

BIO DIESEL

Technology, Engineering & Plants



Introduction

Praj is a leading company dedicated to the field of renewable transport fuels, providing cutting-edge Bioethanol & Biodiesel production technologies.

Praj offers a comprehensive range of services to biofuel producers, worldwide. These include Technology, Engineering and Plants, covering entire range from feedstock handling through to wastewater treatment and disposal solutions.

With installations in more than 35 countries across 5 continents, Praj has proven technological leadership together with deep understanding of local needs and conditions.

The state-of-the-art R&D Centre at PRAJ is focused upon research on Biofuels. The centre develops insights into agro-based feedstocks, innovative bio-fuel technologies and ensures scale-up to commercially viable industrial plants.

Leveraging over two decades of experience in agri-based processes for renewable Biofuels, PRAJ has now developed technology, plants, and services for Biodiesel production. Praj also offers Biofuels Complex wherein one can produce both Bioethanol and Biodiesel. Economy permitting, bioethanol can also be used as a transesterification agent. Use of Bioethanol instead of Methanol makes Biodiesel completely renewable.

Biodiesel has several advantages over petroleum based diesel such as:

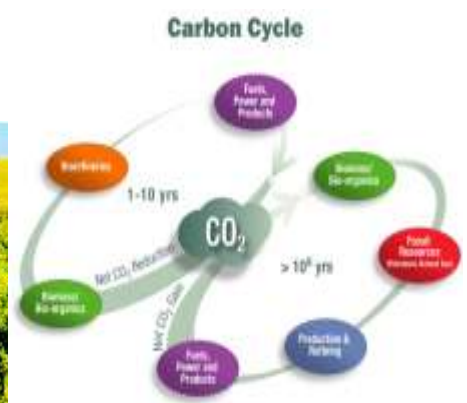
- Closed carbon cycle
- Over 50% reduction in particulate matter
- Over 98% reduction in Sulphur Oxide emissions
- Reduced Green House Gas (GHG) emissions
- Safer to handle - flash point > 130°C compared to 70°C for petroleum diesel

- Does not contain harmful aromatic compounds

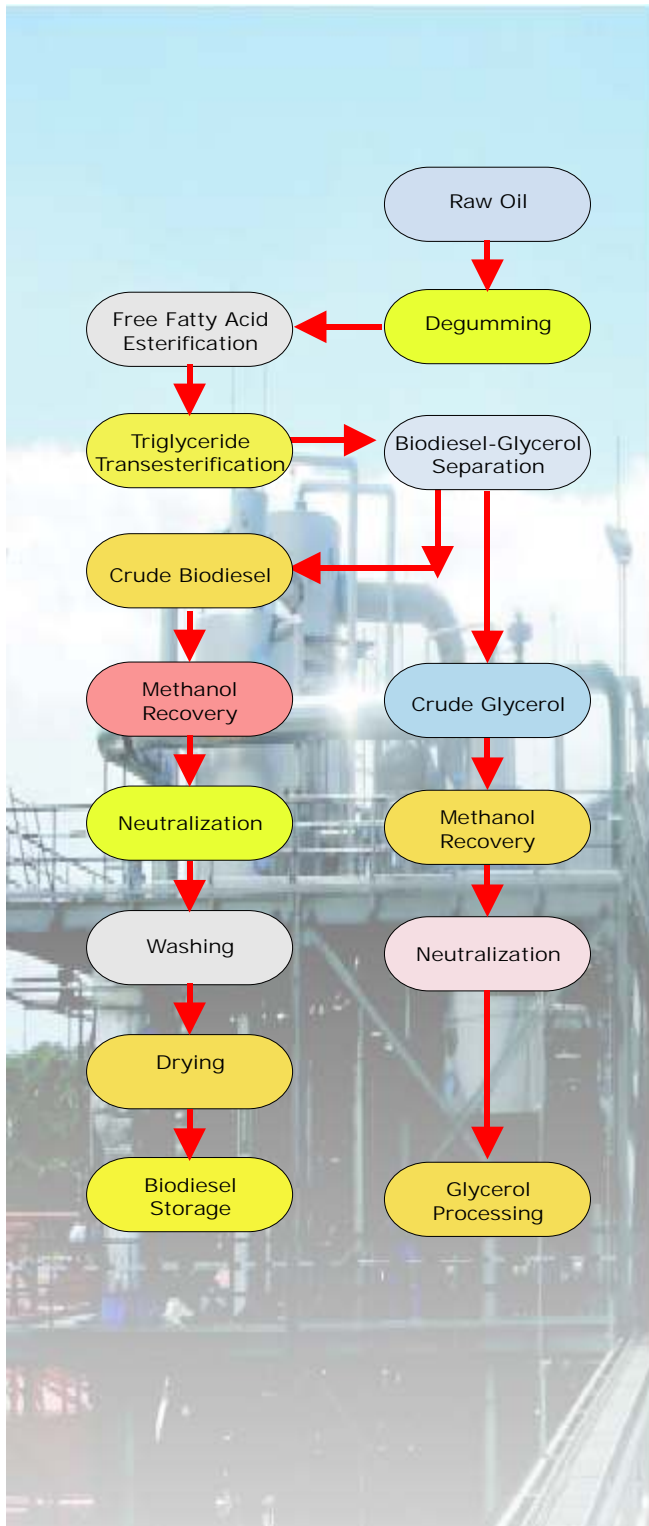
At PRAJ, a dedicated Biodiesel Technology & Engineering division comprising well-qualified / experienced professionals, is backed up by an excellent base in Technology piloting and Process Engineering.

