FRU 1000

(Free Fatty Acid Reduction Unit)

1. GENERAL DESCRIPTION

FRU (Free Fatty Acid Reduction Unit) is a complete machine for the reduction of FFA (Free Fatty Acid) and partially water present in suitable vegetable oils and fats (triglycerides/triacylglycerols) by neutralisation using KM32 (32% concentration of Potassium Methoxide in Methanol) and liquid – liquid extraction using G-phase (a secondary product of CPU) as the extraction medium.

Reduction of FFA in vegetable oils and/or animal fats is achieved by three consecutive processes:

1. First is the saponification of FFA by its reaction with Potassium Methoxide present in fed KM32. The main product of the saponification is soap.

2. Generated soaps are then extracted by G-phase. As G-phase with soaps is heavier than oil/fat, it settles down and is discharged from the bottom of a sedimentation tank.

3. As G-phase is a polar medium, it also attracts water. Thus, oil/fat is dried to certain extent during this process.

4. The neutralised oil/fat can be directly transported for the next process – transesterification taking place in CPU.

FRU is universally usable machine for the FFA reduction and can be adjusted to match the requirements of process and different raw materials up to FFA = 5 % (AN = 5 mgKOH/g). The relevant operating parameters (proportioning of substances, temperatures and system speed) can be set to reach the best results.

The FRU features a continuous process system containing automatic electronic proportioning system of the oil, catalyst and G-phase dosing, unique propeller mixers/reactors, and decanter tanks. The FRU is a CE certified “Plug and Play” compact factory.

2. STANDARD OPERATION

Under standard conditions the FRU1000 will process 1 000 litres of input oil per hour. This value can be reached under optimum circumstances and after a start-up period. The most critical parameters are physical and chemical parameters of raw material, process temperature and sufficient energy supply (compressed air and electricity).

All figures are valid if all required general plant and operating parameters for FRU are fulfilled and if the raw material is within the range of following specifications:

Oil	▪ Source - vegetable oil or animal fat, ▪ Pre-heated to 60°C, ▪ Free from solids and other substances (ϕ < 20 μm), ▪ Acid number < 10 mgKOH/g (FFA < 5.0%), ▪ Water < 0.5% (5 000 ppm), ▪ Pre-pressure = 0.1 – 4.0 bar.
G-phase	▪ Fresh, ▪ Homogeneous, ▪ Originated from the 1st and 2nd stage of transesterification in CPU.
Ambient temperature	▪ 18°C - 30°C
Compressed air supply	▪ min. 1" and 8 bar

