March 2013

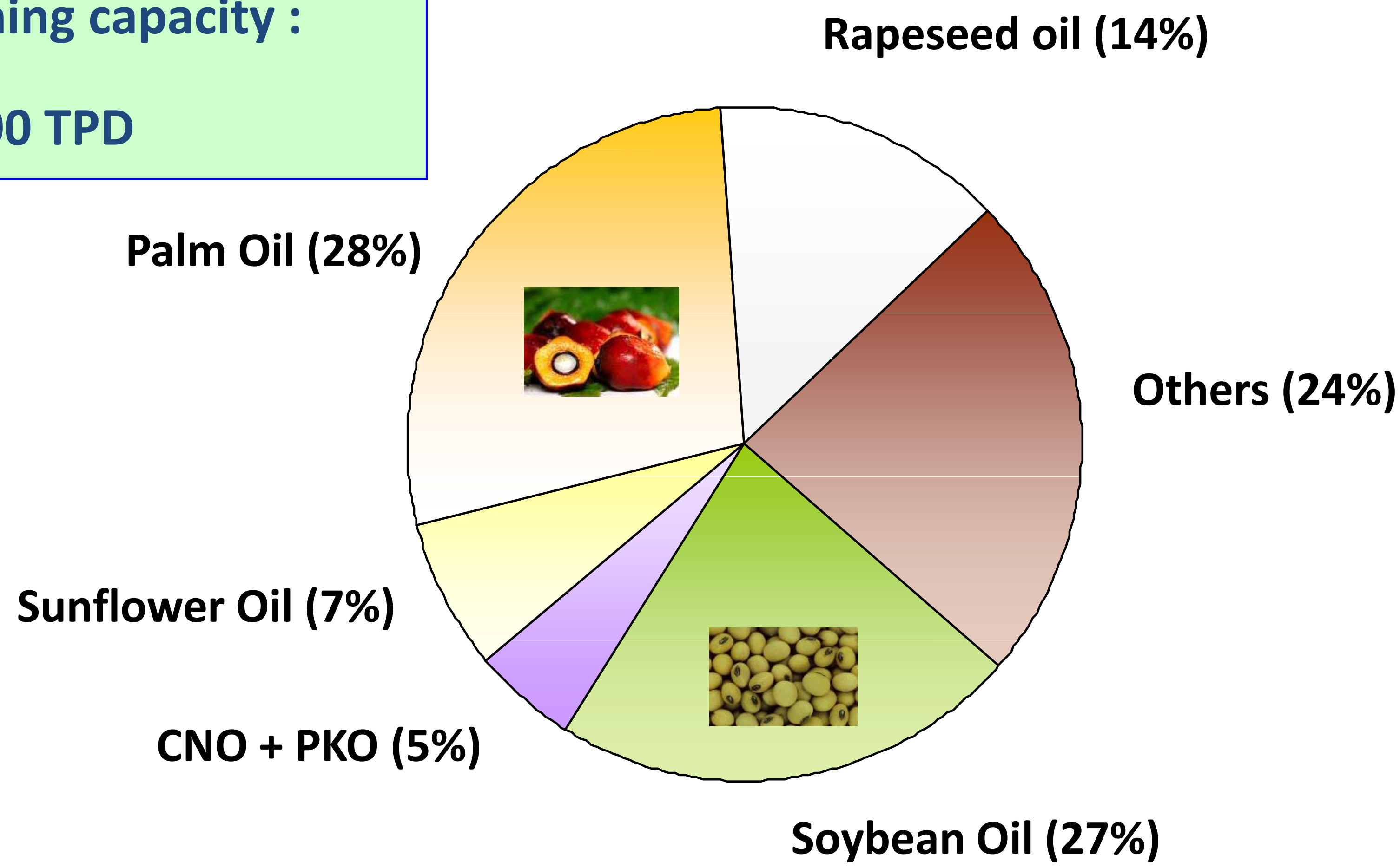
Nano-neutralization of soft oils : a cutting edge technology

