Enzymatic Degumming Improves Oil Refining in China

Southseas, a leading Chinese oil refiner, has successfully introduced enzymatic degumming. The excellent results exceeded their expectations with higher yields, savings in chemicals, and a more environmentally sound process that is easy to operate.

Since March 2003, Southseas Oils & Fats Industrial (Chiwan) Co., Ltd has been applying Novozymes' Lecitase® Ultra in a large-scale enzymatic degumming process. Southseas is the first Chinese company to adopt the new enzyme technology. Their factory is located in Chiwan, not far from Hong Kong in southern China.

The company has about 800 employees and is owned by Kerry Cereal & Fats China, part of the Kerry Holding Group. Their main brand is Gold Dragon Fish and they were the first company to introduce small bottles of edible oil onto the mass market in China.

"Zero" Phosphorus Content

Lecitase Ultra, Novozymes' food-grade enzyme for degumming, is used by Southseas to process soybean oil and rapeseed oil.

Compared with the conventional chemical refining process, physical refining is becoming more and more popular. Enzymatic degumming with Lecitase Ultra is a special type of physical degumming that is proving to give good performance and higher oil yields.

This has been verified by more than a year's experience of enzymatic degumming at Southseas. They have been able to lower the phosphorous content in degummed soybean oil to less than 10 ppm (parts per million), even reaching levels as low as 3 ppm. This is comparable to the chemical process. After decolorization, the phosphorus content in the oil is reduced to virtually zero.

"We have achieved very satisfactory results," comments Liu Xian Wen, production manager at Southseas. "We were pleasantly surprised by the efficiency of the enzymatic degumming process. It is a technical advance that markedly raises the economic performance of oil refining."

High Yields

A large amount of soapstock is produced by the commonly used process of refining, with caustic chemicals. Soapstock is the material produced by the neutralization of fatty acids in caustic refining, and there are large losses of oil during the separation of the soapstock. Based on experience, it is estimated that oil losses amount to 12 kg/t if the soapstock content is 1% of the crude oil. The higher the content of soapstock, the higher the oil losses.

The advantage of enzymatic degumming is that no soapstock is produced, and so there are no losses caused by soap-

stock separation. Generally speaking, more than 1% higher refining yields can be obtained by enzymatic degumming in comparison with the chemical method.

Nowadays in China, the cost of raw materials such as soybeans is increasing and this is squeezing the profit margins of oil refiners. However, just 1% higher yields can mean a 20% increase in net profits for Chinese refiners!

Environmentally Sound

The principle of enzymatic degumming is to convert non-hydratable phospholipids into hydrophilic lysophospholipids. Novozymes, in cooperation with some scientific institutes, is currently carrying out research into how to utilize these gum-like by-products.

Conventional chemical oil refining produces a large amount of soapstock, which needs to be treated before disposal. The first step is acid-cooking using sulphuric acid. Water also needs to be added in the proportion of 10-15% of the total amount of crude oil. The resulting wastewater is acidic and needs to be neutralized using caustic chemicals. The whole process therefore requires large amounts of harsh chemicals with a potentially negative impact on the environment.

In contrast, enzymatic degumming produces minimal wastewater because only 1-2% water needs to be added for efficient degumming. The wastewater actually contains lysophospholipids that can be recycled by mixing degumming water with oil seed meals or recovered by evaporation. In this way, enzymatic degumming becomes a refining process without waste products. In addition, the breakdown of natural vitamin E by strong caustic treatment can be avoided by enzymatic degumming. Vitamin E is likely to remain intact.

Increased Profits

Increased yields, savings in wastewater treatment and utilization of by-products in the enzymatic degumming process give Southseas up to CNY 80 per ton in extra profits, equivalent to approximately U.S. $10. For an oil refining line producing 500 tons per day, this can add up to more than CNY 10 million (U.S. $1.2 million) in extra profits a year.

The Southseas factory in Chiwan had a capacity to refine 1,000 tons per day in 2004, and they estimate that enzymatic degumming technology offers a very quick return on their investment.

Easier Operation

The enzymatic degumming process is simple to implement. Southseas only needed to add an enzyme reactor column and

ADM, Novozymes Honored with Award

The U.S. Environmental Protection Agency (EPA) has presented a team from Archer Daniels Midland Company (ADM) and Novozymes with a 2005 Presidential Green Chemistry Challenge Award for applying enzymes to develop healthier fats and oils for use in applications such as margarine, baking, and confectionery. The award ceremony was held June 20 at the National Academy of Sciences in Washington, DC.

ADM, in collaboration with Novozymes North America, Inc., developed an enzymatic interesterification process using the enzyme Lipozyme® TL IM—created by Novozymes—that is environmentally preferable to the chemical interesterification process to reduce *trans* fats because it eliminates the use of several chemical catalysts, thus eliminating byproducts and waste streams (solid and water). The enzymatic interesterification process also emits no air pollutants. Several of the ADM's NovaLipid™ products are now produced by this enzymatic interesterification process.

