

# CH0204 Organic Chemical Technology

## Lecture 2

### Chapter 1 Natural Products

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# Overview of topics

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## Chapter 1 NATURAL PRODUCTS

- 1 Edible and Essential oils
- 2 Soaps and Detergents; Glycerin



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- 1 Edible and Essential oils
- 2 Soaps and Detergents; Glycerin



# Overview of topics

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1. What are edible and essential oils?
2. What are characteristics of edible and essential oil?
3. What are the major vegetable (or edible) oils?
4. World vegetable oil production scenario
5. Indian vegetable oil production scenario
6. Raw materials source in various parts of India
7. What are the process methods available to produce edible and essential oils of vegetable origin?
8. Soy bean oil production
9. Process description
10. A simple mass balance
11. Hydrogenation of edible oil
12. Process description
13. End Uses of edible and essential oils



# 1. What are edible and essential oils?

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## Edible oil

Fats and oils are found widely distributed in nature, in both the **plant and animal kingdom**.

Fats and oils are the mixtures of the **glycerides of various fatty acids**.

Edible oils are naturally-occurring compounds based on **long chain fatty acids and esters** (particularly glyceride esters), as well as derivatives such as **glycerin, long chain fatty alcohols, surfactants and sulfonates**.

Example: Palm oil, Coconut oil, Rice bran oil, Soybean bean oil and so on.



# 1. What are edible and essential oils?

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## Uses

These oils are used in food, sanitation and in the paint industries.

## The degree of saturation

The degree of saturation of the acids involved affects the melting points of the ester mixture; the more unsaturated give esters with lower melting points and these are the chief constituents of oil.

The more the saturated esters on the other hand are constituents of fats.

The term “Vegetable Oils” is used as synonym for “Edible Oils”.



# 1. What are edible and essential oils?

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## Essential oil

Group of organic compounds which are pleasantly **odoriferous** are called essential oils.

Essential oils may also defined as **volatile, odoriferous oils of vegetable origin**.

“**Essential Oil**” does not mean “**Most necessary**” but rather the concentrated characteristics or quintessence of a natural flavor or fragrance.



# 1. What are edible and essential oils?

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## Essential oil

Essential oils are, in the main, **insoluble in water, and soluble in organic solvents**, although enough of the oil may dissolve in water to give an intense odor to the solution.

Example: Lemon oil, Jasmine oil, Rose oil, Sandal wood oil and so on.

## Uses

These oils are widely used in cosmetics, perfumes, soaps and medicine.





# 1. What are edible and essential oils?

## Essential oil

The compounds occurring in the essential oils may be classified as follows:

1. **Esters** – Mainly of benzoic, acetic, salicylic and cinnamic.
2. **Alcohols** – linalol, geraniol, terpinol etc.,
3. **Aldehydes** – Cital, benzaldehyde, Camohor etc.,
4. **Acids** – Benzoic, cinnamic, myristic etc.,
5. **Phenols** – Eugenol, thymol, carvacrol etc.,
6. **Ketones** – Carvones, methone, methyl heptenone etc.,
7. **Esters** – Cineole, safrole etc.,
8. **Lactones** – Coumarin
9. **Terpenes** – Camphene, limonene, pinene etc.,
10. **Hydrocarbons** – Cymene, styrene(Phenyl ethylene) etc..



## 2. What are the characteristics of edible and essential oils?

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### General Characteristics of fats, oils and waxes

1. The fats and oils are the **mixture of glycerides** of fatty acids.

By the terminology of industry, the **oils are all liquids and fats are solid** at normal temperatures.

2. Waxes are **the esters of polyhydric alcohols** other than glycerin, usually solid in room temperature.

3. Effects of degree of saturation- More the double bond in fatty acid radical (R) controls **the melting point and chemical reactivity**.

## 2. What are the characteristics of edible and essential oils?

### General Characteristics of fats, oils and waxes

R	No. of Double Bonds	Melting point	Reactivity
Stearic	0	69	Nil
Oleic	1	14	Fair
Linoleic	2	- 5	Rapid
Linolenic	3	- 11	Extremely rapid



### 3. What are the major vegetable (or edible) oils?

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#### Vegetable (or edible) oils

