Phospholipase for enzyme-assisted alkaline refining

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Phospholipase C (PLC) products have been on the market for several years already and are well-established in the water degumming of soybean oil to provide additional oil yield (Galhardo and Dayton). While developing the new PLC Quara® Boost for water degumming, my research group discovered that the enzyme could be integrated with the alkaline refining process. The result is a significant increase in oil yield and preservation of the final oil quality from caustic refining (Holm and Nielsen). Recently, the process efficiency has been confirmed in full-scale trials.

- **Phospholipase C (Quara® Boost) enables higher oil yields in water degumming of vegetable oils.**
- **My research group at Novozymes recently documented that incorporating this enzyme directly into the alkaline refining process results in significantly higher yields and preserves the final oil quality from caustic refining.**
- **Enzyme-assisted alkaline refining is simple to establish and has a short payback time, as the typical oil yield is 15–20kg per ton.**

THE PROCESS

The typical alkaline refining process is seen in Figure 1. Some plants start the refining with a water degumming process and continue the process once the oil is degummed. They may already have considered using phospholipase C during the water degumming step to get a higher oil yield. Either way, water degumming includes a gum centrifugation step where some oil is inevitably lost.

Other plants go directly from the crude oil to the caustic step, which eliminates both the gums and the soap stock. Another option is to incorporate a chelating step that uses phosphoric acid to achieve the lowest possible phosphorous content (P-content) in the final oil.

The process our group developed for incorporating PLC Quara® Boost into the alkaline refining process is seen in Figure 2.

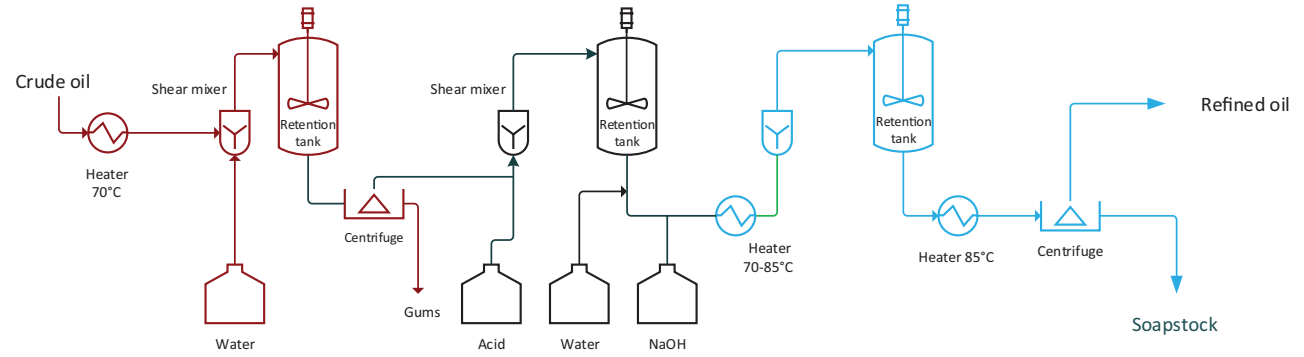

FIG. 1. Alkaline refining process

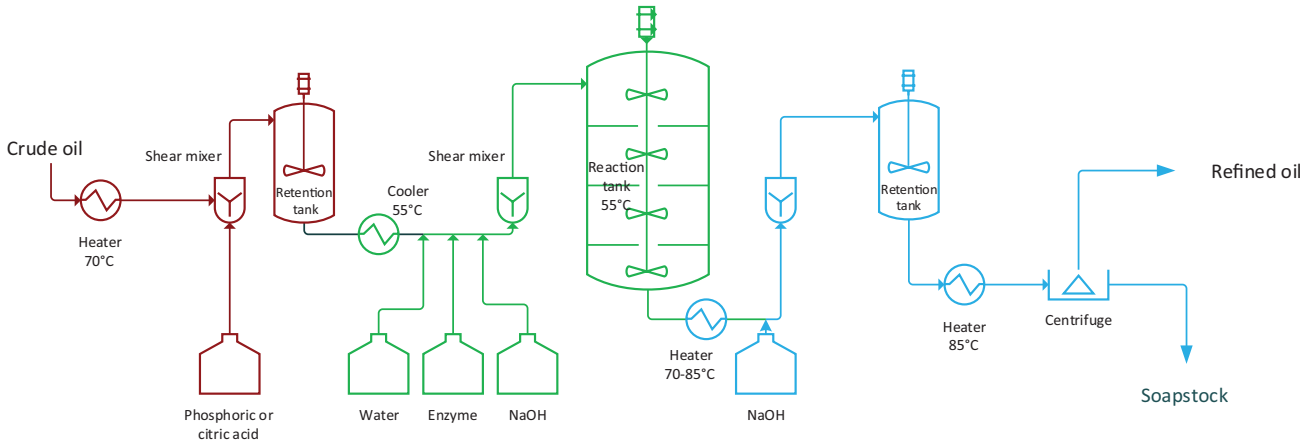

FIG. 2. Enzyme-assisted alkaline refining with phospholipase C (Quara Boost)

THE ENZYME

The Quara Boost enzyme consists of two enzyme molecules that hydrolyze the phosphatidyl choline/ethanolamine (PC/PE) and phosphatidyl inositol (PI), respectively. The phosphatidic acid (PA) is not hydrolyzed. The extra oil yield is the sum of the released diglycerides (DG) and the neutral oil, typically in ratio 2:1. The critical parameters for an efficient enzyme reaction are pH in the water phase, temperature and time of reaction, and an efficient emulsification of the water phase in the oil. The preferred parameters are shown in the flow chart (Fig. 3).

EXPECTED OIL YIELD INCREASE

The increase in yield depends on the amount of phospholipids in the crude oil, which varies considerably depending upon the location, bean/seed quality, and process technology.

Phosphorous from the phospholipids in crude oil typically ranges from 400–1400ppm. Since PA is not converted, the amount of PA must also be taken into account.

From our experience working with phospholipase, we typically get a 75% conversion of the PC + PE + PI in the oil. The limitations in the hydrolysis are caused by different parameters, such as the extent to which the phospholipids are hydrated, variations in the process parameters, the efficiency of mixing, plus the duration of the reaction. Recalculating the expected increase in DG from the phospholipid hydrolysis provides an estimate, as seen in Figure 4 (page 24), based on the phosphorous numbers in the oil (5% PA in the case of the provided example). It should be noted that the numbers used in this recalculation are based upon ^{31}P-NMR data, which typically show a slightly lower P-content than the ICP-P method. In addition to a DG-increase, you can expect a yield of neutral

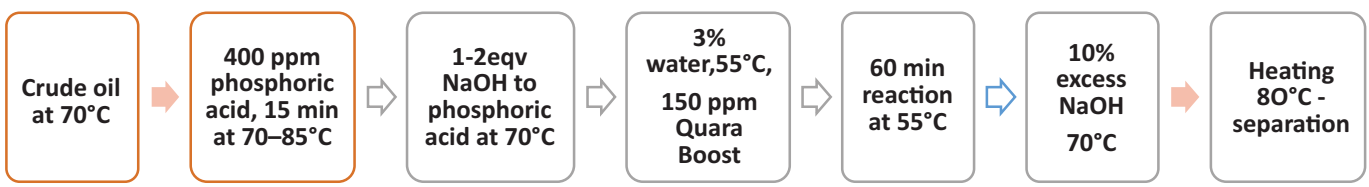

FIG. 3. Process parameters for the enzyme-assisted alkaline refining process