desmet ballestra

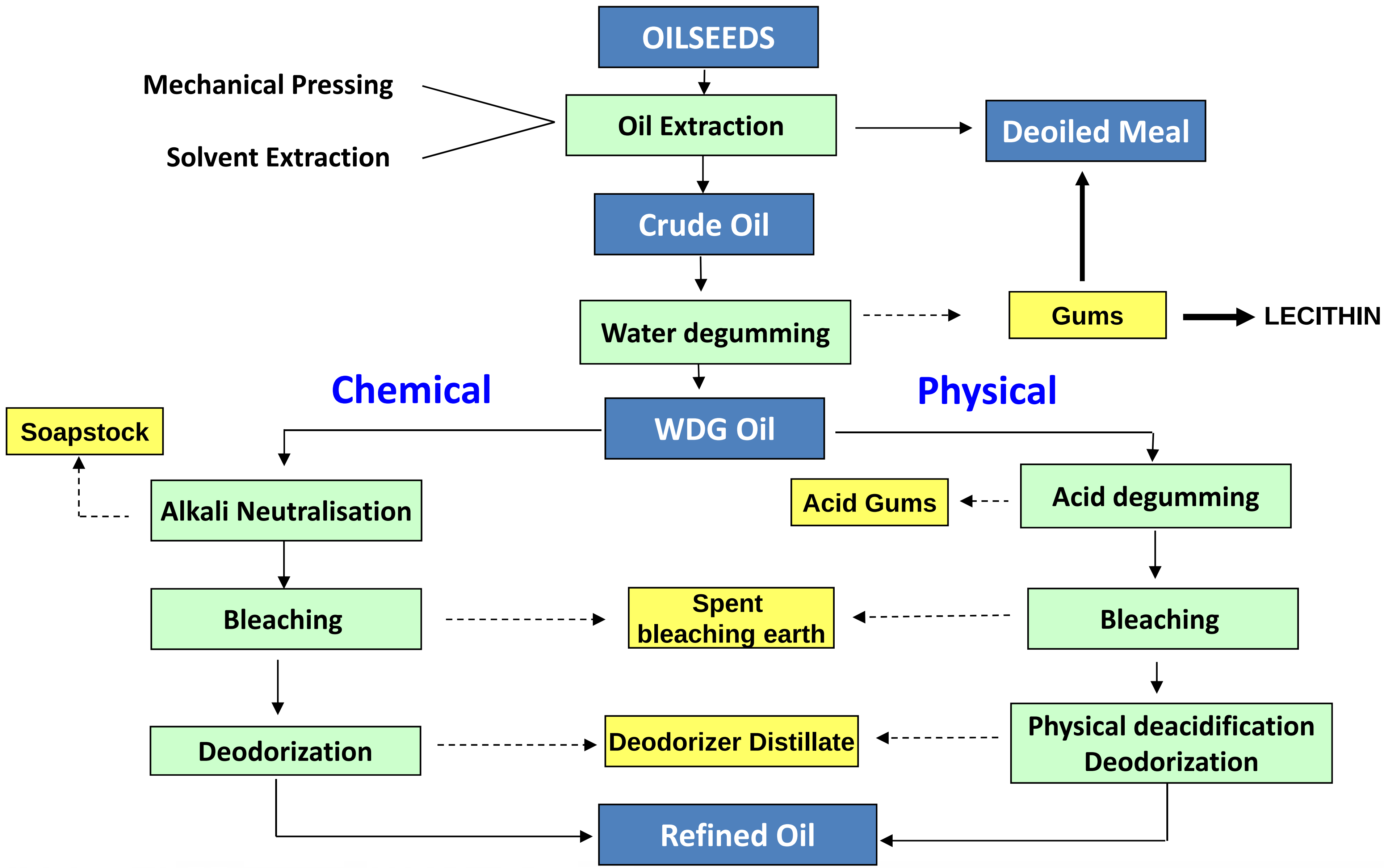
Global Edible Oil Production : 175 Mio tons

