Novozymes Quara® Boost

Alkaline Refining assisted by Enzymes

Quara®Boost is a new PLC enzyme product for enzyme-assisted alkaline refining of vegetable oils. By releasing diglycerides from the phospholipids contained in crude vegetable oil, the degummed oil yield is significantly increased while oil losses in gum phase are reduced.

Benefits

- **Oil yield gain**

Oil yield gain increases by diglycerides resulting from enzymatic hydrolysis of the phospholipids that usually are retained in the oil phase. And also, by the reduction on the losses of oil bound to the soaps during the separation process.

- **No increase in FFA**

The enzymatic reaction does not increase the content of free fatty acids in oil, what means that there is no extra sodium hydroxide consumption nor extra formation of soaps and additional losses.

- **Fewer low value by-products: more protein in meal**

For those producers who mix phospholipid gums at the meal, the protein content in the meal is increased since the volume of gum is reduced and it contains less oil.

- **Fewer low value by-products: less soapstock generated**

As part of phospholipids are converted in diglycerides, soapstock is less and cleaner, has higher TFA (Total Fatty Acids), facilitating further processing. If water degumming of crude oil is applied and its gums and/or part or totality of the soapstock are mixed to the meal, its protein content will find a benefit, once much less phospholipids will be reducing it.

Product

Quara® Boost is a liquid phospholipase product that has activity against three out of four major phospholipids present in vegetable oils: Phosphatidyl choline, phosphatidyl ethanolamine and phosphatidyl inositol. The product contains two protein-engineered phospholipase C enzymes (EC 3.1.4.) produced by submerged fermentation of a genetically modified *Bacillus licheniformis* microorganism. The result of the hydrolysis of the phospholipids is formation of di-glycerides and free P-groups as illustrated in figure 1.

Figure 1. Reaction scheme for phospholipase C.

Performance

Introducing phospholipid hydrolysis during the alkaline refining process can increase oil yield.

In the typical alkaline refining process, there is a yield loss associated with the oil binding to the soaps and the phospholipids during the separation process. In addition, the yield loss is correlated with the FFA, moisture, and impurities in the oil. Like in enzyme assisted water degumming with PLC enzyme this loss can be reduced by hydrolyzing the phospholipids to form DG and result in less oil binding after the hydrolysis. The yield gain will be dependent upon the content of phospholipids in the oil and the degree of hydrolysis of the phospholipids. **The yield gain correlates with the amount of phospholipids in the oil.**

When estimating the yield gain from the oil you need to know the phospholipid content. As the PLC enzyme only hydrolysis the PC, PE, and PI you can expect the maximum formation of DG from these components only. In figure 1 is seen the maximum DG production from full conversion (theoretically) and the 75% hydrolysis estimate which is what we can expect in a good production. With the yield gain from DG there will also be a release of neutral oil from the phospholipids that are hydrolyzed.

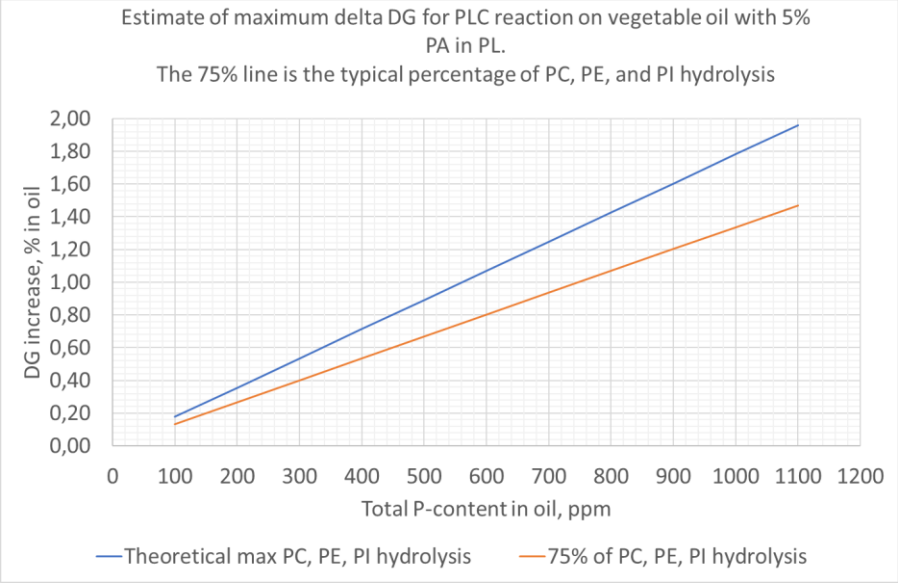

Fig 1. Theoretical increase in di-glycerides (DG) as function of the content of phospholipids. (blue curve). The expected degree of hydrolysis of PC, PE, and PI is 75% which result in the estimate of delta DG in the process.

