

Natural Product Industries

Edible & Essential Oils

Soaps & Detergents; Glycerin

Carbohydrates & [Fermentation](#)

Pulp & Paper Industry

Coal & coal based chemicals

Petroleum

Edible & Essential Oil

- Oils are organic molecule of carbon, hydrogen, oxygen.
- It is composed of long chain fatty acids and esters (glyceride ester) as well as derivative of glycerine, long chain fatty alcohol.

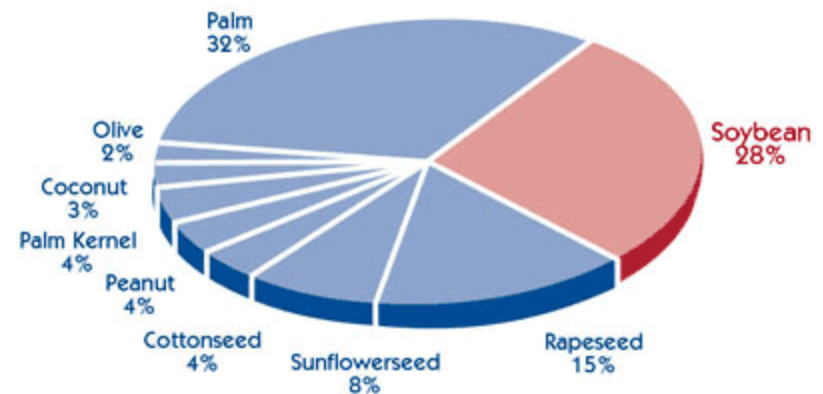
- Non-edible oils

- castor oil, linseed oil.

- Edible oils :

- ground nut oil, coconut oil, soyabean oil .

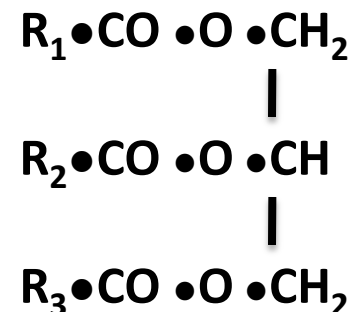
- Oil is used in producing vanaspati ghee, soaps and detergents, cosmetics, medicines, polymers, paints and varnishes and in many other applications.



Edible & Essential Oil

COMPOSITION & STRUCTURE

- R_1 , R_2 and R_3 are not necessarily same.
- Degree of saturation controls the melting point and chemical reactivity



Name (R)	Composition	No. of = bond	Melting Point ($^{\circ}C$)	Reactivity to O_2
Stearic	$C_{17}H_{35}$	0	69	Nil
Oleic	$C_{17}H_{33}$	1	14	Fair
Linoleic	$C_{17}H_{31}$	2	-5	Rapid
Lenolenic	$C_{17}H_{29}$	3	-11	Highly Rapid

Methods of Extracting Vegetable Oils

(a) Cleaning and dehulling:

- Mechanical cleaning is done to remove stones and other undesirable material.
- Dehulling remove hulls, dry outer covering of seed.

(b) Cracking rolls:

- Crushing rolls crush the oil seeds and gets flaked seeds.

(c) Digestion

- 100 parts of flaked seeds are thoroughly mixed with 5-10 parts of water by rotating blades.
- Softening by means of heat and moisture is done here.
- Steam is added for heating purpose.
- Acid is formed by hydrolysis of ester.
- The seeds get swollen up.

(d) Expeller:

- The swollen seeds are crushed under high pressure and cells of seeds get ruptured and oil is released.
- The tapering shape ensures more application of pressure on the seeds
- The oil depleted cake is either sent for solvent extraction or used as animal feed.
- Oil is sent for purification.

(e) Mix tank:

- The extracted oil is treated with alkali like NaOH or Na_2CO_3 to remove fatty acids.

(f) Centrifuge:

- Acids are separated in centrifuge separator.
- These separated acids are used as foots for soap manufacturing.

(g) Rotary filter:

- The clear oil is treated with some bleaching agent like "Fullers Earth Carbon" in filter aid before rotary filter.
- Rotary drum filter is used for removal of seed particles which may be present.
- This finished oil is produced.
- From this process around 1-2% oil content remains in the meal.