Required refining capacity :

400.000 TPD



Physical vs Chemical Refining



Chemical Refining

Still most widely applied refining process

** Independent of crude oil quality ('forgiving' process);*

** Usually gives good refined oil quality ('effect of caustic');*

** Most suitable process for stand-alone refineries;*

But, with its known drawbacks

** High neutral oil losses in the soapstock (especially for higher FFA oils) ;*

** Difficult valorization of the soapstock or acid oil;*

** Difficult and expensive wastewater treatment (environmental issue) ;*

→ **Clear demand for improved chemical refining**

Developments in Chemical Refining

Better valorisation of soapstock

** Dry chemical refining with CaO (formation of Ca-soaps);*

** Chemical refining with KOH (formation of K-soaps);*

** Not applied on industrial scale (not consistent, too high operating cost,..)*

Mechanical improvements

** Centrifugation : from tubular bowl to continuous selfcleaning machines ;*

** Use of better, more powerful mixing systems (less excess chemicals)*

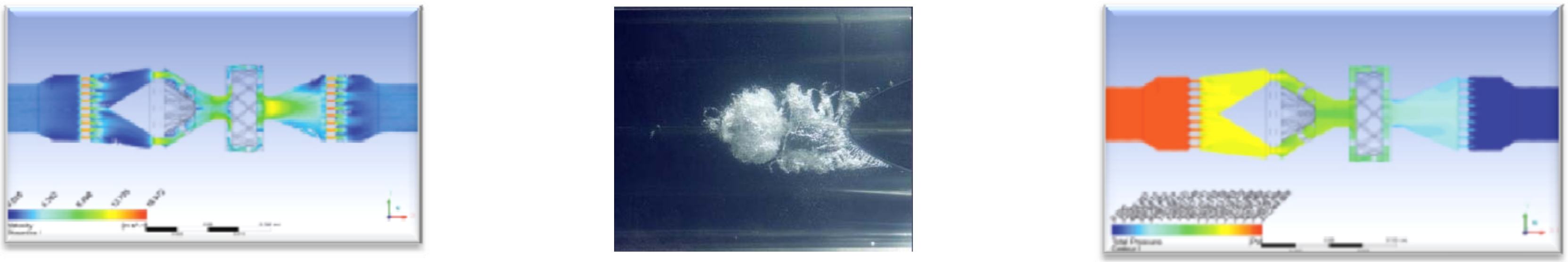
Process improvements

** Replacing water washing by dry 'silica' post-treatment (less waste water);*

**** Nano-reactor technology (only recently industrially applied)***

Nano Reactors®

- ***Hydrodynamic cavitation principle***
- **Effects are generated by pumping two liquids (e.g. oil + water) –from which at least one is low boiling - at high pressure through a specific designed device (nano-reactor)**
- **Formation of small 'nano' bubbles ('cavities') with release of large magnitudes of energy over a small area (high energy density)**



Typical velocity and pressure profile in a Nano Reactor

- **Much more energy efficient than the acoustic cavitation process**
- **Suitable for larger scale, continuous processes**

Applications of Nano Reactors®

Hydrodynamic cavitation

New technology with big potential in various applications

- **Process intensification (faster-higher yield-more efficient)**
- **Cell disruption (biotechnology)**
- **Microbial disinfection/destruction contaminants**
- **Other specific applications**

Use of Nano Reactors™ in Oil Processing

Ref : Gogate – Chemical Engineering and Processing 47 (2008),515-527

Nano Reactors®

- **Nano-reactor design**
  - ✓ Unique (patent pending) internal geometry
  - ✓ Consisting of a series of constrictions (e.g. nozzles)
  - ✓ Originally developed as biodiesel reactor
  - ✓ Optimized design for use in oil processing