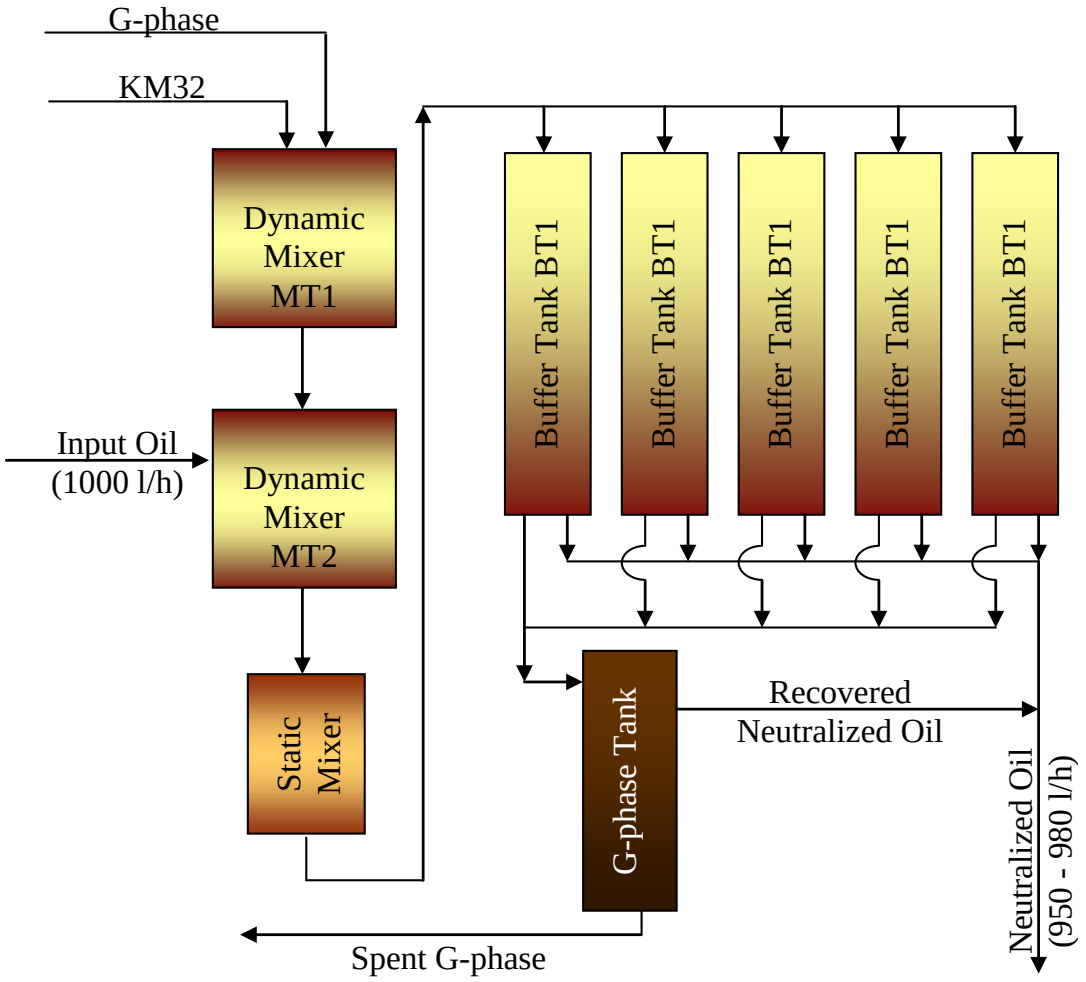
The FRU operation starts with the feeding of the media (Oil, G-phase and KM32). G-phase is pumped in to the mixing tank MT1, as well as the neutralising agent – KM32. The flow rate is controlled by two flow-meters. Flow-meters are connected to the control system. PLC decides dosages of the media according to the set values. Mixing of G-phase with KM32 is realised in the mixing tank MT1. It is a dynamic mixing by a specialised propeller mixing device.

The mixture of G-phase and KM32 is proportionally dosed into the second propeller mixer MT2. It is also controlled by PLC and metered by a flow-meter. During dosing of the G-phase/KM32 mixture, pre-heated oil is also pumped into the MT2. The oil dosage is metered by another flow-meter and controlled by the PLC.

In MT2, neutralisation of oil takes place. In other words, free fatty acids (FFA) react with potassium methoxide present in KM32 producing soap and methanol. To ensure the perfect mixing and complete utilization of potassium methoxide, static mixer is placed after MT2.

The final step of the process is separation of the products by liquid/liquid extraction. The separation happens in five buffer tanks. Liquid levels in the buffer tanks are monitored by level sensor. The readings are sent to PLC. Apart from the liquid level, temperature is maintained at certain value by installed heating devices through the monitoring by temperature sensors. There is one more very important sensor installed in all buffer tanks – conductivity sensor. As there is immense difference in the conductivity between oil and the G-phase, conductivity is an excellent instrument to distinguish between the two media. When the level of G-phase reaches the

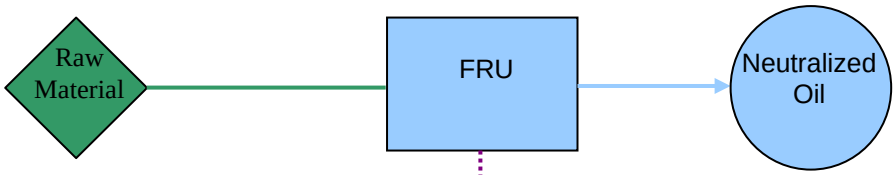
conductivity sensor in either of the buffer tanks, spent G-phase flows into the Tank G-phase. Tank G-phase is equipped with a conductivity sensor as well. In case oil escapes into the Tank G-phase, oil is recovered and sent with the neutralized oil into the outside storage tank.



