novozymes
Household Care

Laundry

Liquid detergents

Application sheet

Enzymes in liquid detergents for household laundry and dishwashing are necessary for obtaining convincing washing results. However, the biggest challenge is to obtain good enzyme stability. This often requires modification of the base formulation.

Benefits

- Liquid enzymes enhance the basic washing performance of liquid detergents, providing stain removal and general cleanness.
- Liquid enzymes perform well under mild washing conditions such as those typical for many liquid detergents. These conditions are also favourable for colour and fabric care effects.
- Liquid enzymes are completely soluble and begin working immediately after the detergent is added to the wash.
- Liquid enzymes increase the whiteness performance of liquid laundry detergents, bringing the performance close to laundry powders.
- Liquid enzymes create environmentally sustainable, peak-performing detergents by replacing chemicals with nature's own efficient ingredients.

Products

Novozymes can offer a number of alternative liquid proteases, amylases, lipases and cellulases. Please find the specific features in our product list in the Novozymes Customer Center or contact your local Novozymes sales representative.

Detergent category	Performance claim focus	Suggested enzyme classes
Heavy-duty laundry	Stain removal Color care Whiteness	Basic: protease, amylase, Cellulase (cleaning), Cellulase (colour care) Advanced: lipase
Light-duty laundry	Stain removal Whiteness	Basic: protease, amylase, Cellulase (cleaning) Advanced: lipase
Laundry booster	Stain removal	Basic: protease, amylase, lipase Advanced: cellulase (cleaning)
Automatic dishwashing	Shine	Basic: protease, amylase

Table 1. Selection of liquid enzymes

Performance

Development of an enzyme-friendly base formulation

The goal for the liquid detergent formulator is to obtain a high-performing product with a long shelf life. This process includes the following steps:

- Developing an enzyme-friendly base formulation
- Selecting the relevant enzyme additions
- Testing the performance and storage stability of the final detergent

Protease stabilisation

In liquid detergents there is direct interaction between the ingredients. As enzymes may be fully active in the aqueous formulation, they will begin catalysing the hydrolysis of suitable substrates. In the case of proteases, they will begin degrading any protein in the formulation. Unfortunately, this protein is identical with the enzymes. Fortunately, the following methods can be used to temporarily stabilise proteases:

- Make detergents with low water content (<60%) and low pH (7-8)
- Block the active site with a borate/propylene glycol complex

In both cases the protease is reactivated when the detergent is diluted in the wash float. The borate/propylene glycol stabilisation system is illustrated below.

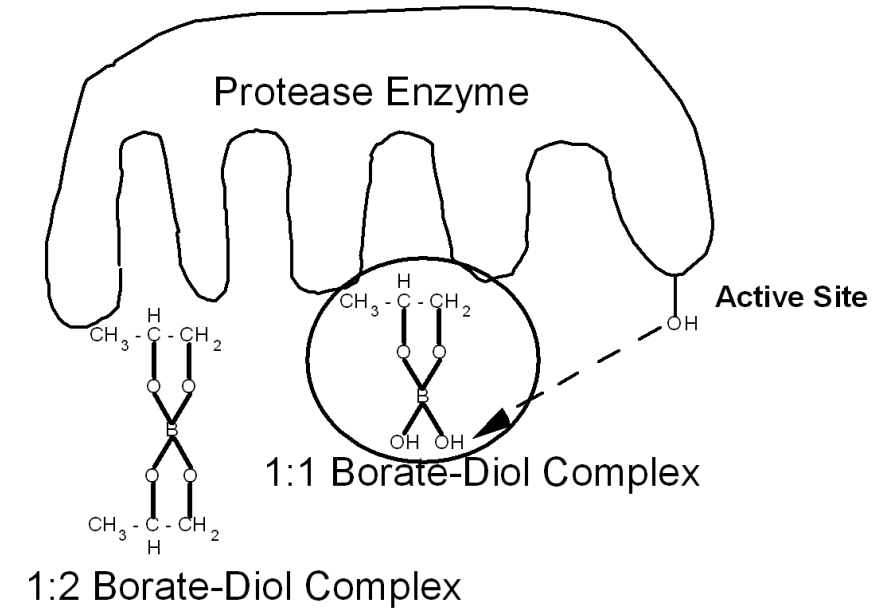

Fig. 1. Source: P&G

An alternative to the borate/propylene glycol stabilisation system is to use formate in combination with propylene glycol and calcium chloride. This system works in the pH range 7-8.

Other factors affecting enzyme stability

Enzymes are large, three-dimensional molecules consisting of long folded chains of amino acids. Under unfavourable conditions the molecules unfold (are denatured) and lose their performance ability. Examples of unfavourable conditions are high alkalinity, high acidity, high temperature and saltiness.

Detergents based entirely on anionic surfactants bind to charged groups on the surface of the enzymes and cause inactivation. Non-ionic surfactants prevent this from happening by occupying the surface of the enzymes.

Enzyme molecules contain calcium as a structural component. Builders and sequestering agents may over time remove Ca^{2+} from the enzymes, resulting in inactivation. In order to prevent this from happening, it is recommended adding small amounts of Ca^{2+}, e.g. 0.1% $CaCl_2.2H_20$.

The following can be used as a troubleshooting checklist:

Parameter	Application range
pH	7-9
Water content	2-50%
Surfactants: Non-ionic Anionic Soap Cationic	Combine non-ionic and anionic/soap 5-20% <10% <15% <5%
Builders/buffers	Use citrate and polycarboxylates
Sequestering agents	Avoid strong builders, e.g. EDTA, DTPA
Sodium Citrate	<10%
STPP	<5%
Phosphonates	<2%
MEA	<5%
$CaCl_2.2H_2O$	>0.1%
Protease inhibitors	Combine Borax and MPG
Borax	1-3%
Propylene glycol	5-10%

Table 2. Troubleshooting list

Preparation of liquid detergents

Liquid detergents containing enzymes must be prepared in a given sequence. Before the enzymes are added, all other ingredients must already be dissolved and the pH adjusted to the correct level. The temperature must not exceed 30°C.

The first enzyme to be added is protease. It must be stirred for 5 minutes in order to form a stable complex with borate and propylene glycol. It is then safe to add the remaining enzymes.

Testing the final formulation

The final formulation should be tested in a realistic washing process. It is recommended including artificially soiled test items that are sensitive to enzymes and of local relevance. Enzyme-sensitive test swatches are commercially available from several sources, e.g. EMPA, CFT and WfK.

The test should be repeated after storage for a given period at a controlled temperature, e.g. 8 weeks at 30°C, in order to check that performance still persists. Storage stability testing may also be based on analytical methods. The analytical methods can be found in Novozymes Customer Center.

Safety, handling and storage

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

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