(h) Extraction:

- The flaked seeds or oil extracted seeds from crushing rolls & Oil depleted cake is also added in extractor.
- The solvent extracts oil from the seeds.
- The wet meal is collected in the middle and is sent for solvent removal.

(i) Solvent removal:

- Steam is used to extract solvent carried by the oil seeds.
- The rotating blades ensure better exposure to steam.
- The solvent free meal is sent to dryer and then used as animal feed.
- Solvent is collected from top and is recycled after cooling it in heat exchanger.

(j) Flash film evaporator:

- The solvent is preheated by steam.
- Oil is concentrated here by evaporating the more volatile component (hexane).
- The hexane is recycled back to extractor after heat recovery.
- The use of flash evaporator reduces the cost of vacuum stripping column.

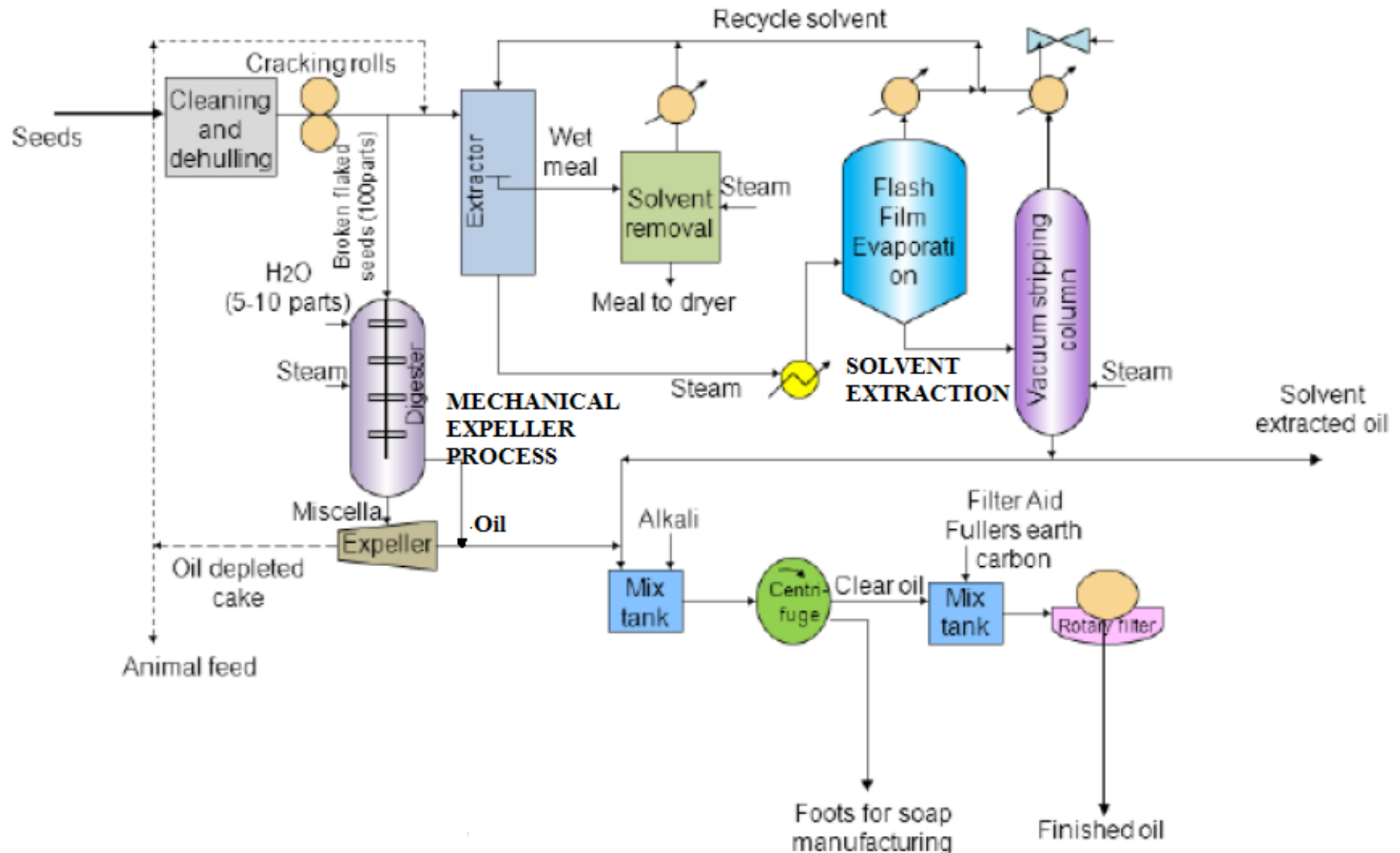
(k) Vacuum stripping column:

