Hydrogenation of Oil

by

Dr. Mitali Madhumita

Centurion
UNIVERSITY

Definition: **Hydrogenation** is a process that reduces unsaturated fatty acid content of triglycerides by attaching hydrogen atoms at the point of unsaturation in the presence of catalyst, usually Nickel.

- Hydrogenation is a process in which a liquid unsaturated fat is turned into a solid fat by adding hydrogen.
- Hydrogenation accomplishes two things-:
  - It increases the melting point of the oil or fat.
  - Resistance to oxidation and flavor deterioration.
- Hydrogenation process depends on several parameters:
  - Pressure& Temperature,
  - Type of catalyst,
  - Speed of agitation etc.

- Hydrogenation converts the liquid oils into semisolid or plastic fats for special applications, such as in shortenings (100% fat) and margarine (80% fat), and it improves the oxidative stability of the oil .

- Hydrogenation requires a catalyst to make the reaction to go at a reasonable rate. The reaction will go without a catalyst , but it needs extremely high temperatures.

- A metal catalyst provides an alternate pathway with a lower activation energy. This allows the reaction to take place at lower temperatures.

- Hydrogenation includes the formation of a saturated compound from an unsaturated compound.

Necessity for Hydrogenation

- Hydrogenated fat is basically a substitute to butter fats.
- Hydrogenated oil helps to increase shelf life and save cost.
- High costs of butter fat and its poor storage stability were detrimental factors that led to the investigation of alternative sources of hard fats.
- This investigation led to the invention of catalyzed H2 addition across unsaturated sites of oils and fats and was quickly commercialized.
- Conversion of liquid oils to solid and semi-solid fats having wide spectrum of physical & chemical characteristics of products were thus obtained

MECHANISM

- The mechanism involved in fat hydrogenation is believed to be the reaction between unsaturated liquid oil and atomic hydrogen adsorbed on a metal catalyst. It is similar to hydrogenation of alkenes.

- Generally, hydrogenation reactions will not occur between hydrogen and organic compounds below 480 degrees Celsius without metal catalysts.

- Catalysts are responsible for binding the H2molecule and facilitating the reaction between the hydrogen and the substrate.

- Platinum, palladium, rhodium, and ruthenium are known to be active catalysts which can operate at lower temperatures and pressures.

- Research is ongoing to procure non-precious metal catalysts which can produce similar activity at lower temperatures and pressures.

- Nickel-based catalysts, such as Raney nickel, have been developed, but still require high temperatures and pressures.

Hydrogen Dry, As pure as possible (usually >99.8%)

- Oil

• Refined,

• Bleached,

• Very low in soap(under 25 ppm)and dry.

• Moisture-Less than 0.05%

• FFA-Less than 0.05%

- Catalyst-

• Reduced Nickel:Concentration-0.01-0.02% (Palladium, Platinum can also be used but avoided due to their high costs)

REACTION CONDITIONS PARAMETER

- Condition Temperature: 140-250°C
- Hydrogen Pressure: 40-60 psi
- Agitator Speed :75-150 rpm
- Cool Water Temperature: 10-20°C
- Cooled Oil Temperature: 70-80°C
- Time: 40-60 min

Monitoring End of Reaction

Technique Used	Principle
Refractive Index :	Refractive Index decreases on hydrogenation
Iodine Value :	Iodine value decreases on hydrogenation
Melting Point:	Melting point increases on hydrogenation
Peroxide Value:	Peroxide value decreases on hydrogenation
Colour:	Colour becomes darker on hydrogenation