Proprietary design of CTI

- **What's happening inside the reactor ?**
  - ✓ High turbulence
  - ✓ Very high shear forces

  → Very good contact

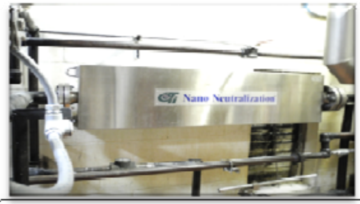
  - ✓ Disruption of molecular agglomerates (e.g. : phospholipid micelles)
  - ✓ Faster and more efficient reactions (e.g. FFA neutralisation)

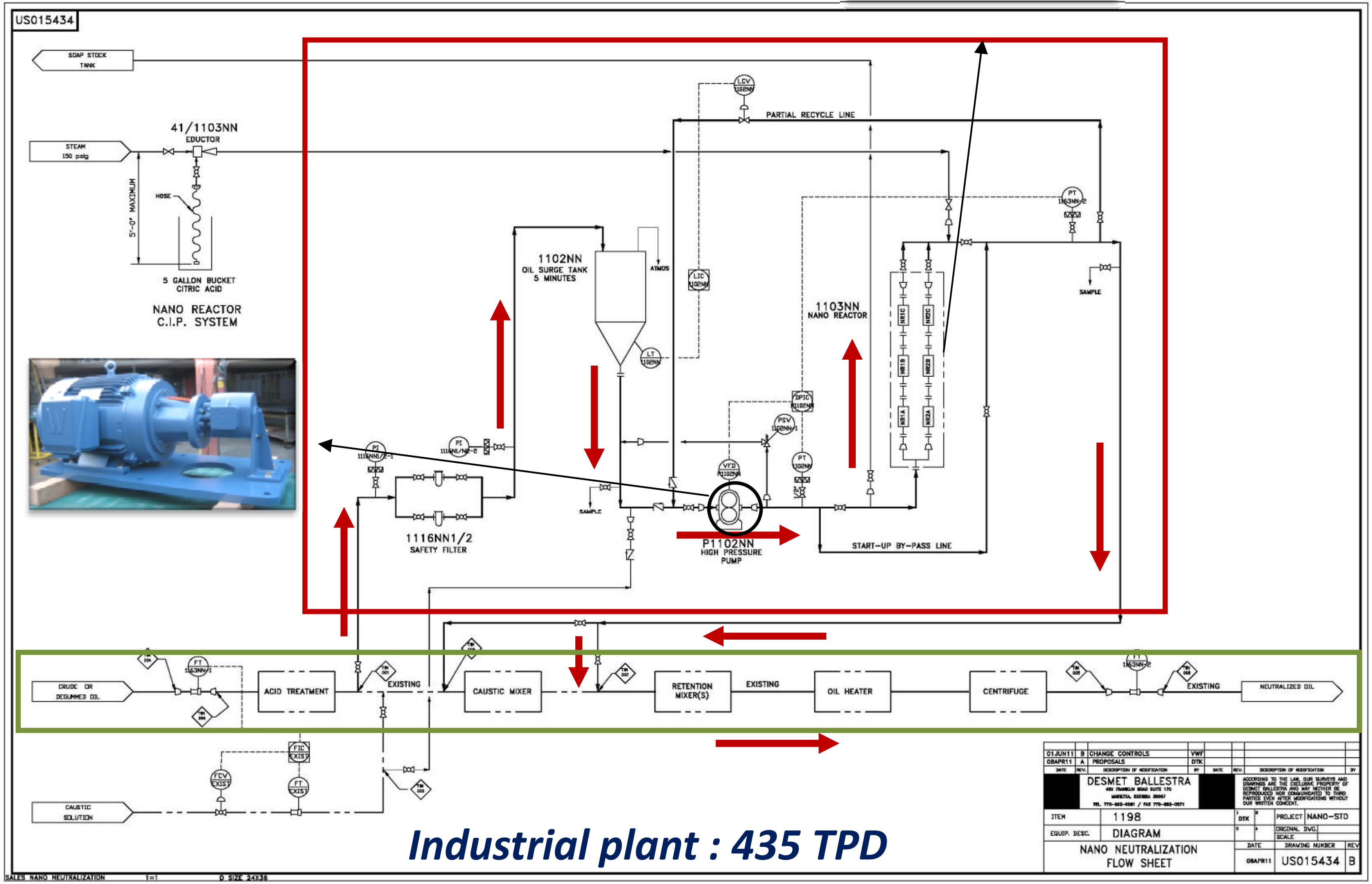
A true reactor, not just a better mixer

Nano Neutralization

- ✓**Patent pending process;**
- ✓**For new or existing chemical refining lines (add-on technology)**
- ✓ **'next generation' chemical refining (more efficient/sustainable)**
- ✓ **Industrially proven on soybean oil**
  - **- 435 TPD plant running since > 1.5 year**
  - **- Proven process benefits (less chemicals, higher oil yield)**
  - **- No mechanical issues (no internal fouling, easy operation)**
- ✓**Also applicable for chemical refining of all other soft oils**
  - **- Successful pilot trials on rapeseed,sunflower and corn oil**
  - **- More industrial plants will start-up in near future (USA, South America, Europe and also in India)**

Nano Neutralization





Industrial plant : 435 TPD

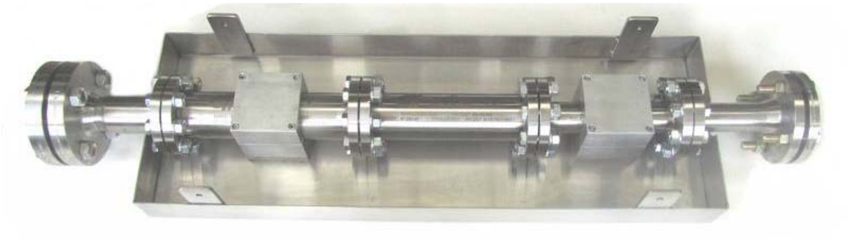
Nano Neutralization

Typical process conditions

Temperature :	**50-70°C** **Also cold processing (10°C) gives good result**