- The oil from flash evaporator is fed here.
- The stripping is done by steam i.e. steam carries away the hexane.
- And it is under vacuum for the reason that the boiling point of hexane and oil are close to each other. Jet ejector is used here to generate vacuum.
- The hexane is recycled again.
- Oil produced here is either directly used or sent for purification.

Solvent Extraction

- Can be use alone or in combination with mechanical method
- Solvent extraction + mechanical method
 - High yield : 98-99% of available oil
 - Poor quality: dark color, odor, free acid content
- Expeller + solvent extraction
 - Yield over 80% as prime quality oil
 - Only 18-20 % as the poorer grade
- Type of solvents used
 - Petroleum cuts in hexane range-flammable
 - Trichloroethylene - toxic

Vegetable Oil Extraction Method

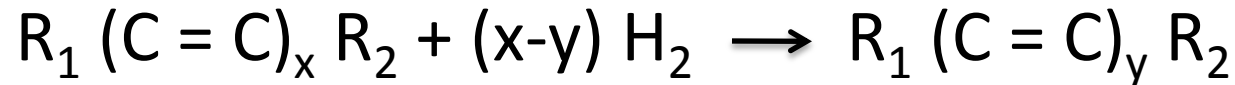


Hydrogenation of Oils

- Hydrogenation
 - Hydrogenation process is used to remove double bonds and to make fats and oil saturated.
 - It raises melting point and improves its stability and resistance to rancid oxidation.
 - The most common end product of hydrogenation is Vanaspati ghee. Other products include hardened industrial oils and partially hydrogenated liquid oil.
- The pressure temperature conditions are complicated for certain types of double bond saturation.
 - Ghee base oil is hydrogenated at (1-2 atm; 135-180°C) for melting point similar to butter.
 - Vanaspati shortening is produced at (2-3.5 atm; 120-160°C) for higher melting point fats.

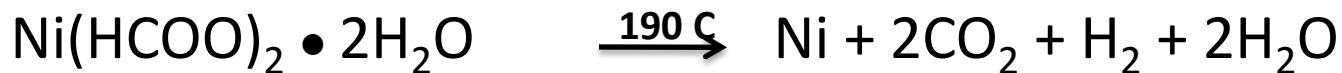
- Chemical reactions

- Hydrogenation



- Catalyst preparation

- Nickel formate decomposition (finely divided catalyst)



