

# Enzymatic interesterification with Novozymes Lipozyme<sup>®</sup> TL IM

Regulations in the U.S. prohibit manufacturers from using partially hydrogenated oils (PHOs) due to the trans fat content. The World Health Organization has launched a program to reduce PHOs and trans fats globally. Europe is also considering limits on PHOs.

Manufacturers continue to demand stable shortenings, with appropriate shelf life, the correct color, and with proper melting properties. Enzymatic interesterification provides a simple, efficient, and environmentally-friendly way to produce margarines without the use of chemicals while improving product quality and production yields.

## Benefits

### High-quality product

- No trans fats
- Higher yield, fewer by-products
- No color change in the fat blend
- Low diglycerides formation

### Simple and continuous process

- Fewer unit operations than in the alternative processes
- No need for washing or post-bleaching
- No chemicals
- Improved industrial hygiene/safety

### Cost-efficient

- Capital investment is low; the process requires only simple reactors
- Total variable costs are competitive with the alternative processes

Efficient and environmentally-friendly

- No wastewater
- Reduced energy consumption
- Reduced production of greenhouse gases

## Performance

Lipozyme® TL IM rearranges the fatty acids preferentially, but not uniquely, in the 1- and 3-positions of the triglycerides. As a result, the melting properties of the fat blend are changed as illustrated in figure 1.

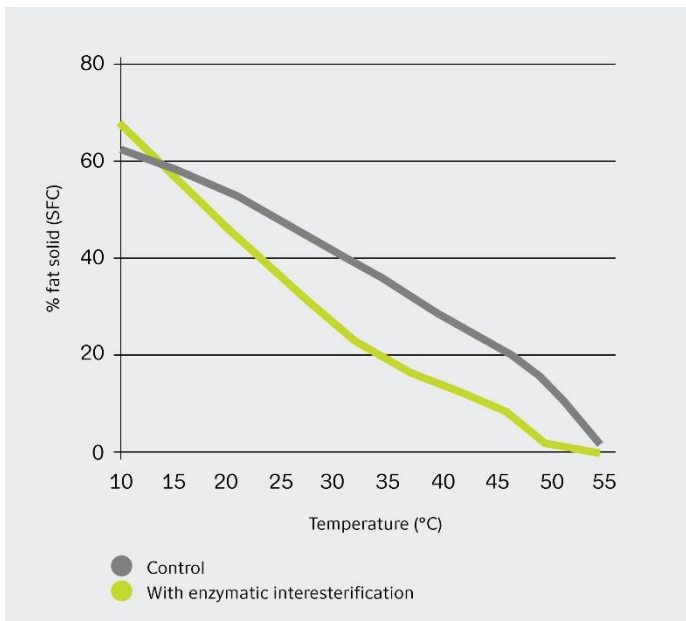


Fig. 1. SFC (solid fat content) of a blend of 70% palm stearin and 30% soybean oil, before and after enzymatic interesterification

## Usage

Lipozyme® TL IM is an immobilized lipase that can be reused many times. Lipozyme® TL IM is not present in the interesterified fat blend.

For pilot-scale and industrial-scale interesterification, we recommend a continuous process with Lipozyme® TL IM in a series of fixed-bed reactors.

For initial interesterification trials in the laboratory, we suggest a batch process.

## Application

### Continuous process

Lipozyme® TL IM is packed as a fixed bed, and the fat is interesterified continuously while passing through the catalyst bed. The flow rate controls the residence time of the fat in the reactor, which in turn controls the level of interesterification.

The optimal configuration is to connect a number of reactors in a series (Figure 2), because this allows a nearly constant flow rate.

As the oil blend is pumped through the reactors, the enzyme in the first reactor gradually loses activity. In a single reactor system, the flow rate would need to be reduced to maintain the conversion.

However in a configuration with four to six reactors, the flow is maintained at a near-constant level by utilizing the activity in all the reactors. This configuration allows all the activity in the first reactor to become exhausted before it needs to be replaced.