Pressure :	**55-65 bar** **No risk for emulsion formation (> 200 bar)**
Maturation time :	**5-20 min** **Longer maturation time not recommended**
Energy consumption :	**2.5 – 4 kw/ton** **Slightly higher than for Ultra High Shear Mixers (Silverson, IKA,….)**

Nano Neutralization Reactors

Available industrial reactors



Lowest capacity : 10 gpm[1] = 50 TPD

Medium capacity : 40 gpm = 200 TPD

Highest capacity : 100 gpm = 500 TPD (under development)

Possible plant configurations

CAPACITY (TPD)	REACTOR CONFIGURATION
50	1 x 10 gpm
100	2 x 10 gpm in parallel fed by 1 HP pump
200	1 x 40 gpm
500	1 x 100 gpm (not available yet)
600	3 x 40 gpm in parallel fed by 1 HP pump

[1]gpm : gallons per minute

Nano Neutralization Reactors

Complete skid mounted unit (400 TPD)

HP pump + 40 gpm reactor (200 TPD)

3 * 40 gpm reactor (600 TPD)

Nano Neutralization

435 TPD Nano Neutralisation of soybean oil - Industrial data

Feedstock	Water-degummed soybean oil (120-170 ppm P; 0.45-0.55% FFA)	
	Nano Neutralization	Classical caustic refining
Process parameters		
- Phosphoric acid (ppm)	**0-100**	**850-900**
- NaOH (% 16.6 °Be)	**0.7**	**1.2**
- Pressure (bar)	65	low
- Temperature (°C)[1]	50	70 to 80
Refined Oil Quality		
- P-content (ppm)	1-3	6-8
- Ca & Mg (ppm)	< 1	< 3
- FFA (%)	< 0.03	< 0.05
- Soaps (ppm)	< 100	200-300