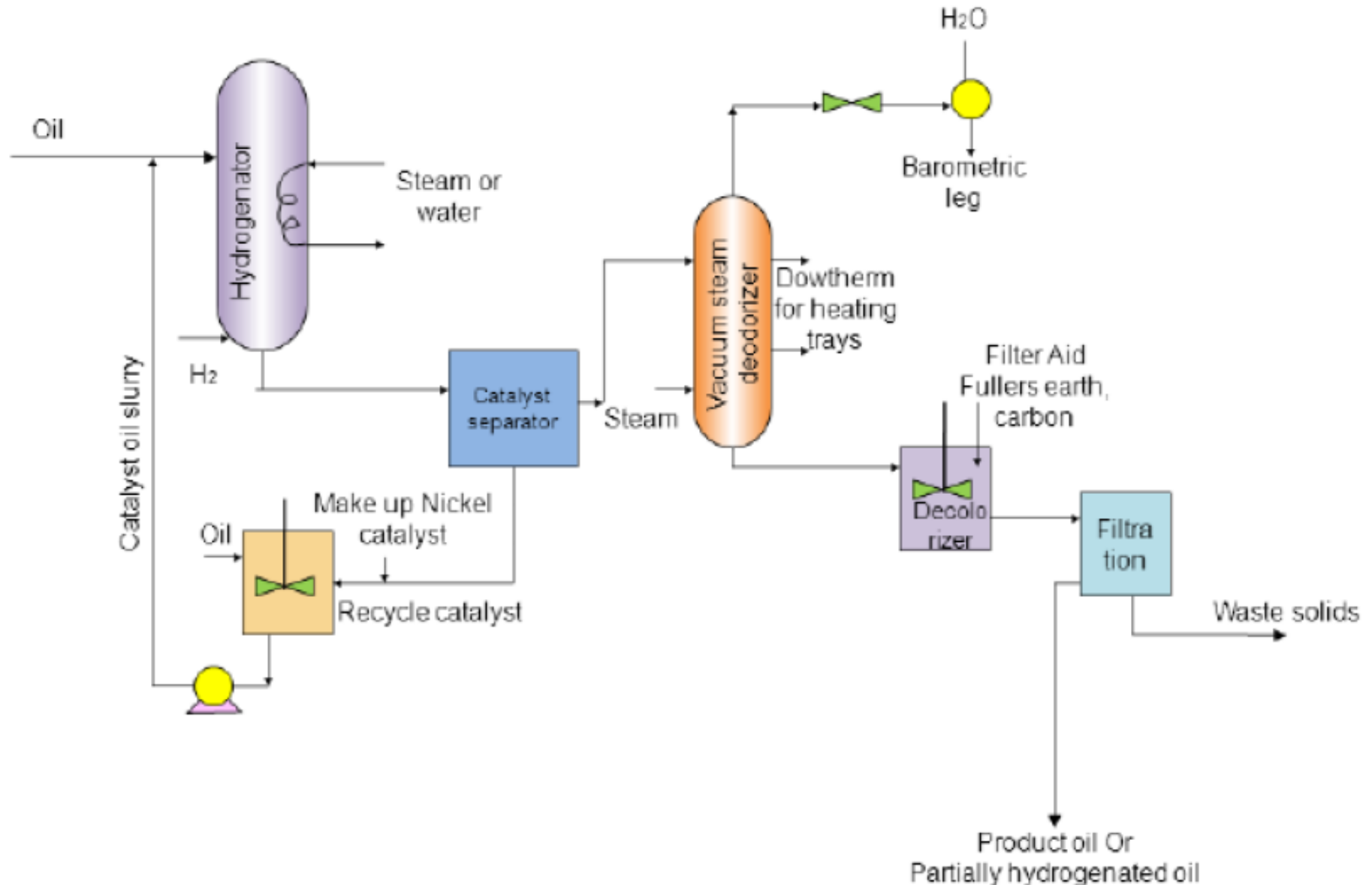
- Reduced Ni on inert catalyst support (Nickel salts precipitated on inert porous carrier e.g., kieselguhr, ditomaceous earth and reduced at high T)



- Raney or spongy nickel method (produces spongy, high surface area catalyst, sodium aluminate is washed out with water)



Hydrogenation of vegetable oils



Process Description

(a) Hydrogenator:

- Oil is fed to the hydrogenator, where hydrogen, and steam are introduced.
- The catalyst oil slurry of concentration 5 to 15 kg per ton of oil is also put.
- The reaction is slightly exothermic so steam is sometimes turned off.

(b) Deodorizer:

- Deodorization of oil removes undesired smell and taste subjecting oil in steam at high temperature and vacuum.
-

(c) Finishing & Cooling:

- Oil color is removed by treating with fuller's earth or carbon.
- It is then filtered, mixed with some vitamins.
- Slow cooling is done for granular structure ghee. For non-granular products rapid chilling is done

Major engineering problems

- Heat of reaction (exothermic)
 - During hydrogenation cooling requires via cooling coils
 - $T < 200\text{ }^{\circ}\text{C}$ to avoid side rxn e.g., pyrolysis and prevent sintering of porous catalyst
- H_2 handling problems
 - Wide explosive limit range
 - Equipment should be leak-tested (with freon on He detector)
 - Carbon steel for oil hydrogenation (to avoid H_2 embrittlement prob.)
- Rancidity
 - The moisture and oxygen cause deterioration of fats. The combine action of both moisture and oxygen causes rancidity which is characterised by bad smell, development of red color, increase in acidity and increase in viscosity. Prolonged exposure to air yield undesirable resinous products causing rancidity.