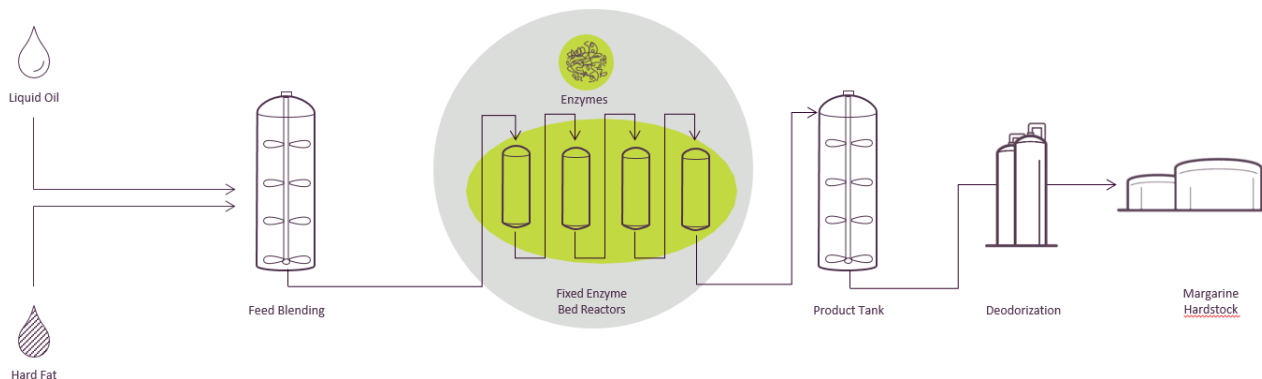


Fig. 2. Process layout for enzymatic interesterification

When exhausted, the first reactor is disconnected from the flow to remove the spent enzyme and refill with fresh enzyme. It is then reconnected to the flow as the last reactor in the chain. The reactor that previously was the second now is first to receive the unconverted oil blend.

In a steady-state system, the first reactor normally contains < 20% of the initial activity and serves as a protective column for the remaining ones which carry out the main conversion.

### Oil quality

The economy of the process is maximized by having the highest possible productivity (kg blend converted/kg enzyme).

Factors that reduce enzyme productivity are residual particulate matter (soaps and phosphatides), oxidation products (peroxide and anisidine values), and residual mineral acids (from bleaching and/or degumming), all of which have a negative effect on enzyme activity and working life.

The desired maximum levels of these and other parameters are shown in table 1.

Water extract of oil	pH >6.0 <9.0
Moisture	0.1%
FFA	1.5% (at 0.1% moisture)
Soaps	1 ppm max.
P	3 ppm max.
Fe	0.1 ppm max.
Ni	0.2 ppm max.
Cu	0.01 ppm max.
Peroxide value	1 meqO /kg max.
Anisidine value	5 max.
Citric acid	25 ppm max.
Temperature	70°C

Table 1. Oil-quality requirements for enzymatic interesterification

## Postpurification

After enzymatic interesterification, there is no need for washing, and only minimal bleaching of the fat. A minimal deodorization is recommended to remove any free fatty acids that are generated during interesterification. Spent enzyme can be disposed off in a similar way as used for spent bleaching earth.

## Batch process

A batch process is very useful for the production of small amounts of fat for physical and chemical characterization. The relationship between the reaction time and the resultant interesterification can be obtained by collecting small fat samples over time and carrying out relevant analysis of these samples.

In the laboratory, it is easier to set up a batch reactor than a fixed-bed reactor, because a batch process can be carried out using standard laboratory hardware.

The principle of the batch process is to allow sufficient contact time between fat and enzyme to achieve the desired interesterification. The fats and Lipozyme® TL IM are mixed in a container (e.g., a beaker). During the reaction, the fat/enzyme mixture is continuously stirred (shaking baths or impeller stirrer) in order to keep the enzyme particles in suspension and ensure good contact between the catalyst and the fat. When the reaction is complete and the mixing has been stopped, the enzyme particles sediment quickly, and the fat can be separated from the catalyst either by filtration or decanting.

## Dosage

Under the recommended operating conditions and with oil blends that meet the quality specifications, Lipozyme® TL IM will deliver a productivity of at least 2,000 kg/kg. For batch reactions, a dosage of 4% w/w enzyme is normally applied.

## Temperature

Lipozyme® TL IM has an optimal operating temperature of 70°C. Operation at temperatures above this will increase the rate of conversion but will also increase the sensitivity of the enzyme to oxidation compounds. This will result in an increased conversion but a shorter working life. Temperatures above 80°C will cause rapid and irreversible enzyme inactivation.

## Product

Lipozyme® TL IM is produced by immobilization of a microbial lipase from *Thermomyces lanuginosus* on a non-compressible carrier. The lipase is a 1,3-specific triacylglycerol lipase (EC 3.1.1.3) produced by submerged fermentation of a genetically modified *Aspergillus oryzae* microorganism.

Lipozyme® TL IM is food grade and kosher/halal approved.

Find more information at [Novozymes Market](#).

## Stability

It is recommended that Lipozyme® TL IM be stored in unopened drums or big bags at a temperature below 25°C. If the drums need to be partly emptied during reactor filling, they should be securely closed again to avoid an increase in the moisture level of the product.

## Safety, handling and storage

Lipozyme® TL IM is a robust product when being used for interesterification. However, enzyme dust can be formed during filling, and protective masks should be worn. Any spillage should be removed with a vacuum cleaner. Safety, handling and storage guidelines are provided with all products.

## Get ahead

Staying ahead of the dynamic food and beverage market requires the best technology and expertise to become even more flexible, efficient and profitable. With our solutions and knowhow, Novozymes can support you on that journey. Let's transform the quality and sustainability of your business together.

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### 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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