Olive oil

Palm oil

Palm kernel oil

Peanut oil

Sun flower seed oil

Coconut oil

Soybean oil

### 3. What are the major vegetable (or edible) oils?

Major vegetable (or edible) oils

Olive Oil



Palm Oil



### 3. What are the major vegetable (or edible) oils?

Major vegetable (or edible) oils

Palm Kernal oil



Peanut or Groundnut oil



### 3. What are the major vegetable (or edible) oils?

Major vegetable (or edible) oils

Sunflower seed oil



Coconut oil



### 3. What are the major vegetable (or edible) oils?

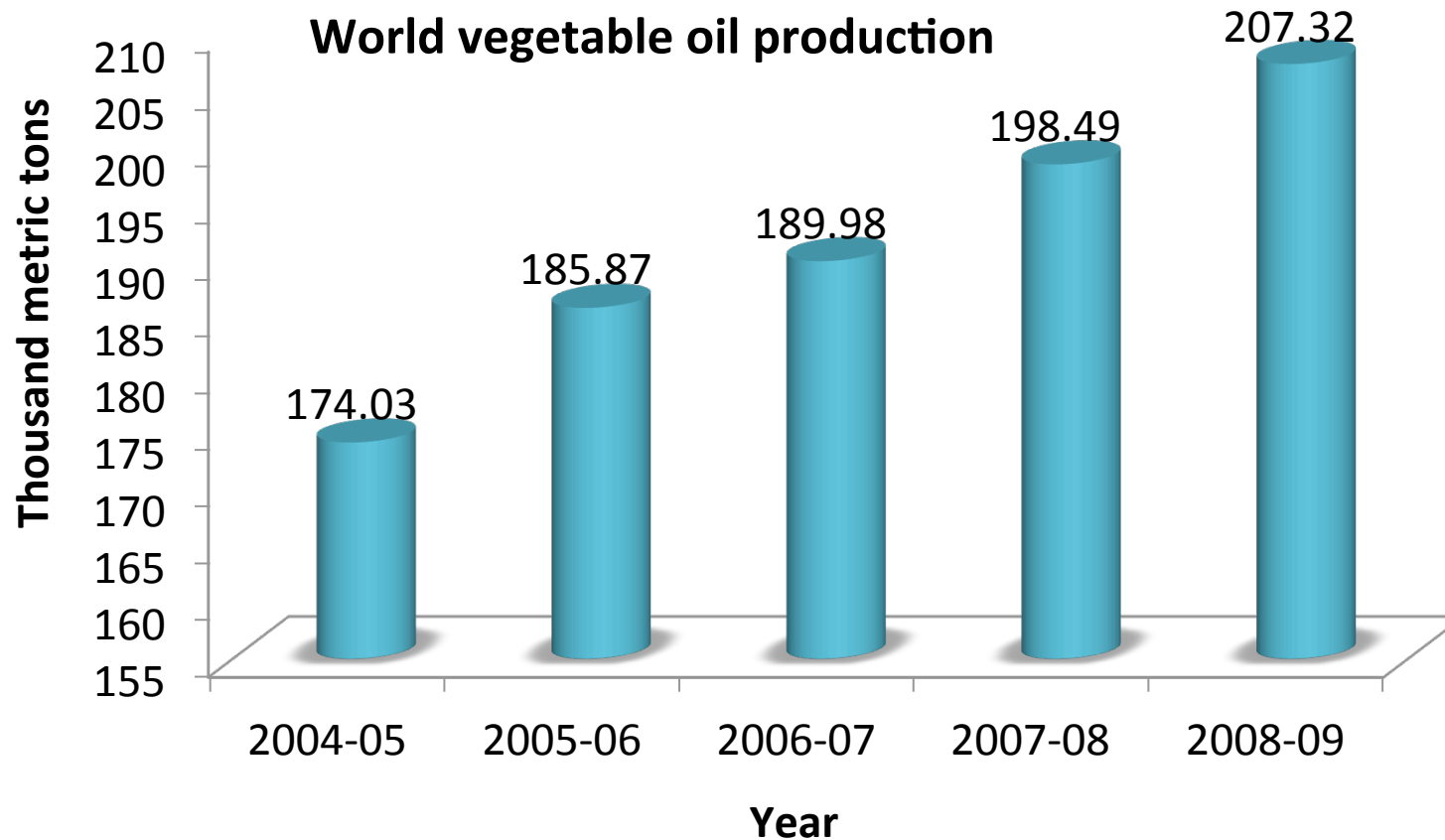
