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CENTRAL ESTERIFICATION UNIT FOR 25 000 TONS/YEAR AND FFA UP TO 50 %

CEU 25000-50

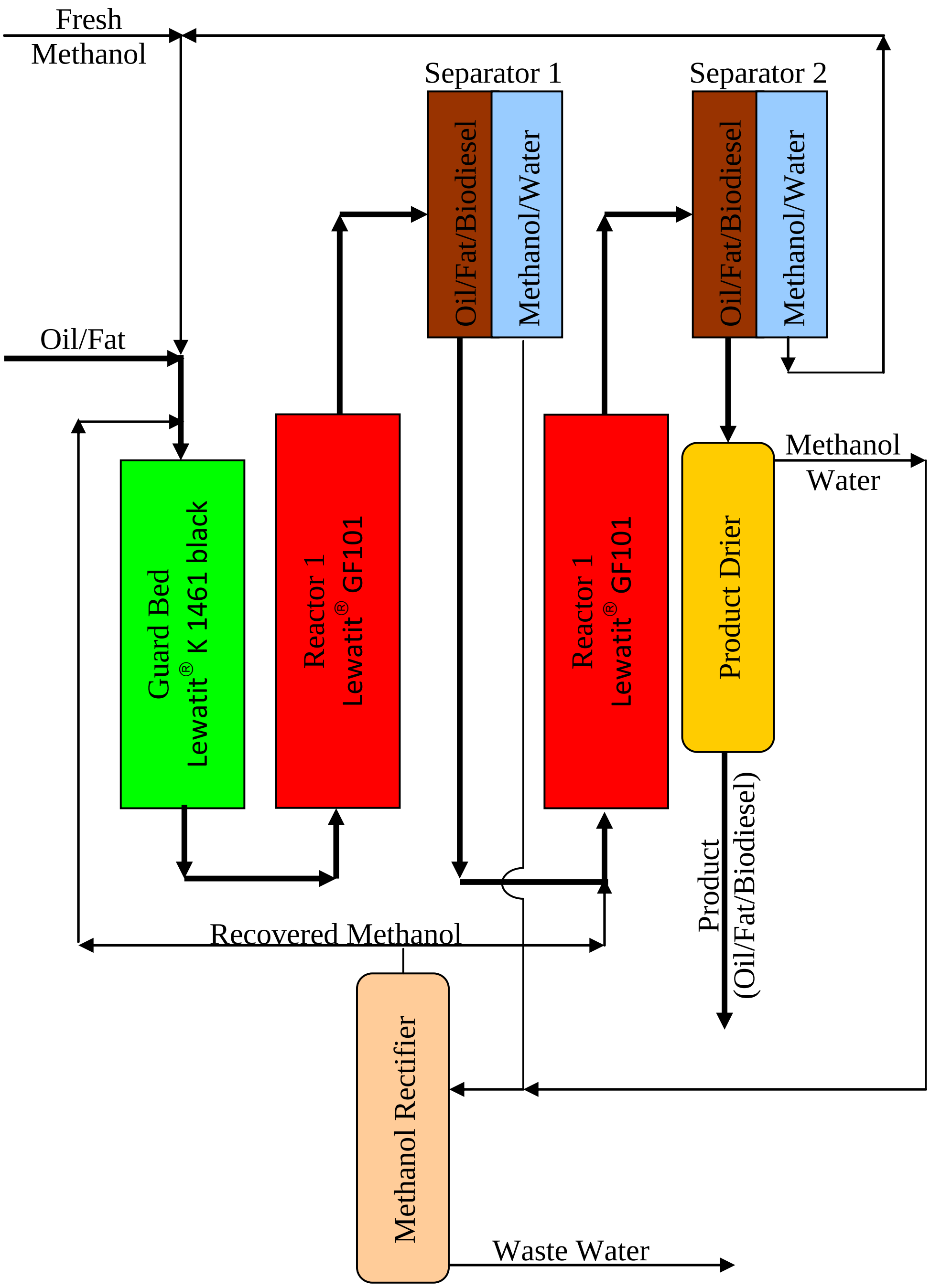
BDTech Assembly Hall

1. Process Description

The purpose of the Central Esterification Unit (CEU) is to convert free fatty acids (FFA), which are present in the raw material, into biodiesel by using heterogeneous catalyst and methanol. The concentration of FFA is expected to reach maximum 50 %. Aging of the raw material may cause a rise in the acidity during storage. Hence it should be handled in order that the acidity does not rise above the maximum allowed value.

The Esterification unit is composed of a guard column, two-stage tower reactors, separators, product drier and methanol rectifier. The raw material, before entering the esterification towers, first flows through the guard column. This column is an insulated cylindrical vessel filled with a strong acidic gel-type, polymer-based resin, in spherical beads form, with sulfonic acid group called Lewatit® K 1461 black. Its beads are of a uniform size, which results in optimal packing and low pressure drops across the bed. The resin is especially suitable for the decatonization of organic liquids; removal of heavy metals from solutions and conversion of salts into free fatty acids (FFA). It also removes proteins and phospholipids from the liquid stream. As its cost is about 1/3 of the heterogeneous catalyst placed in the subsequent

Basic Plant Design 2-Step Esterification



reaction towers, it is an ideal protection medium for wide range of input materials at competitive operating cost. The chosen pre-column offers high operability – responsive to variability in foulants and foulant levels. The guard bed will run at 90°C with the combined FFA-MeOH feed, to get best removal of cations. Under these conditions, approx 25% of the FFA will already be converted by the K1461 (strongly acidic gel type resin).