Praj has created multi-locational Equipment Fabrication and Project Management set-up, to serve clients in different regions.

Praj provides customized solutions that not only deliver high yields and maximum energy efficiency, but also ensure product quality strictly conforming to the necessary standards.



Biodiesel Process



Special features of PRAJ's Biodiesel Technology

- Wide range of standard capacities: 100 to 500 MT/Day.
- Continuous operation with synchronized unit systems.
- Flexibility to operate with Multiple vegetable oil feedstocks.
- Modular specific pre-treatments depending on the type of feed oil.
- Choice of FFA neutralization vs. conversion to biodiesel.
- Proprietary High efficiency cascade transesterification process, based on reaction kinetics.
- Advanced distillation / evaporation designs - Biodiesel-glycerol separation, Biodiesel drying and methanol recovery.
- Reduced operations for centrifugal separations.
- High Biodiesel yields with minimum losses.
- Low consumption of chemicals.
- In-plant integration to minimize energy & fresh water needs.
- Negligible waste-water due to in-process water recycle.
- High purity glycerol as by-product.
- Conformance to ASTM/ EN standards for product biodiesel.

Typical process performance*

Description	Description
1. Feedstock	Vegetable oil (Phospholipids: 3% w/w Max. FFA: 5% w/w max., Triglycerids: 92% w/w Min. water 0.1% max.) Non saponifying components: 0.8% max).
2. Biodiesel purity	97.5% min. Fatty Acid Methyl Ester (FAME)
3. Yield of Biodiesel (97,5% w/w FAME min)	995 to 1003 kg/MT of refined oil OR 950-970 kg/MT of raw unrefined oil.
4. By products (crude Glycerol 85-90% w/w)	Average 10 to 13% of Biodiesel production.(Can be further purified to higher grade).
5. Utilities: Steam	Typical 290 kg/MT of Biodiesel (from refined oil) Typical 390 kg/MT of Biodiesel (from oil with 2% FFA)
Process Water	Typical 2-4% of Biodiesel production capacity depending on feedstock oil composition.
Electric Power	12-22 KW-hour/MT biodiesel production capacity depending upon refined or semi-refined of feed oil.
Cooling water (30°C)	Approx. 25 m3/hr-MT of Biodiesel - For refined oil feedstocks 35 m3/hr -MT of Biodiesel - including degumming and FFA neutralization.
6. Approx. chemical requirements	
Catalyst (K-Methylate 100%)	5 Kg/MT of Biodiesel
Methanol (99.5%)	96 Kg/ MT of Biodiesel (for refined oil feed) 100-122 Kg/MT of Biodiesel (for oil with 5% FFA)
Nitrogen	Small quantities as required
Acids for raw oil pre-treatment	
Phosphoric Acid (85%)	2 Kg/MT of Biodiesel for degumming
Sulfuric Acid (98%)	2-3 Kg/MT of Biodiesel for Oil feeds with high FFA.
7. Expected efficiencies	
Degumming	99%
FFA Esterification	99%
Transesterification	97.5%

* (Performance figures mentioned in the above table are approximate values and may change depending upon feedstock type, feedstock quality, plant capacity and other relevant factors).

Modular Biodiesel Plants

While building Biodiesel plants there are two key considerations...

- Minimum On-site work and related costs
- Minimum Project execution period i.e. Quick start-up

To meet these valuable considerations, PRAJ has developed standard capacity Biodiesel plants with modular skid mounted unit operations.

Skid mounted modular Systems:

Unit operations in a plant of a given capacity are completely prefabricated. The systems are :

- Mounted on skids, ready to ship
- Include equipment / bought-outs and pipe-works
- Instrumentation and automation hardware
- Electrical system and panels

Advantages of Skid mounted systems

- Reduction in site work and execution time.
- Low cost of erection at site.
- Ease of transportation and installation.
- Can be seamlessly integrated with the remaining plant.