Major vegetable (or edible) oils

Soybean Oil

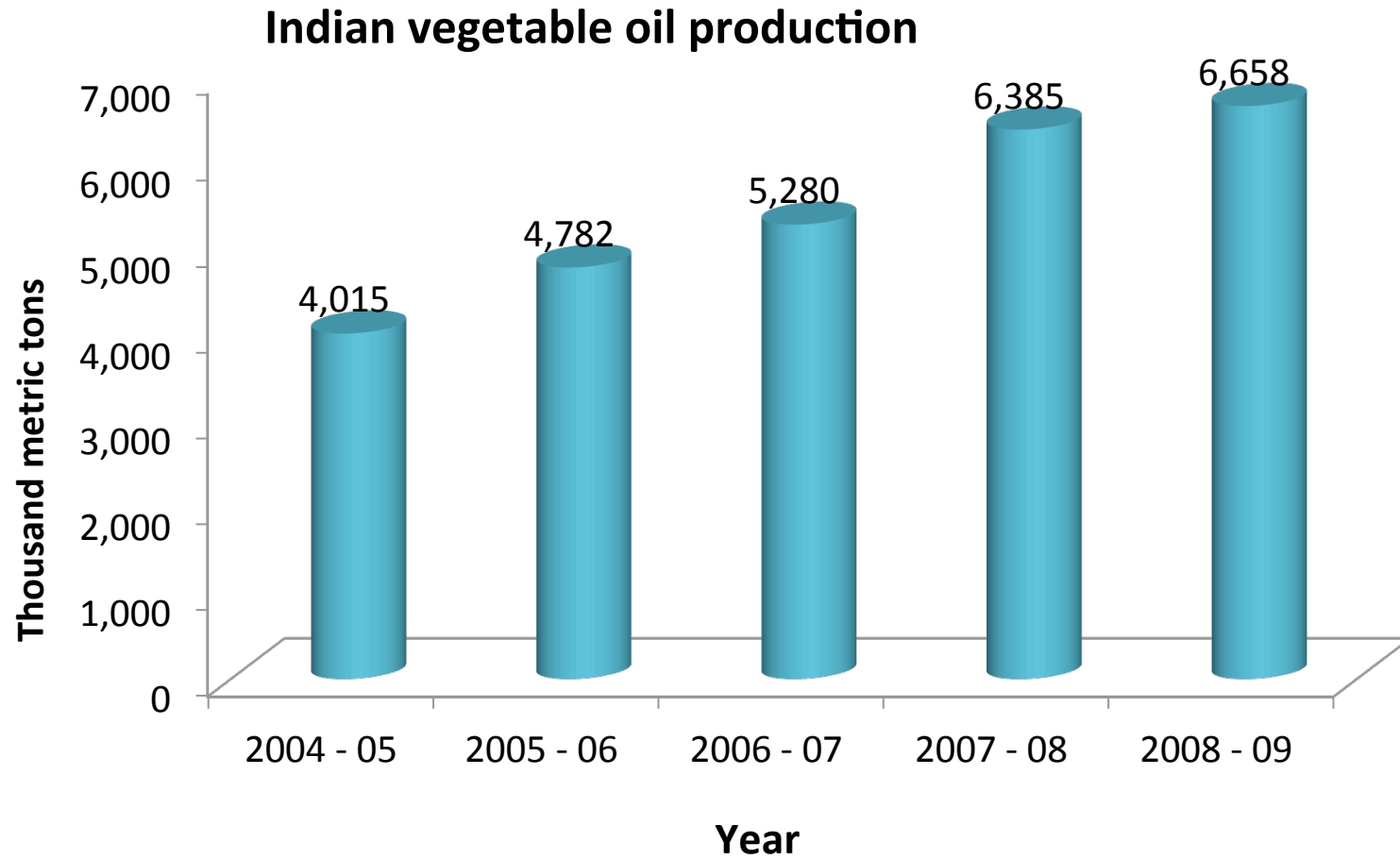




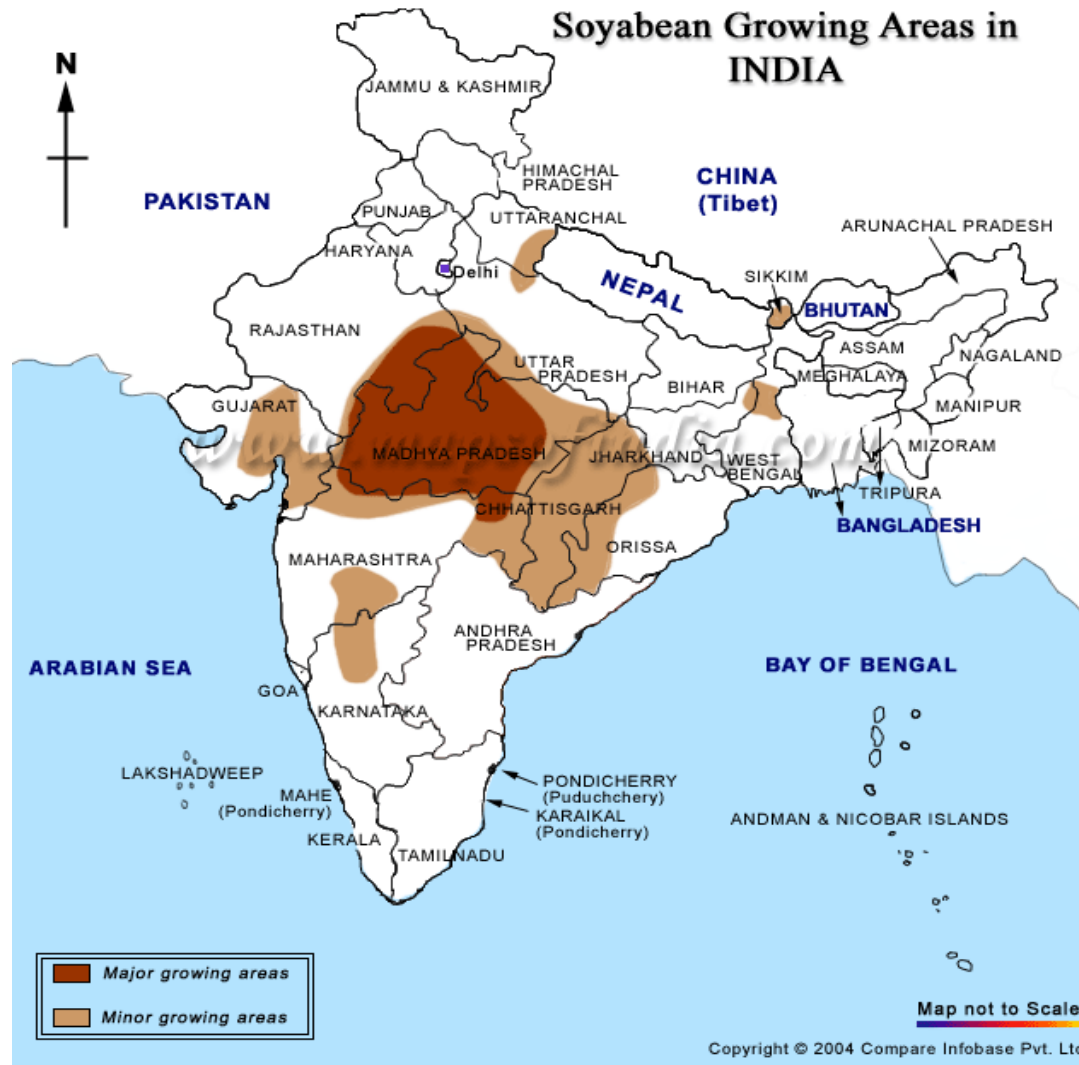
## 4. World production scenario



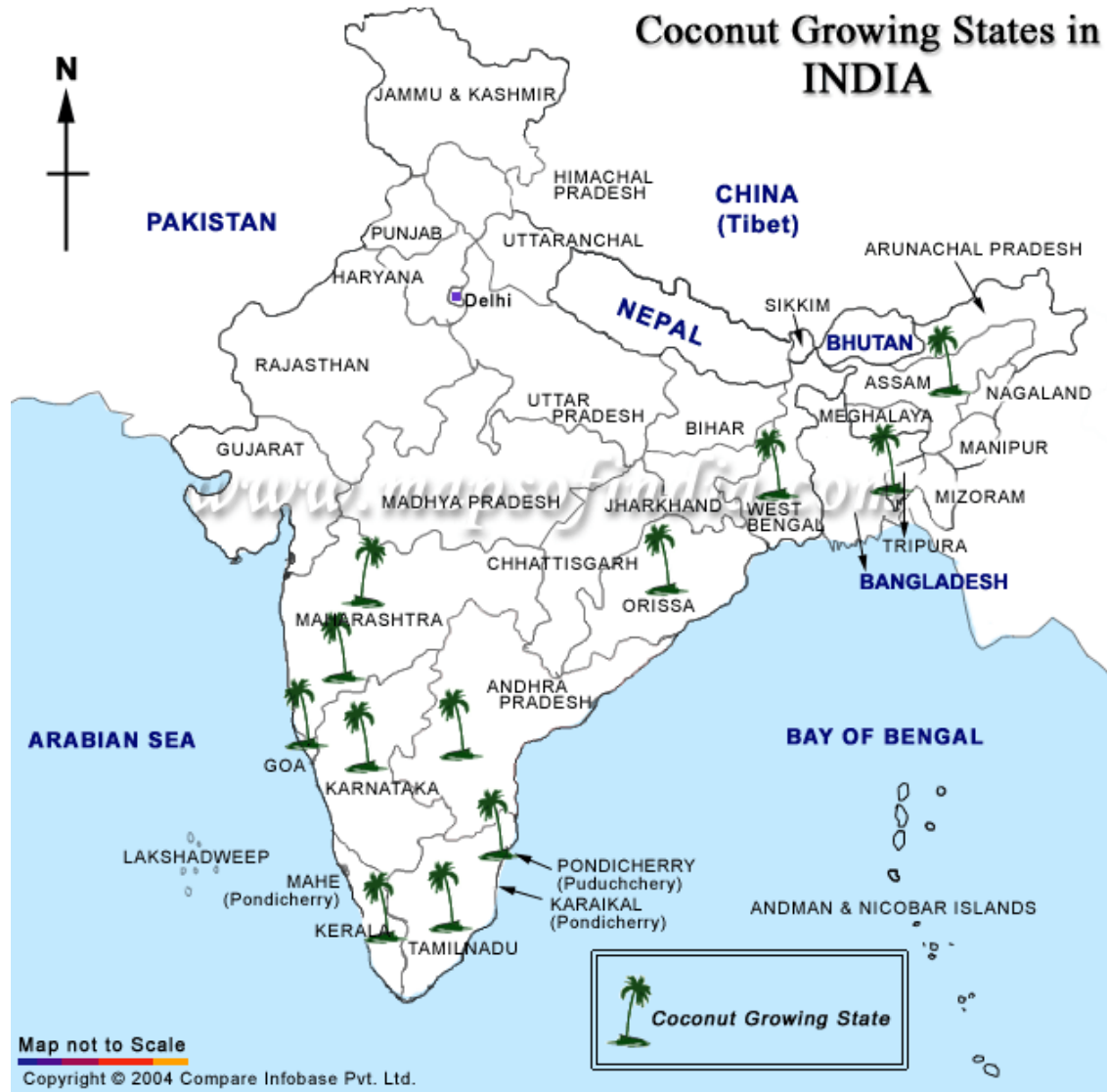
# 5. Indian production scenario



## 6. Raw material resource in various parts of India



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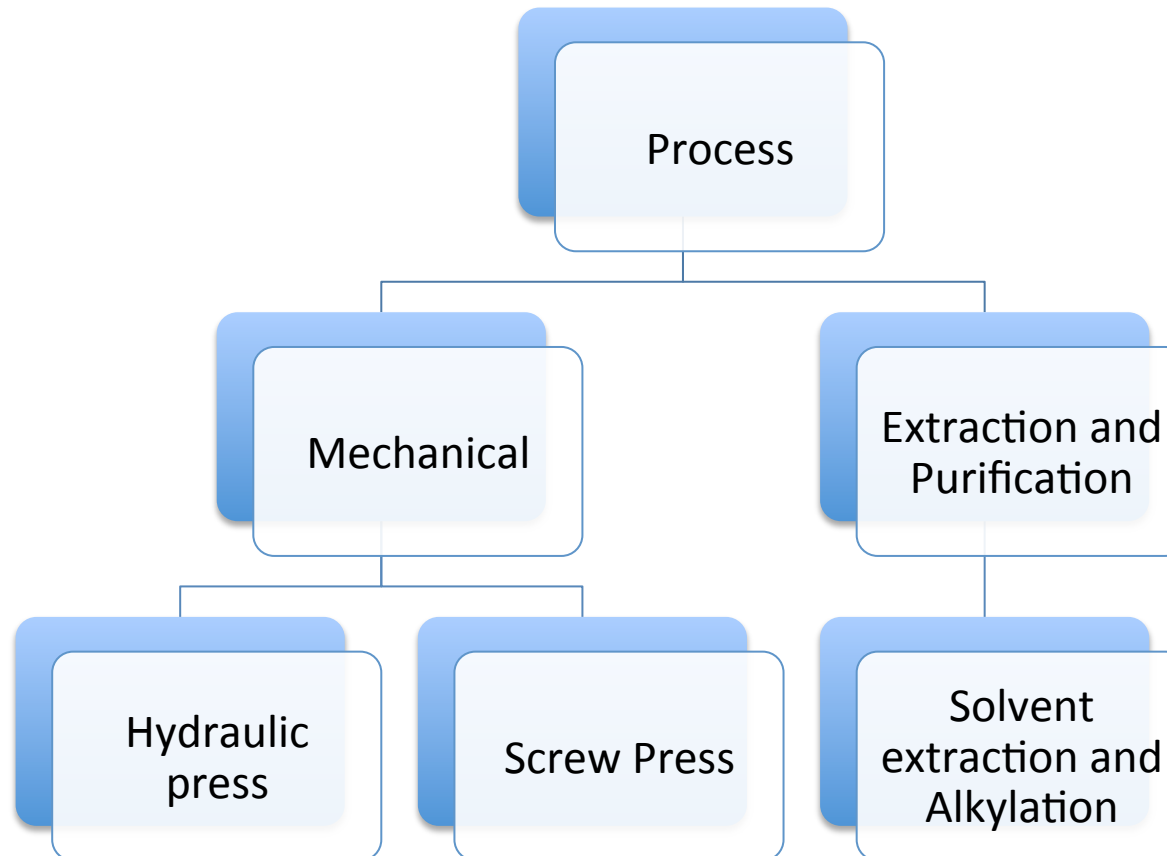
## 6. Raw material resource in various parts of India



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## 7. Methods of production – Edible and Essential Oils



