Alfa Laval India in Vegetable Oil Industry

- 40 years of varied experience.
- As on date majority of Indian market share.
- Supplied more than 600 projects within India.
- Supplied 150 projects outside India.
- All key equipment’s are manufactured under one roof.
Alfa Laval’s Contribution to Edible Oil Industry

- Started serving edible oil Industry by introduction of Solid Bowl Separator: Model SRG-509 suitable for 50 TPD capacity.

- The Concept of “Short mix” to process industry was introduced by Alfa Laval and successfully converted batch neutralizers to continuous Neutralization/Degumming etc.

- Continuous refinery: Early 1980

- Till early 1990’s the concept of continuous refinery was well accepted by the Industry.

- This continuous technology has resulted in “reduction in Oil loss, better quality of end product, increased shelf life and reduced process cost.”
Alfa Laval's Contribution to Edible Oil Industry

- **HEAT RECOVERY** awareness drive was started by Alfa Laval to further meet the expectation of Industry.
- **Critical Instrumentation** Alfa Laval also introduced the concept of critical instrumentation within the refinery. (like Steam Control valves, Frequency Drives, Level control system etc.)
- This has resulted in lowering the steam consumption, Better Energy Saving, Better control on process with better quality etc.

- Thanks to yellow revolution which boosted oil production in the country during 1986 to 1997
- With the time, demand for 100 TPD capacity refinery started coming in.
- Alfa Laval introduced new separator SRG-610 for this capacity.
- With this model the power and water consumption went down.
- What is Next? Customers Expectations were very high and looking for further improvement in efficiency and losses.
- **First Self – Cleaning Separator** is introduced in 1995-1996.
- This separator was PLC based and was used in Degumming application.
- The PLC based automated separator resulted in better control over process thus resulted in better separation. It also minimized the human intervention.
Alfa Laval's Contribution to Edible Oil Industry.

- GOLDEN ERA OF EDIBLE OIL INDUSTRY.
- Port Based Refinery Concept became the reality from 2001 onwards.
- Plant with capacity of 1000 TPD, 800 TPD, 600 TPD became the norm.
- This size of plant needed to run with maximum efficiency and minimum intervention of people.
- For this reason the concept of PLC based SCADA system came in.

Latest Technology development in Edible oil
Latest Technology development in Edible oil

- **Latest Development in Chemical Refining**
  - Enzymatic Degumming for higher Oil Yield and Physical Refining
  - Contherm and Convap for High Grade Lecithin
  - Soap Adsorbent System to reduce effluent generation
  - Implementation of controlled flow Cavitation Technology

- **Bleaching**
  - Prefiltration and Precoating system for reduction in bleaching earth consumption
  - Dry and Wet Bleaching Process
  - Two Stage bleeding - Silica adsorbent system
  - Mitigation of 3 MCPD

- **Deodorizer**
  - GE removal
  - Highest Heat Recovery - low Processing Cost – VHE, VHF
  - Double Scrubber system for higher yield
  - Patented Alfa Laval Soft Column Deo with thin film Technology
  - Closed loop and ICE Condensation Vacuum system
  - SoftFlex™ Deodorizer for Stock change
Up Coming Demand in Edible Oil Industry

<table>
<thead>
<tr>
<th>DEMAND</th>
<th>ALFA LAVAL TECHNOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 MCPD &amp; GE a new Challenge</td>
<td>De-chlorination &amp; GE Mitigation by Improved design</td>
</tr>
<tr>
<td>Zero Trans in Refined Oil</td>
<td>Soft Column Deodorizer</td>
</tr>
<tr>
<td>Less Environmental Impact</td>
<td>Self Cleaning Separator VO Series, VHE, PHE, Closed loop vacuum system.</td>
</tr>
<tr>
<td>Efficient Processes</td>
<td>Enzymatic degumming, Cavitation Technology, Dual Scrubbing</td>
</tr>
<tr>
<td>RBO Winterization</td>
<td>Continuous Winterization for 0 deg C Cold Stability</td>
</tr>
<tr>
<td>Super Olein – Cloud Point , Yield</td>
<td>Low CP and Higher Yield</td>
</tr>
<tr>
<td>Value added Products</td>
<td>CIE, EIE, Tocoboost, Margarine &amp; Shortening</td>
</tr>
</tbody>
</table>

Vision: Delivery of highest quality edible oil at low operational Cost with improve efficiency and less Environmental Impact

Impurities to be removed during refining:
- Free fatty acids
- Phosphates
- Metals
- Pigments
- Oxidation products
- Mechanical impurities
- Moisture and volatiles
- Lipoproteins and glycoproteins
- Odoriferous compounds

