Combating oxidative processes in cosmetics

The cosmetic industry uses a large number of substances that can easily be oxidised by the oxygen in the air. This can cause colour changes (darkening) or highly unpleasant smelling oxidation and spin-off products (rancidity). These oxidation processes especially affect hydrophilic and lipophilic categories of raw materials, such as active agents, plant extracts, perfumes and plant oils. The lipophilic substances include, for example, unsaturated fatty acids, which are susceptible to oxidation in the case of double bonds. Amongst the hydrophilic substances polyphenols are the substances most affected; these darken in colour as a result of oxidation and provoke a discolouring of the product.

In any event, for oxidation to take place the presence or availability of oxygen is required. In addition, the environment can make a decisive contribution to whether an oxidation reaction actually takes place or not. So there are factors which simply start off the oxidation, and in addition there are influences which can further accelerate oxidation. Thus in order to be able to effectively inhibit or entirely prevent oxidation, it is necessary to be aware of these triggering or accelerating processes.

Triggers and stimulants for oxidative processes in cosmetics can for instance include the following:

- Oxygen in the formulation (e.g. dissolved in the water) or also in the container
- Catalysts in the product (e.g. traces of metal in the water, extracts or from the production vat)
- Light in the case of non-lightproof packaging, heat and moisture
- Raw materials that are susceptible to oxidation (e.g. unsaturated fatty acids or polyphenols)
- Unfavourable pH value

Thus the following generally have an inhibiting effect on oxidative processes:

- Non-light permeable and oxygen-protected packaging (airless dispensers)
- Fumigation with nitrogen or argon (displacement of oxygen)
- Suitable **antioxidants** (Vitamin E, Vitamin C, BHT)
- **Complex-forming agents** (EDTA, phytic acid)
- **Reducing agents** (sodium sulphite)
- Low temperatures
- Favourable pH value (generally acid)
- Prevention of a drift in pH value (buffering of the pH value)

A BRIEF OVERVIEW: ANTIOXIDANTS

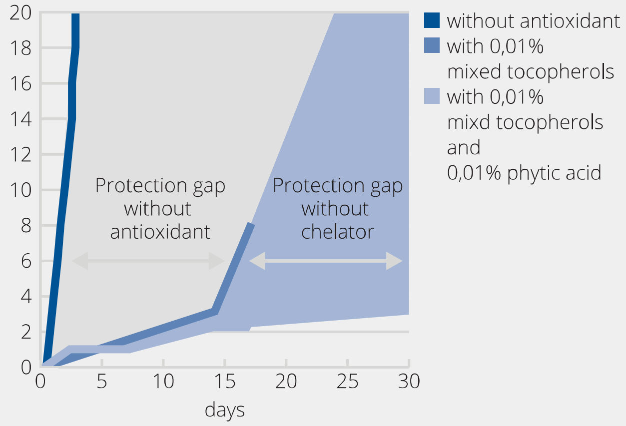
Examples: Tocopherols, mixed tocopherols, hexylresorcinol, carnosic acid, BHT, BHA, ascorbyl palmitate

Effect: They primarily prevent unsaturated fatty acids oxidising and becoming rancid. This counteracts both changes in smell and discrepancies of colour. It can also maintain the spectrum of effects of active agents, since they do not become prematurely oxidised. But perfume oils can also become better stabilised in this way.

Mode of action: An antioxidant reacts more quickly with oxygen, thus indirectly protecting the active agent against oxidative attack. The antioxidant itself becomes oxidised, and is thus consumed. At the same time the oxidised antioxidant itself can become discoloured. Lipophilic antioxidants protect lipids (e.g. plant oils), while hydrophilic antioxidants can protect water-soluble active agents (e.g. polyphenols).

The illustration below clarifies the mode of action of an antioxidant, using a plant-based mixture of tocopherols (Dermofeel MT 70) as an example. Combining these with a complex-forming agent (phytic acid) can also heighten the effect.

Peroxide value of Methyloleate at 40°C in the presence of Cu



(Source: Dr. Straetmans GmbH, Hamburg, Germany)

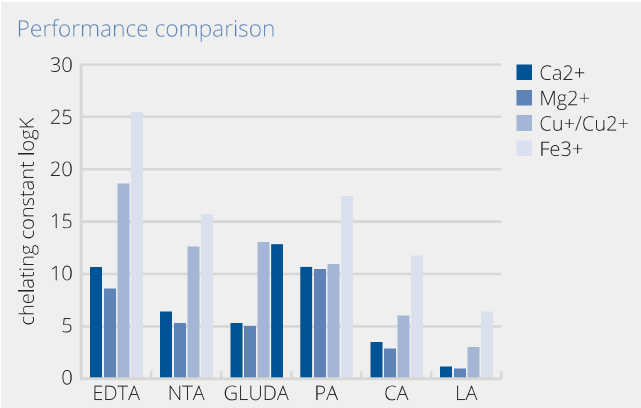
A BRIEF OVERVIEW: COMPLEX-FORMING AGENTS

Examples: EDTA, phytic acid, citric acid, sodium citrate

Effect: They prevent oxidisation of substances catalysed by traces of metals.

Mode of action: Traces of metal can have disruptive effects on a formulation, e.g. in the form of changes of colour or smell. Complex-forming agents are substances which can very quickly form a compound with these ions. In this form of compound, the ions are extracted from the reaction medium and can thus no longer be available as catalysts for oxidisation with oxygen.

The following diagram shows an overview of the performance of various complex-forming agents:



EDTA
(Ethylenediamine tetraacetic acid)
- petrochemical
- poor biodegradability

NTA (Nitrilotriacetic acid)
- petrochemical
- moderate biodegradability

GLUDA
(Glutamic acid N,N diacetic acid)
- partly petrochemical
- biodegradability

PA (Phytic acid)
- natural
- biodegradability

CA (Citric acid)
- natural
- biodegradability

LA (Lactic acid)
- natural
- biodegradability

A BRIEF OVERVIEW: REDUCING AGENTS

Examples: Sodium sulphate, sodium metabisulphite

Effect: Reduction in the available oxygen, thus preventing the darkening of active agents and plant extracts that are rich in polyphenols.

Mode of action: Sodium sulphite is oxidised with the oxygen present in the water to form sodium sulphate. This means that the free (reactive) oxygen has been bonded in the water and is no longer available for oxidative reactions. Subsequent possible oxidation processes are thus hindered, and even substances which would oxidise quickly under normal conditions remain stable in this aqueous solution. This is demonstrated by the following laboratory experiment:

2 % active plant agent was dissolved in water with a pH value of 5.5. 0.1 % sodium sulphite was added to the sample on the left, while the sample on the right was left as a comparison without the addition of sodium sulphite. The pictures show the discoloration apparent after storage for four weeks at room temperature under the influence of light:

t_4 with 0.1 % sodium sulphite

t_4 without sodium sulphite

The level of discolouration at time t_0 with and without sodium sulphite corresponds to the sample on the left (with 0.1 % sodium sulphite).

Summary: Combination systems are generally the most effective in protecting against oxidisation. In an emulsion containing active ingredients that are clearly susceptible to oxidation, for example, it entirely makes sense to use both antioxidants and complex-forming agents. The dosage of antioxidants, complex-forming agents and reducing agents normally used is around 0.05 – 0.2 % of each.