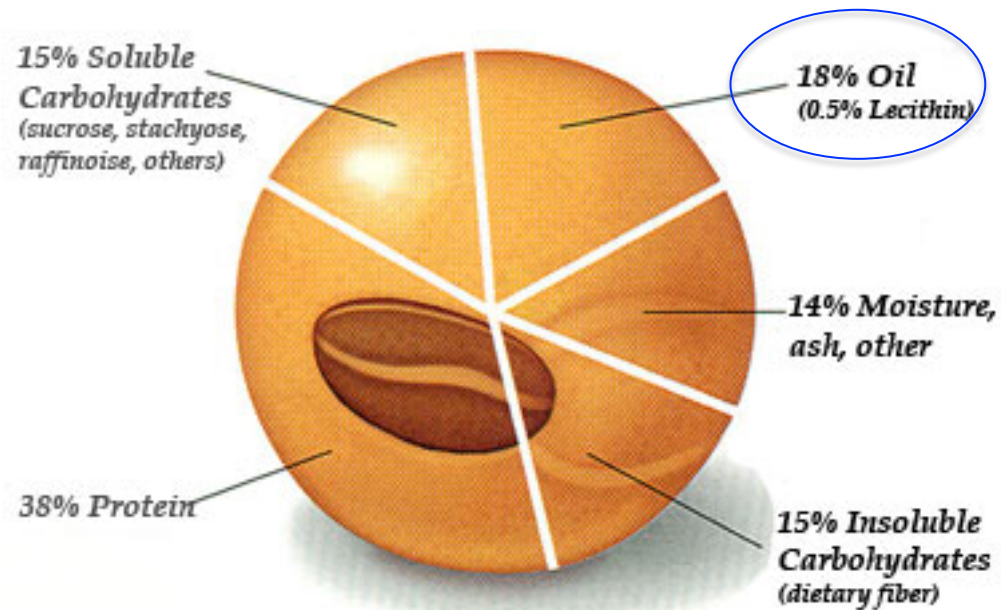
# 8. Soybean oil production

## Composition of Soybean

**WISHH**

**World Initiative for Soy in Human Health**

*Enhancing human well-being through soy*



<http://www.wishh.org/aboutsoy/composition.html>

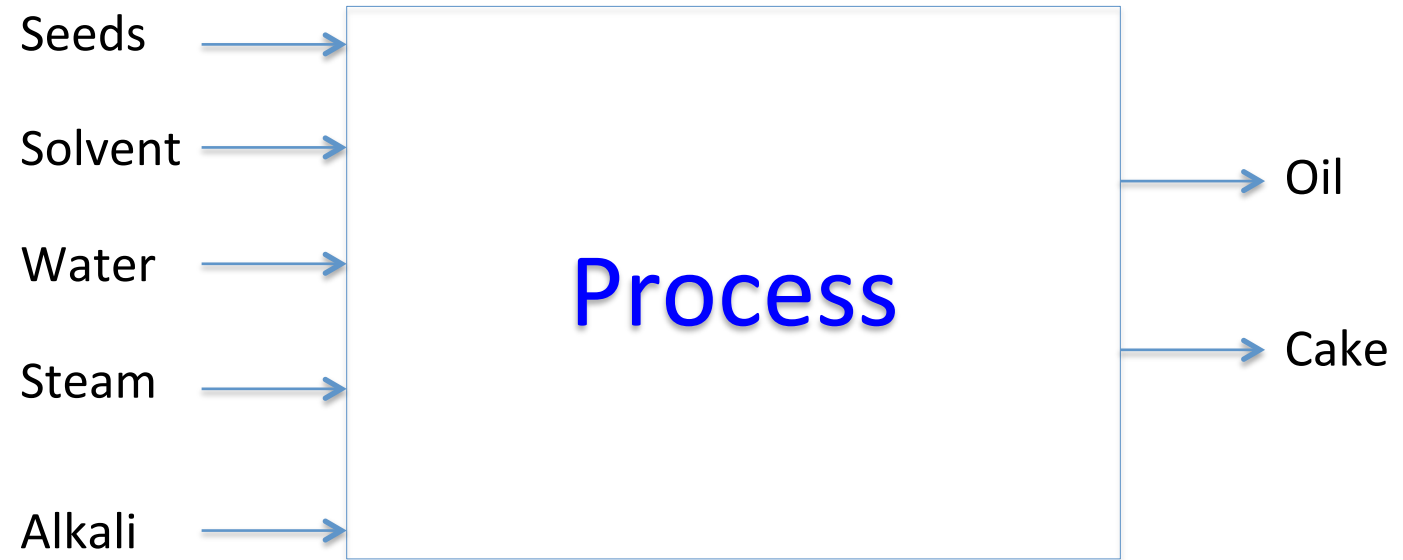
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# 8. Production Process – Soybean oil