The processes for removal of these impurities are called refining and as the chemical properties of these impurities are of different nature several refining stages have to be used.
Physical and Chemical Refining

- Acid Conditioning
- Bleaching
- Winterization
- Deacidification/deodorization

Crude oil → Physical refining → Acid conditioning → Winterization → Deacidification/deodorization → Bleaching

Chemical refining

- Water degumming
- Enzymatic degumming
- Acid oil

Physical refining

- Acid neutralization
- Alkali neutralization
- Dewaxing
- Soapstock splitting

Water degumming → Winterization → Deodorization → Extracted oil

Fatty acid distillate

Improvement in Chemical Refining

Water Degumming

Heater

Vacuum dryer

To storage
Alfa Laval's Current and Future Technologies in Edible oil

- Improved Chemical Refining
  - Contherm and Convap – Gum Drying

Scraped surface heat exchangers
ConVap/Contherm

- High heat transfer efficiency
- Configuration adapted to the product
  - Rotor selection
  - Scraper arrangement selection
- ConVap’s unique construction
- Easy operation and maintenance
Basic Flow Diagram

Alfa Laval's Current and Future Technologies in Edible oil

- Improved Chemical Refining
- Enzymatic Degumming for higher Oil Yield and Physical Refining
Enzymatic Degumming - Background

- Early in 2009 Alfa Laval took lead on enzymatic degumming by partnering with Verenium.
- With Biodiesel boom in Brazil, Alfa Laval successfully occupied 90% market share in enzymatic degumming & Physical refining.
- More energy efficient & Environmentally Friendly Processes
- Milder Processing giving more Natural Products

Enzymes – reduce degumming yield loss

- Phospholipases convert gums to oil-soluble & water-soluble fractions
- Final emulsion is reduced – less gums
- Cleaner separation of oil and water phases
- Less oil lost in heavy phase
**Type of Enzymes: PLA**

PLA enzymes react with ALL type of phospholipids

- **Phospholipid** (PC, PE)
- **Oil Phase** → Free fatty acid
- **Heavy Phase** → Lysophospholipid
- **Centrifugation** → PLA

---

**Type of Enzymes: PLC**

DSM Purina® enzyme (PLC) reacts with phospholipids PC & PE

- **Phospholipid** (PC, PE)
- **Oil Phase** → Diacylglycerol (DAG)
- **Heavy Phase** → Phospho Ester
- **Centrifugation** → PLC
Enzymatic deep degumming

TYPICAL RESULT

<table>
<thead>
<tr>
<th>Processes</th>
<th>Crude Soybean oil</th>
<th>Degummed with water</th>
<th>Degummed with PLC</th>
<th>Degummed with PLA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus (ppm)</td>
<td>1000 ppm</td>
<td>&lt; 200 ppm</td>
<td>&lt; 200 ppm</td>
<td>&lt; 10 ppm</td>
</tr>
<tr>
<td>Free fatty acid (%)</td>
<td>0.0%</td>
<td>0.8%</td>
<td>0.8%</td>
<td>1.1% ~ 1.3%</td>
</tr>
<tr>
<td>Dioctyl glycerol (DAG)</td>
<td>2%</td>
<td>2%</td>
<td>2.9%</td>
<td>2%</td>
</tr>
<tr>
<td>Expected process yield</td>
<td>96.80%</td>
<td>98.90%</td>
<td>97.35%</td>
<td></td>
</tr>
</tbody>
</table>
Improvement in Chemical Refining

Enzymatic Degumming

Plants sold in Brazil (9 plants last 3 years)

Alfa Laval’s Current and Future Technologies in Edible oil

• Improved Chemical Refining
  • Implementation of Cavitation Technology
Cavitation Technology in Long Mix Section

Cavitation Technology Benefits

- Oil Yield Improvement: 0.1-0.5%
- Reduction in:
  - Phosphoric Acid: 50-90%
  - Caustic Usage: 15-50%
  - Residual Soaps: to <150 ppm
  - Residual Phosphorus: to <5 ppm
  - Silica Usage: 40-100%
  - Water Washing: 50-100%
Alfa Laval's Current and Future Technologies in Edible oil

- Improved Chemical Refining
  - Soap Adsorbent System to reduce effluent generation

Soap Adsorbent System
Alfa Laval’s Current and Future Technologies in Edible oil

- Improved Chemical Refining
  - Implementation of Cavitation Technology
  - Enzymatic Degumming for higher Oil Yield and Physical Refining
  - Soap Adsorbent System to reduce effluent generation

- Bleaching
  - Two Stage bleaching - Silica adsorbent system

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Alfa Laval’s Current and Future Technologies in Edible Oil