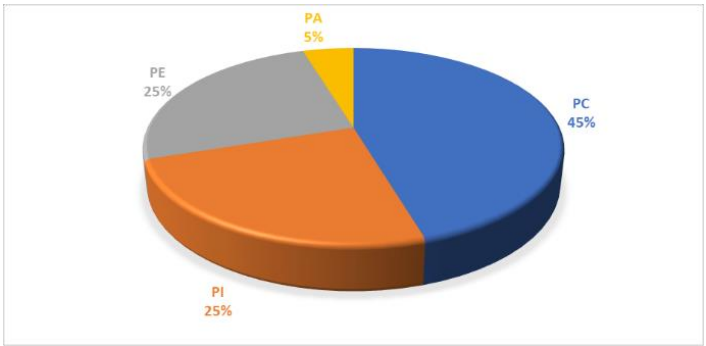

Fig 2. Composition of the phospholipids in the oil used for the DG-increase calculation in figure 2. P-content in oil 1000ppm. PA is not hydrolyzed

Usage

Comparing the standard alkaline refining to the enzyme assisted process

Alkaline Refining

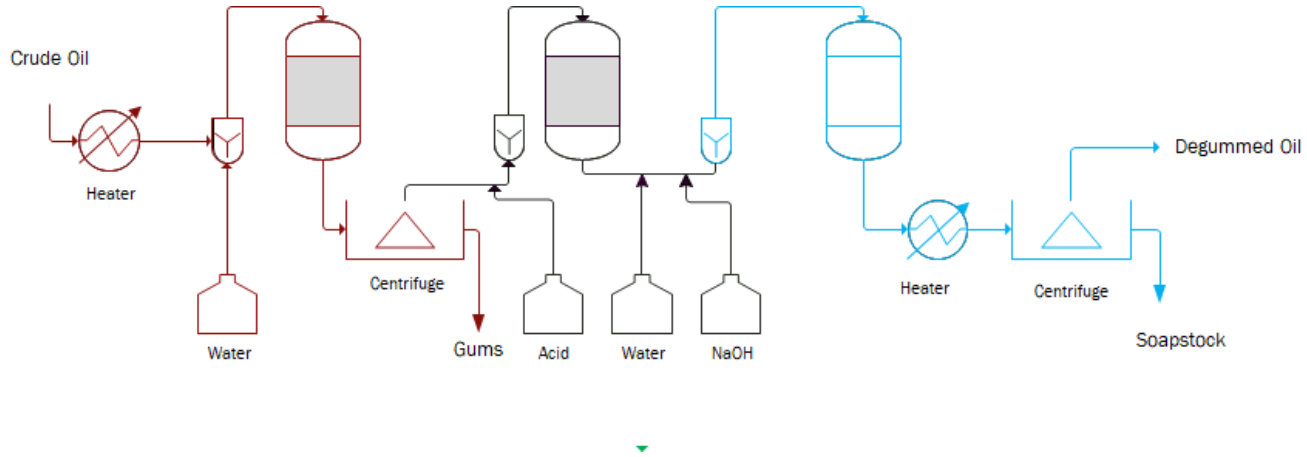

Fig 3a. Standard alkaline refining

Alkaline Refining Assisted by Enzymes

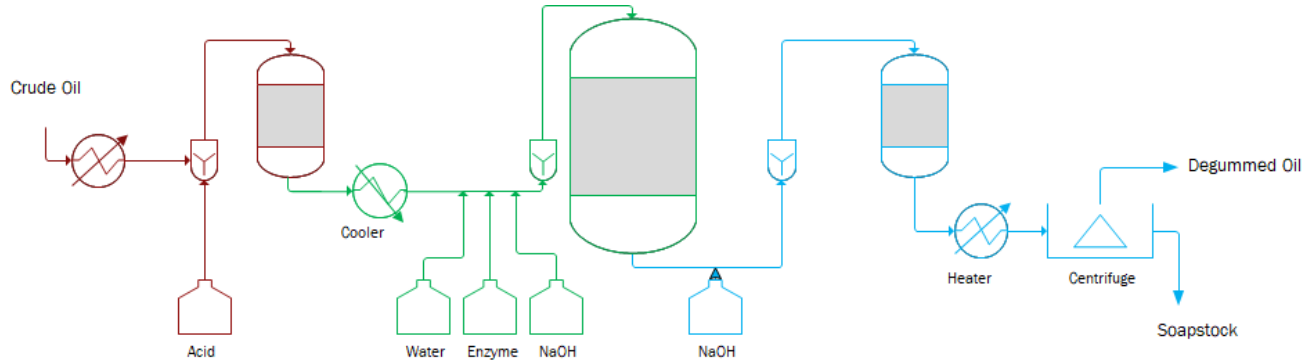

Fig 3b. Enzyme assisted alkaline refining

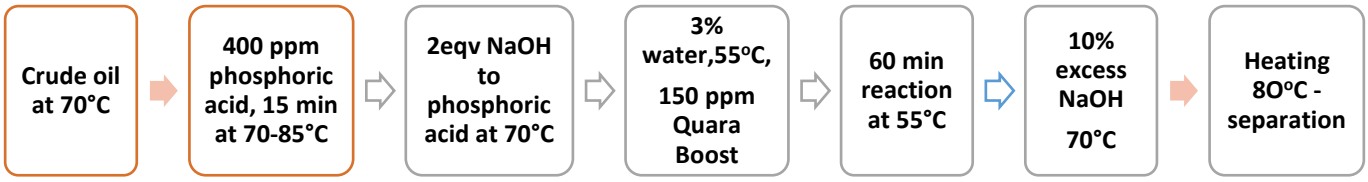

Fig 4. Process parameter proposal. Dosages may change according to oil quality and existing equipment.

About Novozymes
Novozymes is the world leader in biological solutions. Together with customers, partners and the global community, we improve industrial performance while preserving the planet's resources and helping build better lives. As the world's largest provider of enzyme and microbial technologies, our bioinnovation enables higher agricultural yields, low-temperature washing, energy-efficient production, renewable fuel and many other benefits that we rely on today and in the future. We call it Rethink Tomorrow.

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Process details for the enzyme assisted alkaline refining.

Acid/chelation step

The chelation is typically using phosphoric acid in a dosage of 400ppm at 85°C. In some cases, dosage can be adjusted up or down depending upon the quality of the oil, and citric acid may be an alternative (650ppm standard dosage). Bad quality with high NHP requires more acid. Temperature of acid treatment is 85°C for 15 minutes using concentrated acid.

The neutralization of the oil requires NaOH with a typical dosage of 2 molar equivalents to the acid. If the acid pre-treatment step is omitted, it may still be required to adjust the pH of the water phase to >5.0 by for instance 100ppm NaOH addition.

Enzyme reaction.

Enzyme dosage is 150ppm and reaction time 60 minutes at 50-55°C. It might be possible to reduce enzyme dosage to 125 or 100ppm. The 60 minutes is a batch incubation time. If the operation is CSTR, that has to be taken into account. A 1-step CSTR will require much longer holding time (> 180 minutes), whereas a 4-step CSTR should be OK with 90 minutes holding time.