## Process



## Yield of oil

### Mechanical

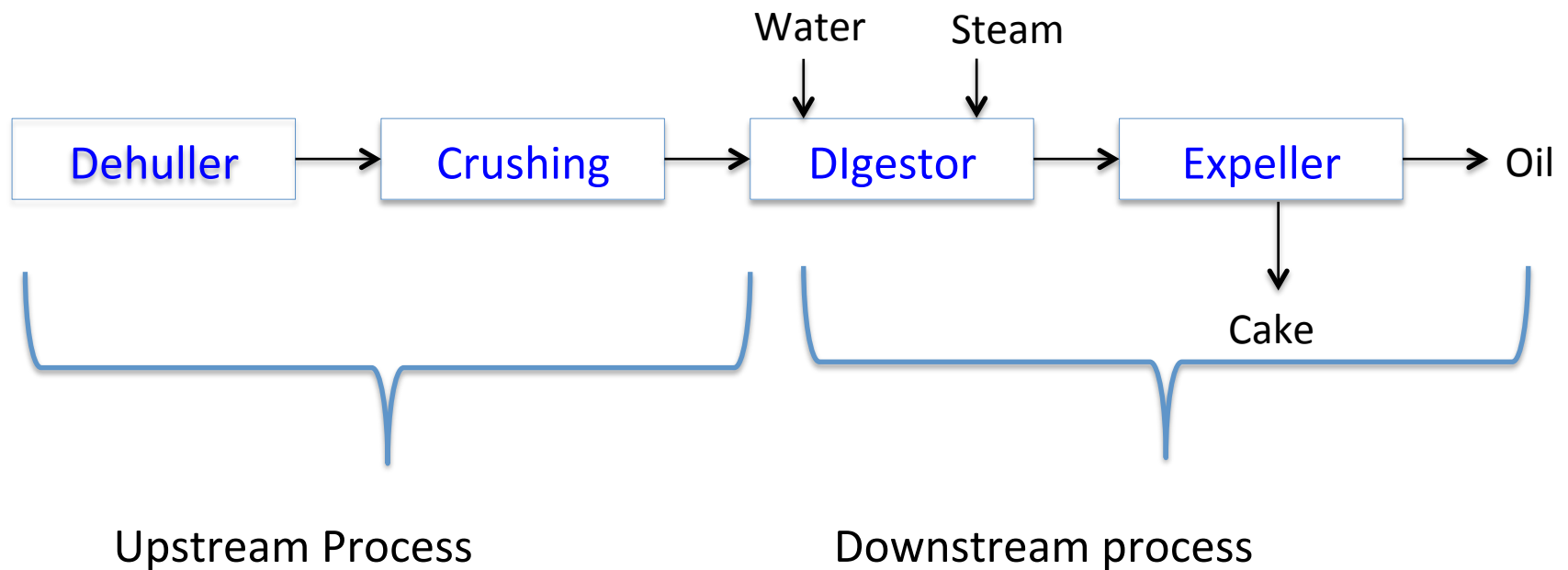
(i) Hydraulic = 14.5 kg/100 kg = 81%

(ii) Screw expeller = 15.3 kg/100 kg = 85%

Solvent Extraction = 18.2 kg/100 kg = **98%**

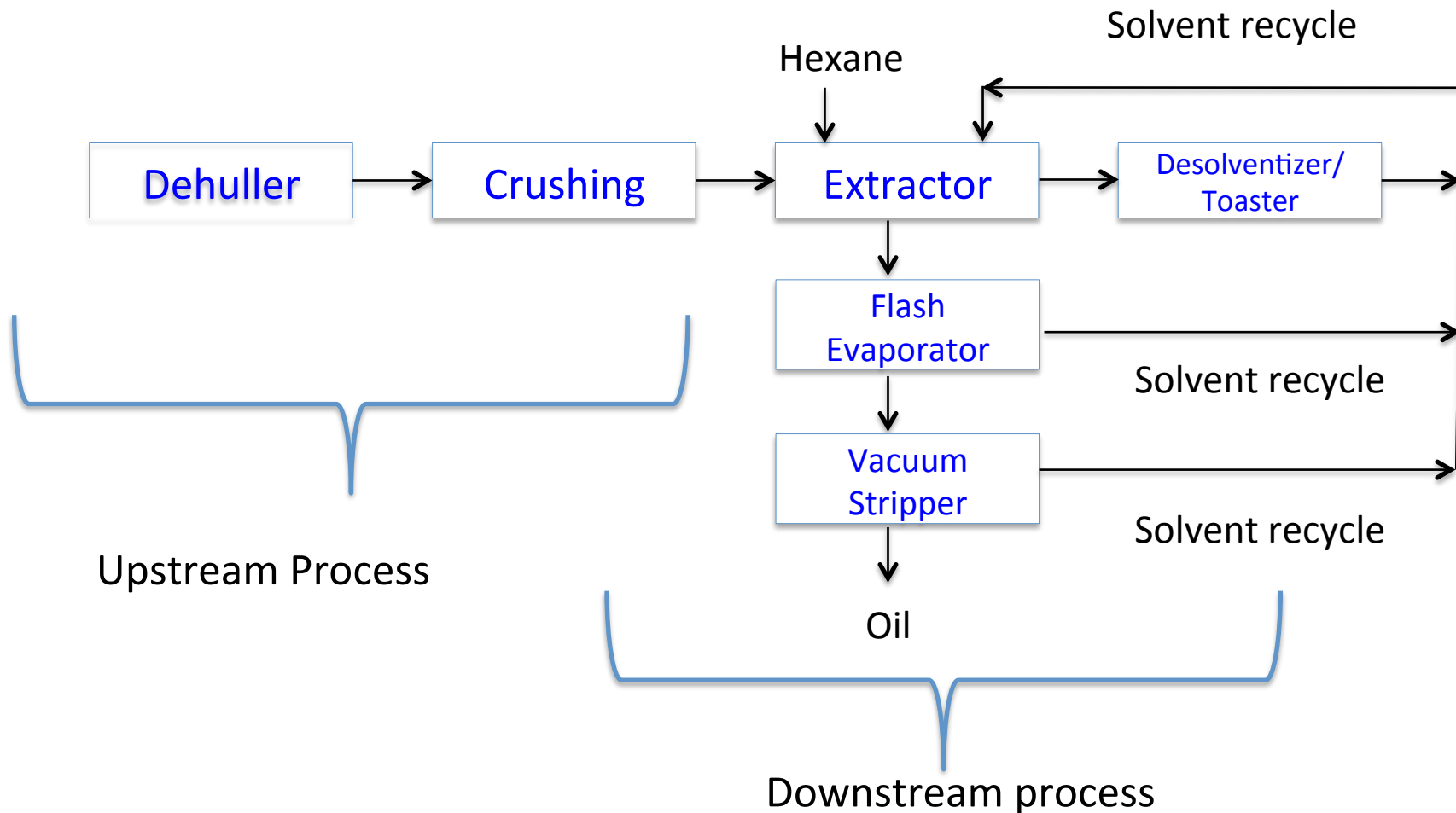
# 8. Production Process-Block diagram

## Mechanical Method



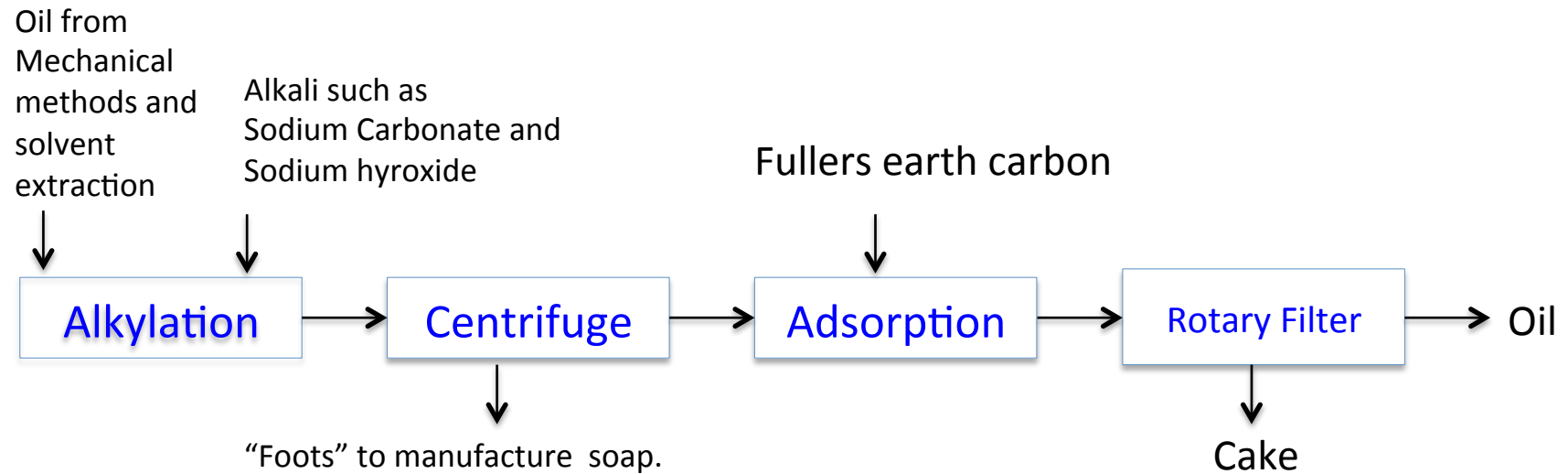
# 8. Production Process-Block diagram

## Solvent Extraction Method

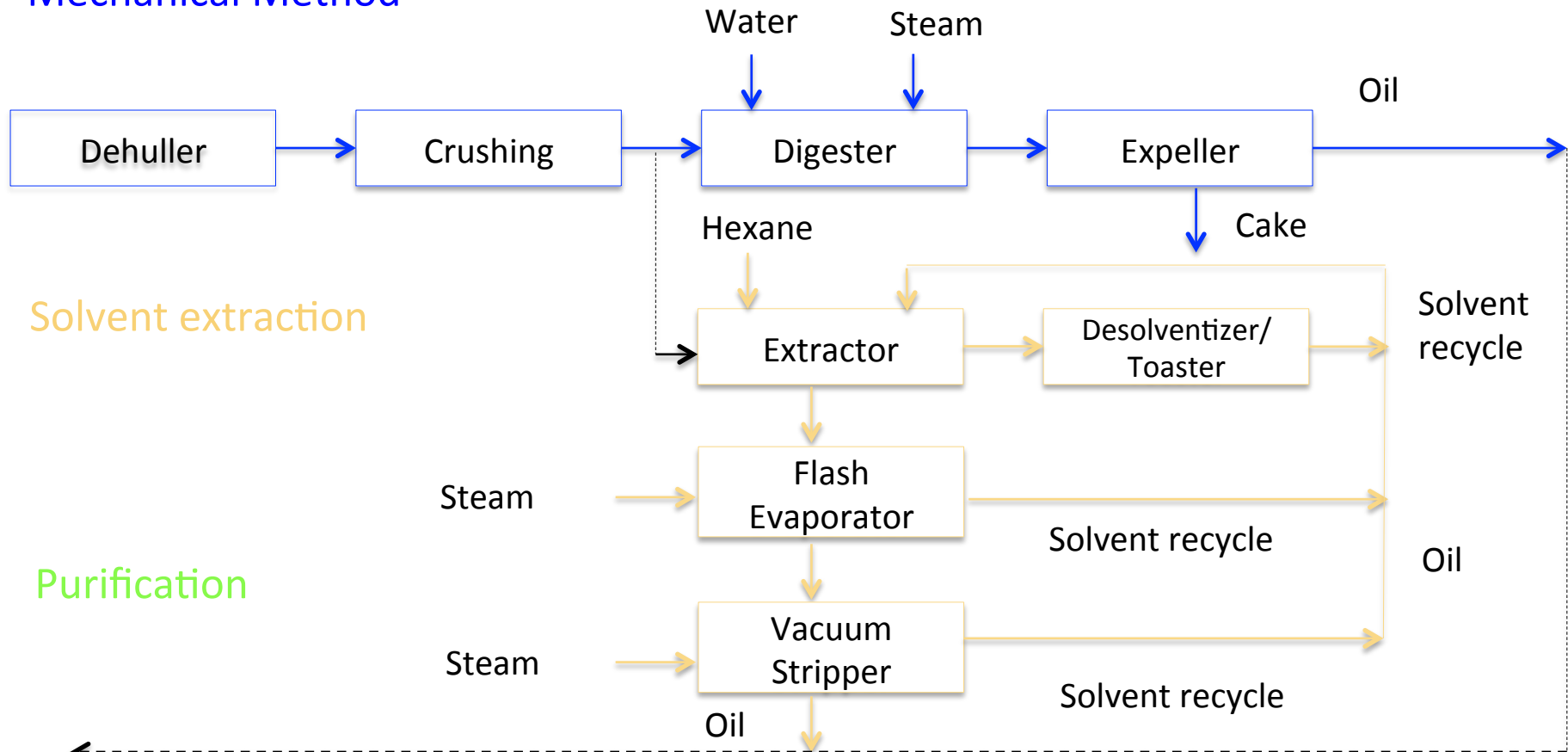


# 8. Production Process-Block diagram

## Purification

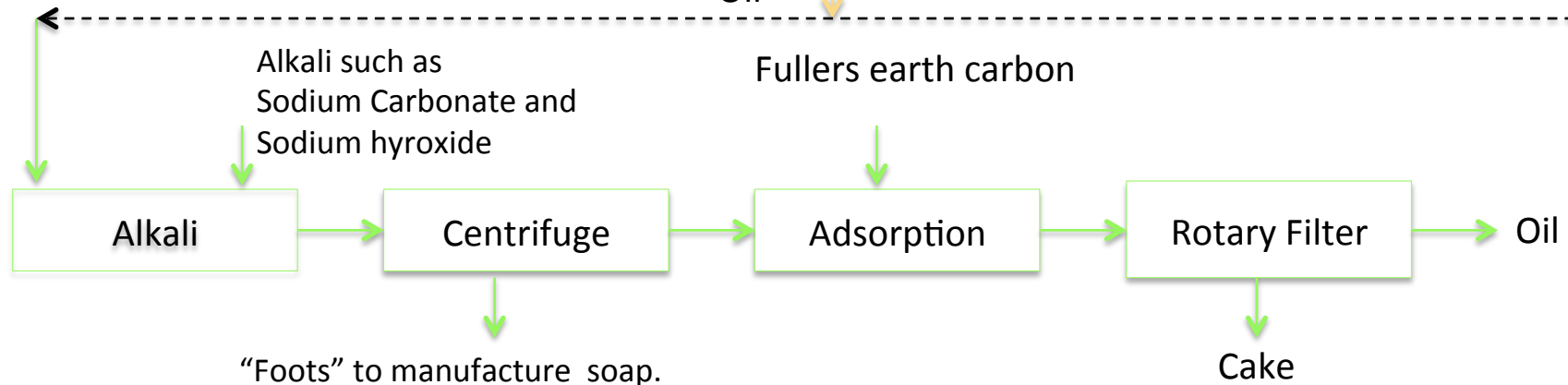


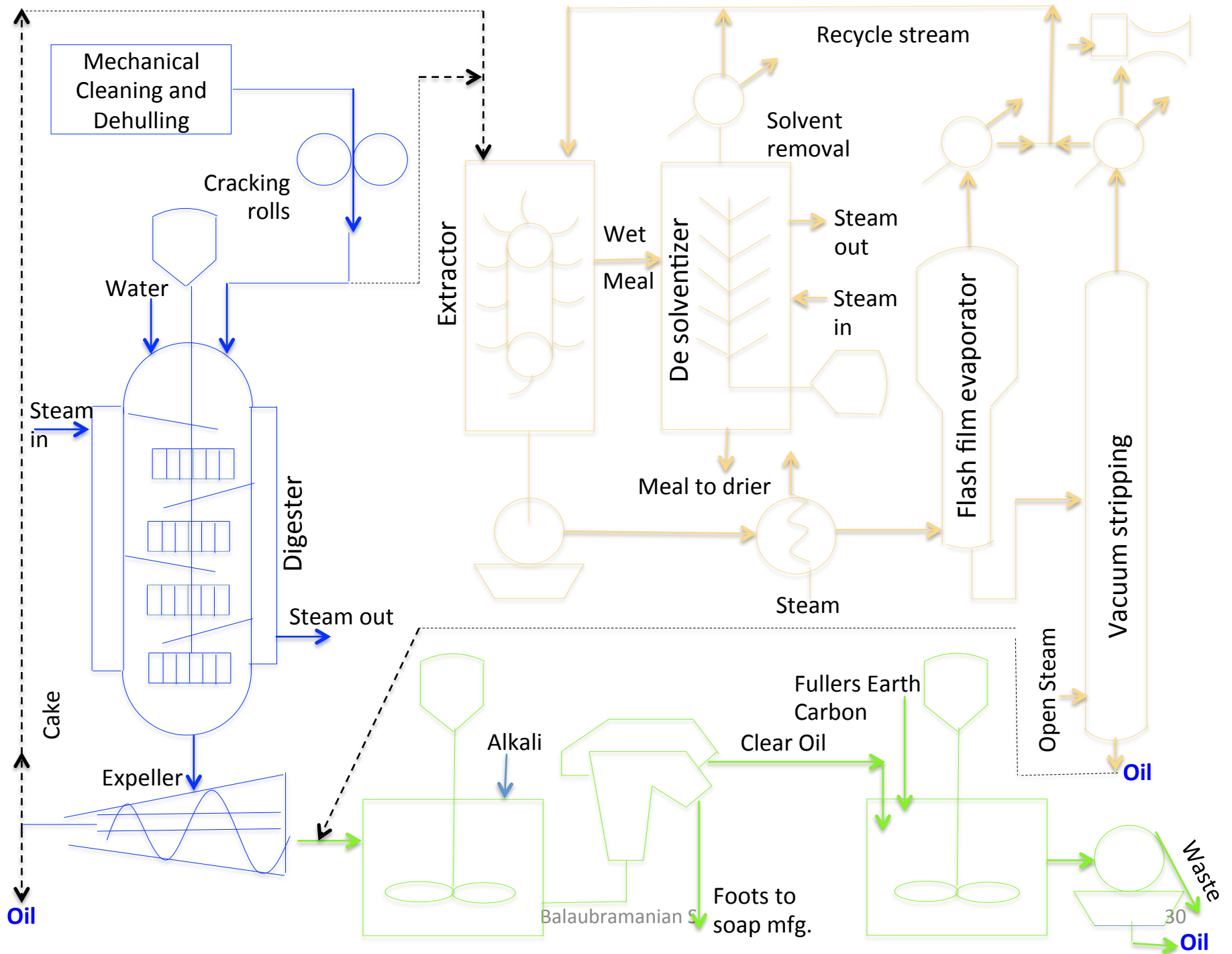
# Mechanical Method



# Solvent extraction

# Purification





# 9. Process Description

S. No	Process	Equipment	Unit operations	Unit process	Objective	Operating conditions
1.	Mechanical (Batch)	(a) Dehuller – Mechanical Cleaning and Dehulling	Physical Operation – Cleaning	_____	Cleaning and removal of hull	_____
		(b) Cracking rolls or Crusher	Size reduction	_____	Size reduction of seeds into flakes	_____
		(c) Digester	Steam cooking	_____	Make the flakes more susceptible to release oil	220 -250 °F (104 – 121 °C)
		(d) Screw Expeller	Solid-Liquid separation by pressing	_____	Release of oil from cooked	_____

# 9. Process Description

S. No	Process	Equipment	Unit operations	Unit process	Objective	Operating conditions
2.	Solvent Extraction (Continuous)	(e) Extractor	Extraction (Solid-Liquid) Separation	_____	Removal of solute(oil) from the seeds (flakes) by adding solvent (hexane)	80 – 96 °C