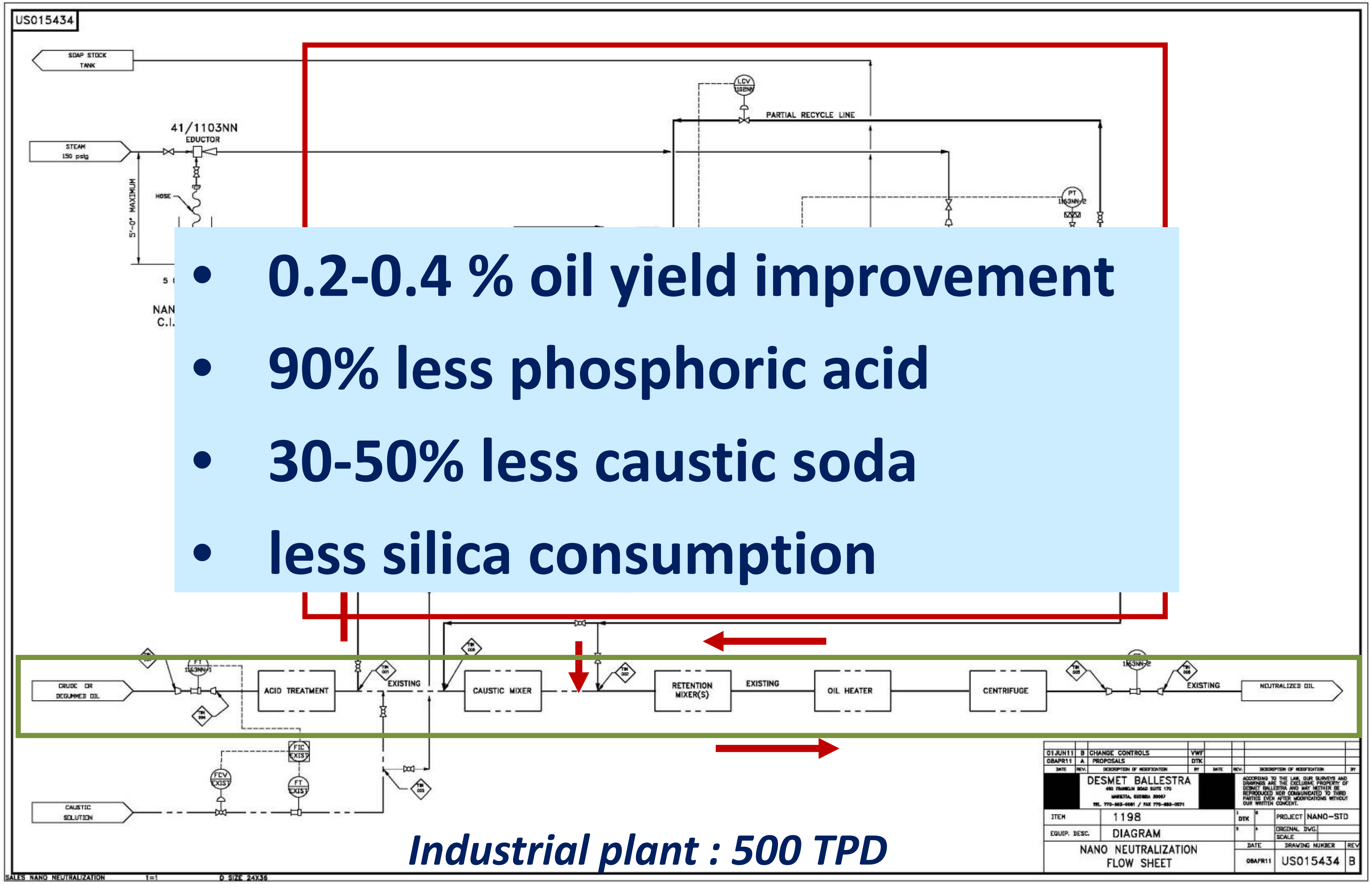
[1] Temp. range : 50-65°C; oil heated to 80°C prior to centrifugation