Total water dosage in enzymatic reaction normally 2-3%.

Saponification.

The saponification is made with NaOH in amount to neutralize the phosphoric acid, the phosphatides, and the FFA including a 10% surplus to the FFA. The NaOH treatment is carried out at 70-85°C.

Water wash with 5-10% water is done to eliminate soap in oil.

Control analysis.

Incoming oil in plant.

- • P-content by ICP, Diglycerides. Non Hydratable Phospholipids (NHP). Periodic monitoring of phospholipid composition (NMR) is desirable.

pH

- pH (of water extract) before enzyme addition. Method is using 10% KCl-containing water for extraction, separation and check pH in water phase. Expected value 5.0 - 5.5.

Temperature of reactor

- Note the enzyme reactor temperature. Should be 50-55°C

Enzyme dosage pump

- Use a proper mass flowmeter or note the time and volume of the enzyme tank to make an estimate to compare to feed pump dosage setting.

Spin test oil before and after centrifuge to check eventual centrifuge issues.

- Sample centrifuged in lab. P-content in the oil phase. Read volume of gum phase.

Soap, di-glycerides, FFA and P-content in crude and final oil.

- Analysis of oil after separation, i.e. final oil.

Yield analysis.

- Oil in gums, amount of gums per hour, oil per hour.
- • Oil in soapstock, measurement of soapstock produced per hour, yield calculation through mass flowmeter with high precision in the inlet and outlet of process or centrifuge.

Parameters that can be tested during the trial period:

- Acid pretreatment, vary acid dosage 400-800ppm, check NaOH for pH-adjustment. Plants with controlled cavitation system can use lower phosphoric acid dosages.
- Enzyme dosage 75-150ppm
- Water content to optimize the enzyme and the centrifuge performance.

Customer support

Enzymatic degumming is an innovative technology based on the development of new enzymes as well as a novel application technology. The technology is supported by Novozymes technical service team and engineering partners.

Safety, handling and storage

Safety, handling and storage guidelines are provided with all products.

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