		(f) Desolventizer or Toaster	Solid-Liquid Separation	_____	Separation of solvent hexane from the cake (meal)	_____
		(g) Flash film or rising film evaporator	Liquid – Liquid Separation	_____	Separation of hexane from water and oil	_____
		(h) Vacuum Stripper	Gas – Liquid Separation	_____	Separation of volatile (gas) or odorous components from the solute oil (Liquid)	_____



# 9. Process Description

S. No	Process	Equipment	Unit operations	Unit process	Objective	Operating conditions
3.	Purification (Continuous)	(I) Mixer - Settler	_____	Alkylation	Alkali such as Sodium hydroxide and Sodium Carbonate is added to remove free fatty acids as "Foods"	_____
		(j) Centrifuge	Solid – Liquid Separation	_____	Removal of "foods" by centrifugation	_____
		(k) Adsorber	Solid – Liquid Separation	_____	Removal of color components using adsorbents like fullers earth carbon	_____
		(l) Rotary drum filter (for large scale) or Plate and Frame filter press (for small scale)	Solid – Liquid Separation	_____	Separation of oil and solid waste or rejects	_____

# 10. A simple mass balance-Mechanical Process

## Commercial Production

Commercial production =  $f$  (Unit operation + Unit processes)

(or)

Commercial production =  $f$  (Physical Changes+ Chemical Changes)

## Plant Attainment

The continuous process designed to operate 24 hours a day, 7 days a week, through out the year as well. Some downtime (startup and shutdown) will be allowed for some process.