Flow diagram

Buffer tanks BT 1-5 are filled in a stepped-wise manner. It first flows into the Buffer tank BT1. After it is full, the mixture is pumped into the next Buffer tank BT2. This feeding procedure continues until the Buffer tank BT5 starts to be fed. In the meantime, spent G-phase separates from the neutralized/purified oil at the bottom of each Buffer tank. The whole procedure is set in a way that before BT5 starts to be filled with the mixture from Static mixer; spent G-phase in BT1 is settled. Hence, when the input mixture from Static mixer starts to be fed into BT5, the neutralised/purified oil is pumped out from BT1 either directly into CPU or into a tank farm. After the Buffer tank BT1 is emptied, fresh mixture is fed into the BT1 from Static mixer. This procedure is repeated for all Buffer tanks. The whole procedure is controlled by the PLC.

3. PROCESS OVERVIEW



Raw Material Requirements for FRU	
P	max 50 mg/kg
H_2O	max 0,5 %
FFA	max 5,0 %
Impurities	free from solids (< 25 micron filter)

4. UTILITY CONSUMPTION DATA

Annual duty	**7250**	**t/year**		
Annual production	330	days/year		
Volumetric flow-rate	1000	l/hour		
			Assumption: FFA = 5%	
Inputs				
Oil	7250	t/year	7930	m^3/year
KM32	316	t/year	318	m^3/year
G-phase 1,2	792	t/year	720	m^3/year
Outputs				
Oil (neutral)	6888	t/year	7530	m^3/year
G-phase 4	1471	t/year	1340	m^3/year
Electric energy	15	kW	118,8	MWh/year
Compressed air	20	m3/hour	158400	m3/year

Connections			
Oil	IN	1	"
Methanol	IN	1/2	"
KM32	IN	1/2	"
G-phase	OUT	1	"
Neutralized Oil	OUT	1	"

Ventilation Line	OUT	2 "	
Compressed air	IN	1 "	
Other Data			
Dimension	20 "		ISO Container

5. USAGE AND MODE OF OPERATION

The FRU is a standardized free fatty acids reduction technology. The FRU is designed for 24 hour/day operation by qualified personnel. The process parameters shall be monitored constantly and adjusted as required. Interrupted operation may affect the product quality and production yield.

6. CONNECTIONS

All gas or liquid pipelines are connected by BDT quick couplings in the specified size. The connection from BDT machines (FRU) to the peripherals (tanks, air, etc.) on the project site must be made by the customer, using flexible hoses (included in the scope of delivery). All components are hermetically sealed or connected to ventilation. Pressure tanks or pressurized tank-type reactors are used in FRU.

7. AUTOMATION CONCEPT OF PROJECT

The FRU control system can be integrated into the overall project automation. The FRU operating and performance parameters can be monitored from the plant control room. BDTech recommends a fully integrated control room to monitor all project-related systems including the FRU, CPU, tank farm, pumps, etc.

8. Remark

- All mentioned data are calculated for maximal flows under standard conditions. Results may vary if operated under conditions deviating from BDT standards and if feedstock qualities vary.
- All data are subject to change in case of technical requirements.
- All modifications to standard FRU module should be discussed prior to commencement of FRU construction.
- Main part of the FRPU technology, placed in the Production Hall, is built as a tight system. Technological tanks accumulating methanol in FRU are pressure-less,

atmospherically ventilated into the external environment outside the Production Hall. Therefore, the Production Hall requires normal safety level against explosive atmosphere.

- It is recommended that the client checks the local regulations for operating a biodiesel production factory.