As esterification is an endogenous reaction and certain part of the reaction already occurs in the guard bed, the feeding into the 1st reaction vessel will be heated again to 90°C. While flowing through the cylindrical reactor, the mixture gets into the contact with the solid catalyst - Lewatit® GF101. Lewatit® GF101 is a strongly acidic, macroporous, polymer-based resin in spherical bead form with the sulfonic acid group. It is ideally suited as a heterogeneous catalyst for organic reactions, particularly for esterification. Large pore structure, high degree of cross-linking and good mechanical stability enables this catalyst to be used in polar and non-polar media.

The effluent from the 1st reactor enters a separator, which separates polar phase (MeOH + H_2O) from the fatty phase (FAME + FFA + TAG) by difference in density. The polar phase is transported for the methanol rectification. Recovered methanol is then charged back into the process and waste water is discharged. **The methanol rectifier is set in a way to get high purity of methanol (> 99%) and low content of methanol in water phase (< 0.1%), so that water can be directly discharged into the sewer.** ***Please check the local regulation on the industrial wastewater discharge into the public sewage system!*** **As all methanol vapours from the technology is condensed and recovered back to the process, the only emission leaving CEU is the wastewater, which can be charged into the sewer without treatment as it contains permissible traces methanol.**

The esterification reaction is finalized in the 2nd reaction vessel with the aim to achieve FFA < 1 % in the final product. The fatty phase is again heated to 90°C along with MeOH before they enter the reactor. The reactor is identical with the 1st reactor. However, as only about 5.5% of the remaining FFA is reacted in the 2nd reaction vessel, the temperature drop is much lower than in the 1st reactor. The same phase separator is also placed after the 2nd reactor. As the polar phase contains about 98 % MeOH, it is pumped directly back into the guard bed without rectification, saving especially operating cost.

Final step of the CEU 25000-50 is drying of the product (FAME + TAG) by a vacuum evaporator that removes water and methanol, which were not separated by gravity in the up-flow stage.

2. Standard Processing

Under standard conditions the CEU 25000-50 will process 25 000 tons of feedstock per year during uninterrupted operation. The performance of the CEU 25000-50 is measured under BDTech standard process conditions using a low viscous (~ 25°C, <

40 mm^2/sec), fresh, degummed raw material. The requirements for the proper running of CEU 25000-50 are as follows:

- Minimum 1 bar pre-pressure from an external oil tank or external pump,
- Compressed air supply permanent ≥ 7 bar at the connector to CPU during operation (if applicable),
- Stable supply of electricity,
- Ambient temperature in production hall 18°C to 30°C min. 12 hours before starting the CPU and permanent during the production,
- Oil processed at 90°C in CEU 25000-50.

Divergent parameters or improper operation can cause lower yield, quality or cause damage to the CPU.

3. Raw Material

	Input
Multi-feedstock	oils and fats of vegetable and animal origin
Temperature	90°C, liquid, low viscous (< 40 mm^2/sec)
Impurities	clean, free from solids (< 25 micron filter)
Other substances	free from other substances, namely emulsifiers, gums
Phosphorus	< 50 ppm
Water	< 0.1%wt.
Acid Number / FFA	AN = max. 100 mgKOH/g (i.e. max. FFA content ~ 50 %)

4. Utility Consumption Data

Annual duty - oil IN	**25000**	**t/year**		
Annual production	330	days/year		
Flow-rate - oil IN	3450	l/hour		
Inputs				
Oil	25 000	t/year	27 322	m^3/year
Methanol	1 413	t/year	1 789	m^3/year
Lewatit K1461	23	t/year	28	m^3/year
Lewatit GF101	3,3	t/year	4,3	m^3/year
Out				
Oil/Biodiesel mixture	25 616	t/year	28 470	m^3/year
Water	797	t/year	797	m^3/year
Heat energy	548*	kW/hour	4 337	MW/year
Electric energy	385	kW/hour	3 053	MW/year
Connections				
Oil	IN	2 "		
Methanol	IN	1/2 "		
Water	OUT	1/2 "		
Oil/Biodiesel mixture	OUT	2 "		
Ventilation Line	OUT	2 "		
Compressed air	IN	1 "		
Other Data				
Dimension	20 "		ISO Container	
	plus external towers 3x			

** Energy necessary for heating strongly depends on the heat recovery for other processes!*

5. Remark

Advantages of the process can be summarised as follows:

– The process does not cause destructive and degrading changes at the double bonds, unlike the homogeneous catalyst (for instance sulphuric acid).
– The catalyst does not have to be removed because it does not mix with the product, unlike the homogeneous catalyst.
– No need to neutralize wastewater, secondary product of the esterification process.

- No generation of wastewater with high salt content (typical for homogeneous catalyst), only water dischargeable into sewer is generated.
- As all methanol vapours from the technology is condensed and recovered back to the process, the only emission leaving CEU is the wastewater, which can be charged into the sewer without treatment as it contains permissible traces methanol.
- Lower operating cost compared with the homogeneous catalyst (no feeding of a mineral acid, an acid neutralization agent, disposal of the high salinity wastewater).
- The estimated frequency of the catalyst Lewatit® GF101 replacement is 2 – 3 years. Hence, It is estimated that the cost of the Lewatit® GF101 consumption is 1.11 EUR/ton of the product.
- The consumption of the Guard bed is estimated to 23 tons per year. It is estimated that the cost of the Guard bed consumption 2.19 EUR/ton of the product.
- Corrosion is avoided as sulphuric acid is not used.
- The product does not contain free water and methanol.
- Impurities are removed by the guard bed.