Skid Mounted Systems give flexibility to use different types of feedstocks. For instance, if the feedstock has high Free Fatty Acids (FFA) content in some batches, then it can be processed through Section 4 (Acid Esterification) before sending it to section 5 (Triglyceride Transesterification). Alternatively, if the feedstock is like Palm Fatty Acid Distillate or Acid oil, section 4 can be the predominant section of the plant.

Feed-stocks	Required Sections
Refined Oil	5 & 6
Raw tree borne oils -Jatropha or Pongamia	1,2,4,5 & 6
Raw veg. oils like canola, sunflower, soybean.	2,3 or 4,5,6
Degummed oil (<2% FFA) Soybean or rapeseed oils.	3,5 & 6
Degummed oil (>2% FFA) Palm oil or acid oil.	4,5 & 6

The pre-built skids are available for

1. Extraction of non-lipids
2. De-gumming
3. Alkali refining
4. Acid Esterification
5. Transesterification
6. Distillation, Evaporation & Centrifugation

PRAJ Infrastructure and Services

PRAJ Biodiesel plants are backed up by Multi-locational, high quality infrastructure and services:

Detailed engineering

- Highly specialized and experienced professionals
- Advanced designs of equipment, instrumentation and electrical systems
- Compliance to a variety of design codes
- Integrated approach

Equipment Manufacturing

- Dedicated fabrication facilities for equipment and systems
- High quality and advanced practices in forming assembly and welding
- Well-equipped bases for skids with piping, instruments and electrical systems
- Pre-testing facilities for check-ups before despatch

Project Management

- Experienced project teams for different regions
- Networking for local project execution arrangements
- Assistance and support for local permitting norms
- Well laid specifications and assistance for peripheral systems and utilities
- Advanced methods for project planning and execution logic.



PRAJ: Knowledge services

At PRAJ, there is a strong focus on knowledge acquisition and technological development.

Matrix -the innovation center at Praj is dedicated to creation of knowledge and expertise on Biofuels.

The Expertise comprises:

- Agriculture of oil sources - Backward integration for feedstocks
- Process Oleo chemistry
- Reaction kinetics and process development
- Pilot studies Engineering and technology commercialization

Experts at PRAJ provide services for assessment and feasibility studies for selection of local oil feedstocks in different countries / regions.

A variety of in-field trials are also taken up for crop optimization, studies on yields and viability and selection of right feedstock along with preprocessing technologies and by-product management.

The laboratory facilities, specialized in oleo-chemistry, help in compositional analysis and in deciding the necessary processing steps in biodiesel plants, as well as the analysis of biodiesel quality as per different standards.

Pilot facilities help in testing different feedstocks for confirmation of process and design parameters and also generating correct specifications for plant design.

These services help clients in deciding optimum feedstock combinations as well as in efficiently building/operating process plants.

In addition, PRAJ research teams are working on developing innovative solutions to improve viability of biodiesel process. Some of the areas include, increase in yields and productivities, novel alternate bulk applications for byproducts like glycerol and value added products from de-oiled cakes.



Comparative performance of oil-crops for Biodiesel

Crop Variety	Cultivation cycle	Annual feedstock yield (per hectare)	Oil yield	Comments on crop specialties
Tree Borne non-edible / edible oil seeds				
Jatropha	3 years from plantation. Seeds are borne once a year	1000 trees x 6 kg seeds/ tree = 6000 Kg 30-35% oil x 95% extraction	1.7-2.0 MT / year / hectare	Under irrigated conditions. Non-irrigated seed yields can be as low as 1.2 MT/Yr
Pongamia	4 years from plantation. Seeds are borne once a year	500 trees x 4 kg seeds/ tree = 2000 kg 35-40% oil x 95% extraction	0.6 to 0.8 MT / year / hectare	Under Irrigated conditions. Non-irrigated seed yields can be as low as 0.3 MT / year / hectare
Oil Palm	3 to 4 years from plantation and continues till 25 years	125-140 trees per hectare give 11-13 MT/ Hectare annual fruit yields 28-32% oil on fruit	3.1 to 4.2 MT / year / hectare	Requires high rain of about 1400 to 1600 mm or irrigation Hence tropics (Equator +/- 17 Deg)
Short duration field oil crops				
Soybean	90 days twice a year in tropics	2 MT / hectare avg. seed yield 12-14% oil 2 cycles per year	0.4 to 0.5 MT / year / hectare	Warm tropical humid climate 400 to 600 mm rainfall or equivalent irrigation
Rapeseed	90 days	2 MT / hectare avg. seed yield 35-37% oil 2 cycles per year	1.3 to 1.4 MT / year / hectare	Cold climate and bright light 300 mm rainfall or equivalent irrigation
Sunflower	100 days	2 MT / hectare avg. seed yield 30-32% oil 2 cycles per year	1.1 to 1.2 MT / year / hectare	Dry & warm climate High irrigation approx. 400 mm



Network

PRAJ Network Domestic

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Biofuels. Our Passion.