The plant attainment, that is, the percentage of available hours in a year that plant operates, will be usually 90 to 95%

Therefore,

Plant attainment, % =  $(\text{hours operated}) / (8760) \times 100$

# 10. A simple mass balance-Mechanical Process

## Plant Attainment

If we assume that the soybean oil production plant has plant attainment of 95%, then the number of hours plant operated in a year is calculated as follows

$$1 \text{ year} = 365 \text{ days} = 8760 \text{ hours}$$

$$\text{Plant attainment, \%} = (\text{hours operated}) / (8760) \times 100$$

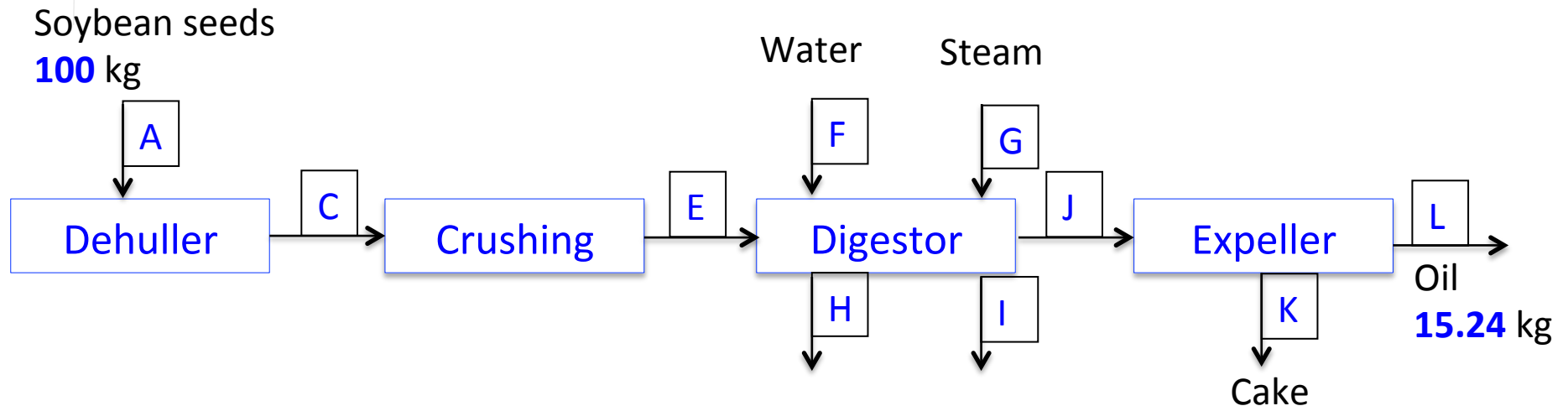
$$95\% = (x) / (8760 \text{ h}) \times 100$$

$$95 / 100 = (x) / (8760 \text{ h})$$

$$(x) = 8760 \times 0.95 = 8322 \text{ h}$$

Hence the number of hours plant operated in a year = **8322 h = 347 days**, allowing 18 days in a year for shut down and start up process.

# 10. A simple mass balance-Mechanical Process



Stream, kg/h	A	B	C	D	E	F	G	H	I	J	K	L
Protiens	68.00	0.68	67.32	0.67	66.65	0.00	0.00	6.67	0.00	59.99	58.79	1.20
Oil	<b>18.00</b>	0.18	17.82	0.18	17.64	0.00	0.00	1.76	0.00	15.88	0.64	<b>15.24</b>
Moisture and Ash	14.00	0.14	13.86	0.14	13.72	0.00	0.00	1.37	0.00	12.35	12.35	12.35
Water	0.00	0.00	0.00	0.00	0.00	100.00	0.00	10.00	0.00	90.00	88.20	1.80
Steam	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	98.00	0.00	0.00	0.00
<b>Total, kg/h</b>	<b>100.00</b>	1.00	99.00	0.99	98.01	100.00	100.00	19.80	0.00	178.21	147.62	30.59

If the plant produces 17.99 or 18 kg per hour of soybean oil, then for one year of continuous operation i.e. **8322 h = 347 days**, allowing 18 days in a year for shut down and start up process. The quantity of soy bean oil produced will be **365.78 kg per day** i.e. **1,26,926.7149 kg per annum** or **126.93 tons per annum**

# 11. Hydrogenation of edible oil

## Hydrogenation

Hydrogenation is a unit process which is used in the fat and oil industry to **remove the double bonds**, raise melting point of the fat, and **improve its resistance to rancid oxidation**.

## Hardening of oils

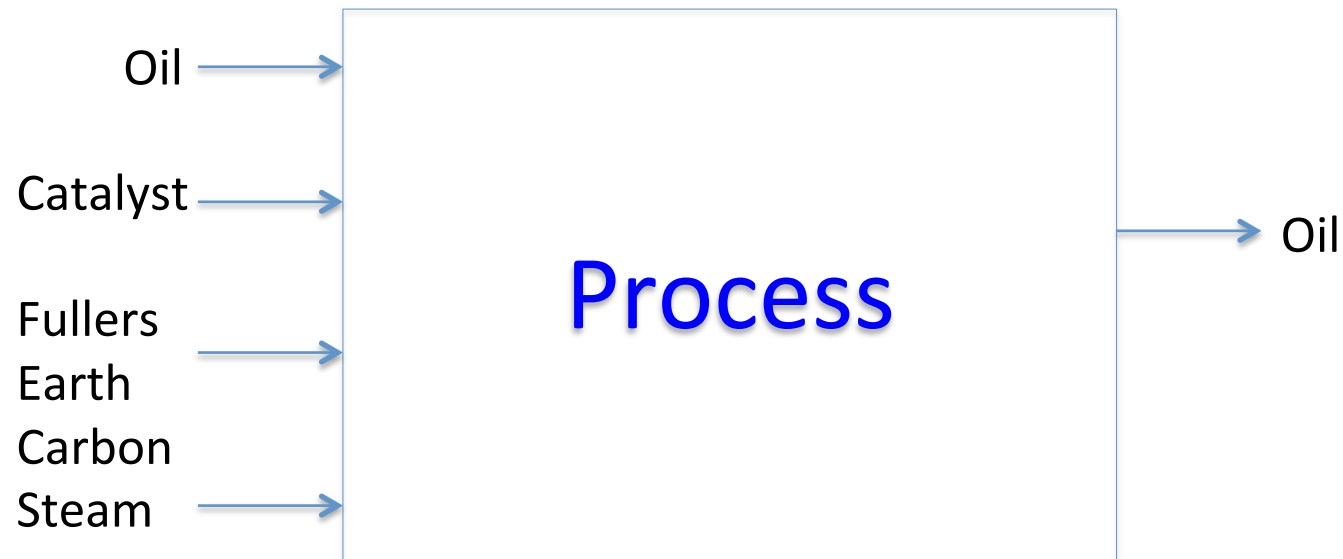
Glycerides of unsaturated acids are liquid at room temperature and so are unsuitable for edible fats. By converting the **unsaturated acids into saturated acids, oils are changed into fats** by introduction of **hydrogen**.

This introduction of hydrogen is known **as *hardening of oils***. The oil is heated and hydrogen is passed under pressure, in the presence of finely divided nickel catalyst.

The major end product in India is **Vanaspathi**, a solidified household oil for cooking. Other products are **vegetable ghee**, hardened industrial oil, and so on.

