, and the overall kinetics is enhanced by the resulting fast contact between the two reactants.

An almost tenfold viscosity reduction is observed when oil is converted to methylester; the steady state viscosity of a continuous reactor is, therefore, consistently lower than the initial reaction mixture viscosity of a batch system, which allows an overall higher mixing intensity at comparable mixing energy inputs.

The above aspects add up to the general advantages of a continuous process (reduced equipment sizes at given plant capacity thanks to the elimination of loading/unloading dead times, reduced energy and utilities consumption, easier automation of process control, higher product quality uniformity), making it almost a must, once the economics of commercial scale plant are accounted for.

As for the plant safety management, the reduced reaction volumes imply that much lower methanol amounts are present at any time in the process sections, which greatly reduces the fire hazard.

A further feature, unique to the Desmet Ballestra continuous process, resides in the dedicated reactors design, which allows the continuous separation of the glycerine phase from the reaction mixture within each of the three reaction steps.

This allows shifting the reaction equilibrium toward the products, so maximising the yield, and to minimise the catalyst consumption.

As for the downstream Methylester purification unit, the Desmet Ballestra technology foresees the following steps:

- Evaporation (BEFORE the methylester washing section) of most (85% approx.) of the unreacted methanol in dry form, suitable for direct recycle to the transesterification section.
- Washing of the residual glycerine and soaps by means of water; the water phase leaving from this section is recycled to the glycerine purification section.
- Final Methylester drying; the wet methanol stream separated in this section is sent to a rectification unit, in order to recover it to the transesterification section.

Latest improvements

Market is moving to more stringent specifications and, because of the strong increase of the vegetable oil prices, to the usage of less costly feedstocks, which usually results in processing off-spec and low quality oils with higher contamination levels.

So it will be more likely that biodiesel producers will become more and more confronted with varying feedstock qualities causing problems in achieving all biodiesel specifications as set today.

On top of that, the biodiesel users (read the petroleum companies) who basically buy the biodiesel, become more and more selective and hence start to impose more stringent specifications.

We already are confronted today with demands to reduce the TC from 24 to 10 ppm, and MGDG- TG from 0.8%-0.2%-0.2% to 0.4%-0.1%-0.1%.

In many markets (like USA and Latin America) a new test (Cold Soak Test) is required.

In order to prepare ourself and especially our clients to deal with the more stringent biodiesel qualities, DB has developed already inhouse solutions to deal with these future requirements.

Our answers are the following :

1. IMPAC (IMProved Acid Conditioning)

High temperature - strong acid treatment of the oil. It has a positive impact on haze & total contamination reduction.

2. REACTOR "0"

Preconditioning of the refined oil with spent catalyst prior to transesterification.

3. IMF (Improved Methanol Flash)

It's basically an optimization of methanol removal before biodiesel washing.

Because of the lower content of methanol the biodiesel is more effectively washed (more haze removing).

Besides REACTOR "0", IMPACK and IMF, a further improvement has been already tested in industrial plants and is today available to tackle these new challenges. Especially the Total Contamination can be further reduced when applying;

4. Biodiesel Clarification System in biodiesel storage

Clarification of the finished biodiesel after a certain storagetime (typically 24 hours at 35 - 40°C) using a high speed clarifier.

By installing REACTOR "0" plus IMF plus Biodiesel Clarification DB is able today to guarantee 10 ppm of TC processing any kind of feedstock.

Cold Soak Test is reached when applying :

5. Biodiesel Post Treatment FACT (Fatty Acids Conversion Technology)

To process high acidity feedstocks cheaper than traditional vegetable oils.

Fatty Acids Conversion Technology

Today feedstocks account for more than 80% of the total cost to produce biofuels or biodiesel.

Furthermore, the biofuel industry, being very profitable until the end of last year, is now facing problems as a result of the strong increase of the feedstock prices.

The new generation plants must be flexible with the possibility to process lower quality raw materials but always matching the required quality specifications.

Desmet Ballestra has developed a new continuous esterification process able to process high acidity feedstocks in order to produce biofuels and, if integrated with the transesterification, biodiesel according to the EN14214 norm (FACT = Fatty Acids Conversion Technology) starting from cheaper raw materials.

The new process uses a heterogeneous catalyst in a fixed bed reactor without the typical disadvantages of a homogeneous catalyst process (requiring sulphuric or other acid) : wastes, limitation in capacity, etc...

Easy Process Control

Process Automation

Easy management

Whatever the size of the plant, the various processes used in winterising are easy to manage today, thanks to the rational approach offered by computers and programmable logic controllers.

Reduction of risks

Automation serves various purposes, among which we would like to mention the reduction of risks attributable to human mistakes, the obtention of a better and constant quality, superior yields, reduced consumptions and a higher degree of safety.

Any framework of any network

The framework of automation networks – to which it is easy to add other digital systems- is so flexible that numerous solutions exist, for both new and old plants. These networks do meet the requirements of all the processes used today.

Centralised Supervision

Permanent follow up

Centralised supervision is the most efficient tool to permanently follow production.

Overall view

The method, using selected softwares, continually offers an overall view of the ongoing activities and of their historical account.

Reports

- Analogic reports
- Reports on variables
- Preventive maintenance reports
- Production reports: flowrates, quality controls, etc

Easy to analyze, these reports are the undeniable witness of the complete activity of a process.

No data unattended

Central supervision is the ultimate management tool that leaves no data unattended.