According to Hans Christian Holm of the Novozymes Oils & Fats team, Danish legislation banning *trans* fatty acids from food products and impending changes in the U.S. Nutritional Labeling and Education Act that will require the labeling of *trans* fats on all nutritional fact panels in the U.S. by January 1, 2006, have food manufacturers looking for solutions to reduce the amount of *trans* fats in their products.

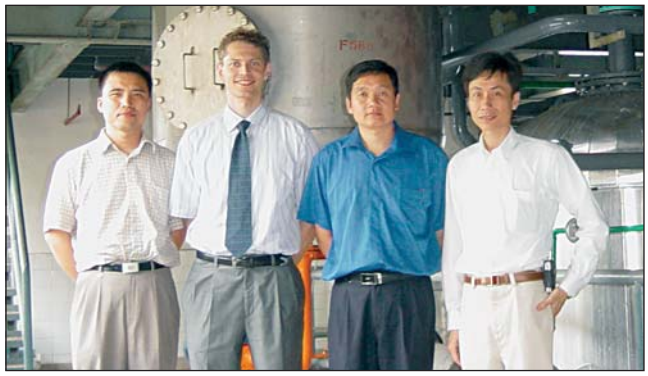
"Novozymes is seeing huge global interest in our enzymatic interesterification process for the production of margarines and shortenings that are free of *trans* fatty acids," added Holm.

Executives at both companies were very pleased to receive the award. "It is a great honor and motivation to receive this year's Green Chemistry Award. It ushers in a new era for Novozymes and for the world at large in which we are starting to use biotechnology for more sophisticated applications with wide-ranging impacts such as healthier foods. It also underlines our company's commitment to use biological solutions to create the necessary balance between better business, cleaner environment and better lives," said Thomas Nagy, president of Novozymes North America.

"ADM is pleased to have received two Presidential Green Chemistry Awards this year," stated G. Allen Andreas, chairman and chief executive of ADM. "As an agricultural company, we rely on the earth's bounty for our livelihood and our commitment to environmental stewardship is a part of our daily operations throughout the company. Having the innovation of our ADM research division and our company's respect for our environment recognized by the U.S. EPA through these two awards is truly gratifying."

The Presidential Green Chemistry Challenge Awards Program is an opportunity for individuals, groups and organizations to compete for annual awards in recognition of innovations in cleaner, cheaper, and smarter chemistry. The program provides national recognition for outstanding chemical technologies that incorporate the principles of green chemistry into chemical design, manufacture, and use and that have been or can be utilized by industry to achieve their pollution-prevention goals.

This is the second presidential Green Chemistry Challenge Award presented directly to Novozymes in the past four years. Novozymes has also been a partner in one additional award during that same period. ADM is the first company to receive two of the five Green Chemistry awards in the same year (ADM also received an award this year for a product involved in the reduction of VOC in latex paints).



From left: Yang Bo, technical consultant at Novozymes in China; Christian Hertz, marketing manager, Oils & Fats, Novozymes; Liu Xian Wen, production manager at Southseas; Wang Xuan, project manager at Novozymes in China.

take away a centrifuge in comparison to their existing chemical process.

The process is easier to operate than the chemical process. One of the operators at Southseas commented: "Enzymatic degumming is a very stable process and easier to operate. There is little need for adjustment when the properties of the oil change."

There are two main reasons for the ease of operation. Firstly, in the chemical process, the dosage of caustic soda must be adjusted according to the acidity of the crude oil. If too much caustic soda is added, it can cause saponification, leading to increased oil losses. In contrast, enzymatic degumming only requires a small dose of caustic soda to adjust the pH value to 4.5-5.2. This dose is insufficient to cause any saponification.

Secondly, separation of the oil from the gum is easier. In chemical refining, incomplete separation in a centrifuge often causes increased oil losses. The temperature, the amount of water and the quality of the crude oil influence the oil/water emulsification. The operator must pay great attention to all these factors. In the enzymatic process, there is little emulsification, so it is easier to control the centrifuges.

Close Cooperation

For the successful implementation of the enzymatic process, Liu Xian Wen, production manager at Southseas, Wang Xuan, project manager, and Yang Bo, technical consultant, from Novozymes China, cooperated closely. Before the production-scale trials, they had gone through a precise project plan, including checking the critical points such as the mechanical high-shear mixer, pumps, heat exchangers, etc. Quality control and laboratory staff supported the trials under the management of Xie Qian Ling, Southseas' QA and R&D manager. The operators were trained by Liu Xian Wen.

The first plant trial gave a good result. It took only five hours to adjust all the parameters in order to obtain the optimum conditions. Wang Xuan of Novozymes comments: "The keys to the success of enzymatic degumming at Southseas are, firstly, our highly effective Lecitase Ultra and, secondly, the excellent management and staff at Southseas."

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