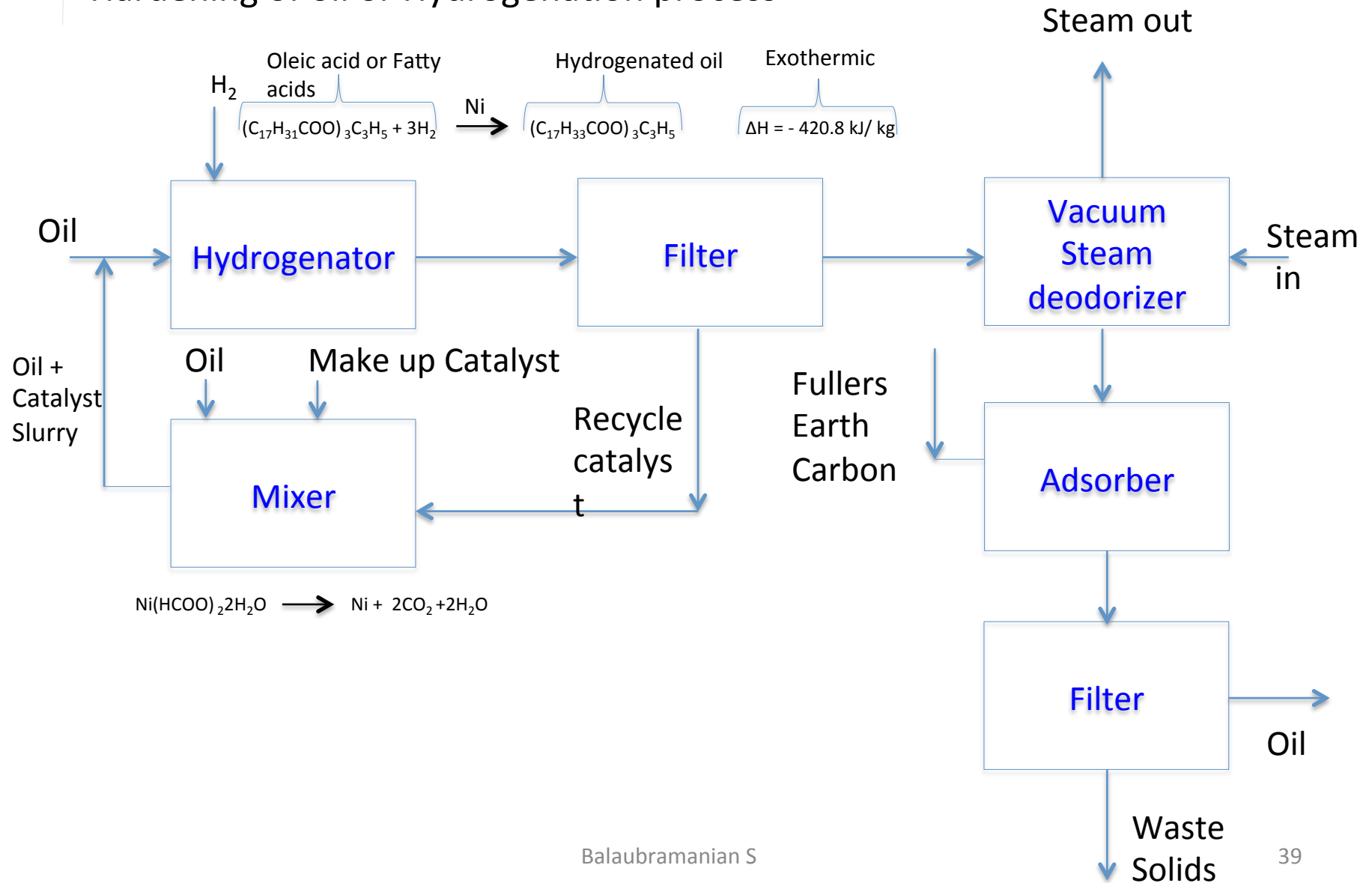
# 11. Production Process — Hydrogenation of oils

General process

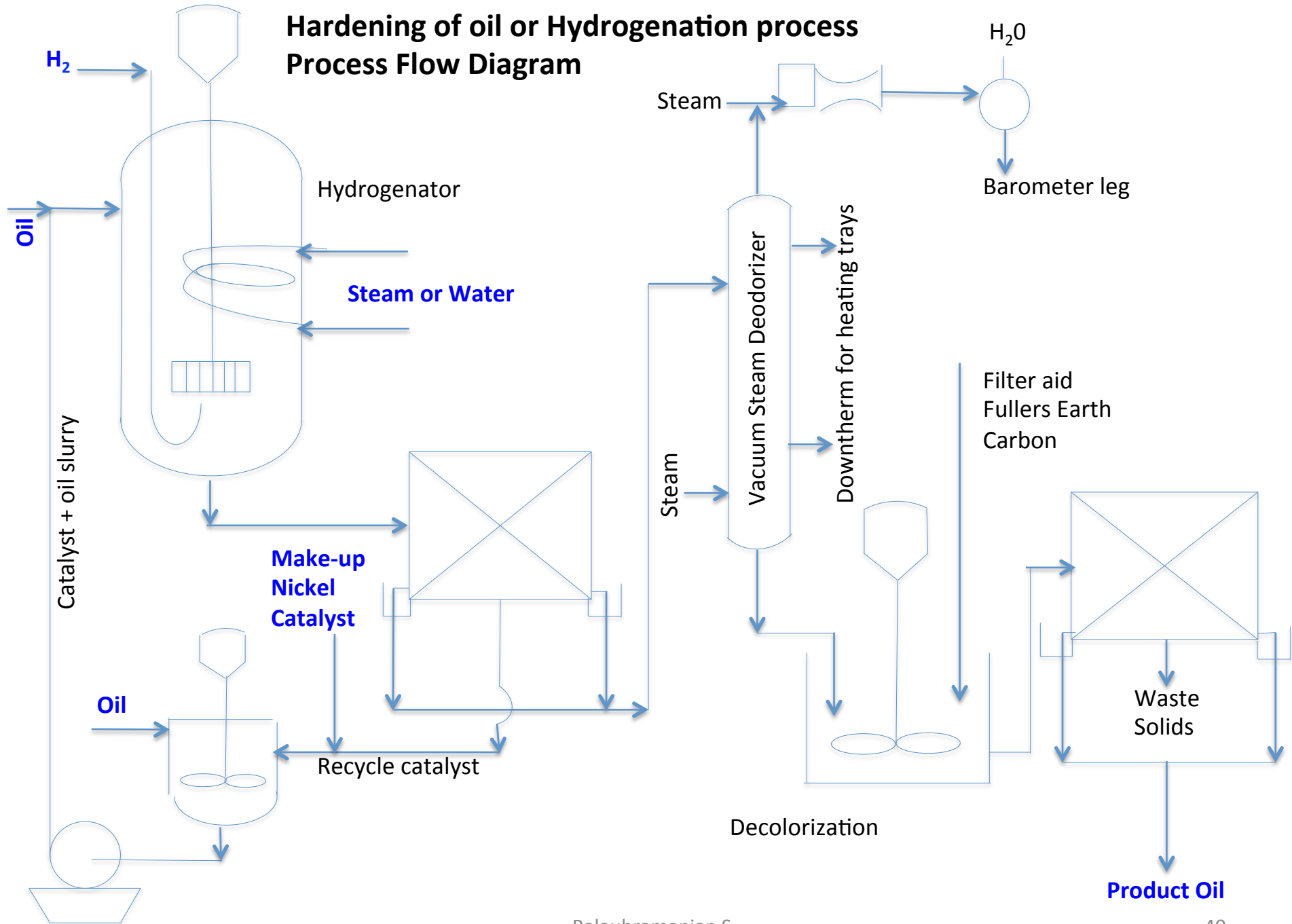


# 11. Production Process- Block diagram

Hardening of oil or Hydrogenation process



# Hardening of oil or Hydrogenation process Process Flow Diagram





# 12. Process Description

S. No	Process	Equipment	Unit operations	Unit process	Objective	Operating conditions
1.	Hydrogenation (Batch/Continuous)	(a) Hydrogenator	_____	<b>Hydrogenation</b>	Remove the double bond to improve the resistance to rancidity	1 – 2 atm 120 -160 deg. C
		(b) Filter	Solid-liquid separation	_____	Separation and recycle of oil and oil slurry with catalyst	_____
		(c) Vacuum steam deodorizer	Liquid-gas separation	_____	Remove volatile odorous materials by using steam	_____
		(d) Adsorber	Solid-liquid Separation by pressing	_____	Removal of color components using adsorbents	_____
		(e) Filter	Solid-liquid separation	_____	Separation of oil and solid waste	_____
		(f) Catalyst mixer	Solid-Liquid mixing	_____	Mixing of catalyst With oil	_____



# 13. End uses of edible and essential oils

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## **Edible oils**

Food - Hydrogenated oil (Vanaspathi)

Soaps and Detergents

Cosmetics

Paints and Varnishes

## **Essential oils**

Cosmetics

Perfumes

Soaps

Medicines



# 14. References

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