- 3 MCPD and GE

Refinery – latest challenge

**Process contaminants:**

**3-MCPDE (3-monochloropropanediol esters)**
- Possible effect on kidney & male fertility*
- Formed at temp. >140°C, in the presence of chloride ions**
- Difficult to be removed after its formation

**GE (Glycidyl Esters)**
- Genotoxic and carcinogenic (can damage DNA & cause cancer)*
- Formed rapidly at temp. >220°C at long retention time
- Main pre-cursor Diacylglycerides (DAG)
- Can be removed by post-refining

*European Food Safety Authority (EFSA)
**Institute of Food Science & Technology, UK (IFST)

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3-MCPDE = 3-monochloropropane, 1,2-diol
GE = Glycidyl Ester
TAG = Tri-acylglycerides
DAG = Di-acylglycerides
MAG = Mono-acylglycerides
Cl = Chloride Ion
H+ = Acids
Formation mechanism from DAG to GE

Contributing factors:
- High Diacylglycerides (DAG)
- High deodorizing temperature (>220°C)
- Long retention time in deodorizer
- Hydrolysis at high temperature with steam effect

Ref: Sierdien et al. (2012) Food Chemistry 133, 2295-2302

Alfa Laval PalmFlex™ GE Stripping - Advantages

- One step refining (no re-refining)
- Higher oil quality & stability
- No post-bleaching earth consumption
- No oil loses in post-spent earth
- Saving of utilities consumption
- No increase in 3MCPD & FFA
- Superb bland taste & odourless
- High operation flexibility
Alfa Laval's Current and Future Technologies in Edible oil

- Deodorizer
  - **Highest Heat Recovery - low Processing Cost**
    - Double Scrubber system for higher yield
    - Patented Alfa Laval Soft Column Deo with thin film Technology
    - Closed loop or ICE Condensation Vacuum system for Low Processing Cost
    - SoftFlex™ Deodorizer for Stock change

[Diagram of Deodorizer System]
Alfa Laval's Current and Future Technologies in Edible oil

- Deodorizer
- Double Scrubber system for higher yield
Cost benefits Analysis Single Scrubber vs Double Scrubber

<table>
<thead>
<tr>
<th>Details</th>
<th>Single Scrubber</th>
<th>Double Scrubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed FFA</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>PFAD FFA</td>
<td>89%</td>
<td>93%</td>
</tr>
<tr>
<td>PFAD Generation A/B</td>
<td>5.62%</td>
<td>5.38%</td>
</tr>
<tr>
<td>Savings Per ton</td>
<td>(5.62-5.38)% = 0.24%</td>
<td></td>
</tr>
<tr>
<td>Oil Price @ Rs 65 / kg</td>
<td>2.4 kg X Rs 65 = Rs 156 / ton</td>
<td></td>
</tr>
<tr>
<td>For 100 TPD Plant yearly Savings 250 days</td>
<td>Rs 39 Lakhs</td>
<td></td>
</tr>
<tr>
<td>Investments</td>
<td>Rs 45 Lakhs</td>
<td></td>
</tr>
<tr>
<td>ROI</td>
<td>1.2 Years</td>
<td></td>
</tr>
</tbody>
</table>

Oil Price @ Rs 65 / kg 2.4 kg X Rs 65 = Rs 156 / ton

For 100 TPD Plant yearly Savings 250 days Rs 39 Lakhs
Investments Rs 45 Lakhs
ROI 1.2 Years

Alfa Laval’s Current and Future Technologies in Edible oil

- Deodorizer
  - Highest Heat Recovery - low Processing Cost – VHE , VHF
  - Double Scrubber system for higher yield
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  - Closed loop and ICE Condensation Vacuum system for Low Processing Cost
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## Conventional, Closed Loop and Ice Condensation Vacuum System

<table>
<thead>
<tr>
<th>Feature</th>
<th>Conventional</th>
<th>Chilled water</th>
<th>Ice Condensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Steam Consumption</td>
<td>High</td>
<td>Reduced Steam Consumption</td>
<td>Very Low Steam Consumption</td>
</tr>
<tr>
<td>Use of Dirty Cooling Tower</td>
<td>Reduced order Problem</td>
<td>Reduced order Problem</td>
<td>Much Reduced Order Problem</td>
</tr>
<tr>
<td>High Effluent emission</td>
<td>Reduced effluent emission</td>
<td>Reduced effluent emission</td>
<td>Much Reduced effluent emission</td>
</tr>
<tr>
<td>Vacuum of 1 to 1.5 mbar in the deo is possible</td>
<td>Vacuum of 1 to 1.5 mbar in the deo is possible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System is good for Zero Trans Oil</td>
<td>System is good for Zero Trans Oil</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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