Nano Neutralization

Nano Neutralisation of rapeseed/canola/sunflower oil - Pilot data

	Sun	Rapeseed oil		Canola oil	
Crude oil					
FFA (%)	1.72	1.44		0.56	
P (ppm)	35	290		410	
Process conditions					
Pressure (bar)	65	65	65	65	65
Temperature (°C)	70	70	70	70	70
Phosphoric acid (ppm)	0	0	0	0	140
Excess caustic (%)	0	0	5	5	5
Nano-neutralized oil					
FFA (%)	0.11	0.10	<0.03	0.02	0.02
P (ppm)	10	13	9	75	7

Nano Neutralization : Proven advantages



- 0.2-0.4 % oil yield improvement
- 90% less phosphoric acid
- 30-50% less caustic soda
- less silica consumption

Industrial plant : 500 TPD

Nano neutralization : Explaining the benefits

BENIFITS	PROVEN SAVING	EXPLANATION
Less phosphoric acid	90% less	Nano reactor destroys typical PL micelle structure As a result, non-hydratable PL become more hydratable with nearly no acid
Less caustic soda	Min. 30% less	Less caustic required for neutralisation of phosphoric acid; Less excess caustic for FFA neutralisation due to better mixing effect
No water wash Less silica	Min. 50% less silica	Better phase separation because of less salts/soaps (less acid and caustic) gives lower soap content in once-refined oil (after first centrifuge)
Increased oil yield	0.2-0.4% yield increase	Less excess caustic gives less oil saponification and less neutral oil entrainment in soapstock Refining losses : (FFA+PL+MIV)* 1.35 ↘

Benefits can be scientifically explained

Nano Neutralized *vs* conventional refined soybean oil

Comparison of industrial refined soybean oil samples

Quality Parameters	Soybean Oil (US Standard)	
	Industrial Nano-refined	**Conventional Chemical refined**
FFA (% C18:1)	**0.02**	**0.02**
P (ppm)	**<1**	**<1**
Fe (ppm)	**<0.05**	**<0.05**
***Trans* FA (%)**	**0.53**	**0.57**
Color (R – $5^{1/4}$”)	**1.2**	**1.2**
Tocopherols (ppm)	**815**	**792**
OSI (hr at 97.8°C)	**15.5**	**15.7**

Nano-neutralization has no negative effect on refined oil quality

Other Potential Applications

Nano-cold neutralisation

Nano-degumming

Nano-treatment crude palm oil

Enzyme-assisted nano-degumming

Pilot test unit

Containerized pilot unit for feasability trials in our R&D center

10 GPM reactors (smallest available)

No lab scale testing

Summary & Conclusions

- ✓ Nano-reactor is a complete new technology in edible oil refining
- ✓ Successfully introduced is chemical refining (nano-neutralisation)
- ✓ Truly 'next' generation process that meets all demands of oil processors
  - More efficient (higher yield, lower operating cost)
  - More sustainable (less chemicals, no water washing)
- ✓ Other applications in edible oil refining will come

Reference List

Growing Every Day …

COMPANY	COUNTRY	CAPACITY/OIL TYPE
Carolina Soya	USA	200TPD Crude Soybean
Perdue	USA	435TPD Water Degummed Soybean
AOM	Argentina	200TPD Water Degummed Soybean
Pampabio	Argentina	200TPD Water Degummed Soybean
Molinos	Argentina	600TPD Water Degummed Soybean
Bunge	USA	700TPD Crude Soybean
La Fabril	Equador	240TPD Water Degummed Soybean
Bunge Expur	Romania	200TPD Rapeseed/Sunflower
Abis Export Pvt Ltd	India	250TPD Water Degummed Soybean

Thank You

More info on

www.nanoneutralization.com

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