Preservatives for Personal Care

Your choice for product safety
Definition “Preservative”

- A Preservative is any chemical used to kill or prevent the growth of micro-organisms preventing contamination or spoilage of a product (or raw material)

- Common organisms that contaminate cosmetics and are used in Ph. Eur. Challenge test
  - Gram negative Bacteria: Pseudomonas aeruginosa
  - Gram positive Bacteria: Staphylococcus aureus
  - Fungi (Yeast): Candida albicans
  - Fungi (Mould) Aspergillus niger - Not pathogenic
Importance of Preservatives in Cosmetics and Toiletries

- Legislative and Regulatory Conformance
- Cosmetic products are prone to Contamination
- Health and Safety Risks
- Cost Implications
- Ethical Reasons and Company Integrity
**Legislative Reasons**

- A cosmetic product must not cause harm to the consumer
- It must not contain pathogenic (harmful) organisms
- Restrictions to number of organisms if contaminated by non-pathogenic organisms

<table>
<thead>
<tr>
<th></th>
<th>CTPA (cfu)</th>
<th>CTFA (cfu)</th>
<th>COLIPA (cfu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General use products</td>
<td>&lt;1000</td>
<td>&lt;1000</td>
<td>&lt;5000</td>
</tr>
<tr>
<td>Baby products</td>
<td>&lt;100</td>
<td>&lt;500</td>
<td>&lt;500</td>
</tr>
<tr>
<td>Used around the eye</td>
<td>&lt;100</td>
<td>&lt;500</td>
<td>&lt;500</td>
</tr>
</tbody>
</table>
Most cosmetic products are ideal environment for microorganism

- Available water in formulations
- Suitable pH & temperature
- Some common cosmetic ingredients are used as nutrients (food) by organisms

Why preserve your formulation?

Health & Safety Reasons
- Skin Irritation
- Infections to sensitive areas such as eye, leading to blindness, etc.
- In extreme cases, serious illness even death

Cost Implications
- Cost of complaints, batch rejections due to spoilage of product
- Drop in pH, emulsion breakdown, loss of viscosity and colors, cloudiness, malodor, etc.
## Regulation of Preservatives

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Preservative Approved</th>
<th>Allowed in All Applications</th>
<th>Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>54</td>
<td>34</td>
<td>Annex VI Positive Restricted List</td>
</tr>
<tr>
<td>USA</td>
<td>57</td>
<td>40</td>
<td>CTFA / CIR</td>
</tr>
<tr>
<td></td>
<td>CIR reported</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>44</td>
<td>16</td>
<td>Positive Restricted List</td>
</tr>
</tbody>
</table>

The Ideal Preservative

- Effective against all organisms
- Safe at use concentrations
- Cost effective
- Global Approval particularly EU, USA and Japan
- Stable and effective over product shelf life
- Easy to use and handle
- Effective at target pH of product
- Raw material & formulation compatibility
- Readily soluble in water
- Heat Stable
- “Meet customer’s own criteria”
## Trends in the Market

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Methylparaben</td>
<td>5693</td>
<td>7306</td>
<td>7731</td>
<td>6893</td>
<td>7161</td>
<td>7866</td>
</tr>
<tr>
<td>Propylparaben</td>
<td>5329</td>
<td>6030</td>
<td>6278</td>
<td>5621</td>
<td>5809</td>
<td>6260</td>
</tr>
<tr>
<td>Butylparaben</td>
<td>483</td>
<td>1072</td>
<td>1991</td>
<td>2174</td>
<td>2326</td>
<td>2784</td>
</tr>
<tr>
<td>Imidazolidinyl Urea</td>
<td>1254</td>
<td>2499</td>
<td>2498</td>
<td>2025</td>
<td>2038</td>
<td>2036</td>
</tr>
<tr>
<td>Ethylparaben</td>
<td>31</td>
<td>581</td>
<td>1240</td>
<td>1451</td>
<td>1725</td>
<td>2310</td>
</tr>
<tr>
<td>Phenoxyethanol</td>
<td>17</td>
<td>253</td>
<td>1143</td>
<td>1480</td>
<td>1670</td>
<td>2227</td>
</tr>
<tr>
<td>DMDM Hydantoin</td>
<td>15</td>
<td>318</td>
<td>955</td>
<td>943</td>
<td>993</td>
<td>1062</td>
</tr>
<tr>
<td>Isothiazolinones</td>
<td>0</td>
<td>512</td>
<td>808</td>
<td>595</td>
<td>699</td>
<td>699</td>
</tr>
<tr>
<td>Diazolidinyl Urea</td>
<td>0</td>
<td>130</td>
<td>690</td>
<td>701</td>
<td>725</td>
<td>737</td>
</tr>
<tr>
<td>Quaternium-15</td>
<td>599</td>
<td>673</td>
<td>704</td>
<td>505</td>
<td>516</td>
<td>515</td>
</tr>
</tbody>
</table>

Source: Cosmetic & Toiletries FDA; frequency of use of preservatives in cosmetic formulations
Classification of Preservatives

- Paraben Esters
- Formaldehyde Donors
- Halogenated
- Alcohols
- Inorganics
- Piroctone Olamine
- Organic acids
## Clariant Preservatives by Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Name</th>
<th>Clariant single active</th>
<th>Clariant Blends</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parabens</strong></td>
<td>Methylparaben</td>
<td>Nipagin® M</td>
<td>Nipasept®, Nipastat®, Nipacide®, Nipacombin®, Nipacombin® SK, Phenonip®, Phenonip® ME, Phenonip® XB</td>
</tr>
<tr>
<td></td>
<td>Ethylparaben</td>
<td>Nipagin® A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Propylparaben</td>
<td>Nipasol® M</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Butylparaben</td>
<td>Nipabutyl®</td>
<td></td>
</tr>
<tr>
<td><strong>Formaldehyde donors</strong></td>
<td>DMDM Hydantoin</td>
<td>Nipaguard™ DMDMH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imidazolidinyl Urea</td>
<td>Nipa Biopure® 100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diazolidinyl Urea</td>
<td>Nipa Biopure® 200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sodium Hydroxymethylglycinate</td>
<td>Nipaguard® SMG</td>
<td></td>
</tr>
<tr>
<td><strong>Halogenated</strong></td>
<td>Bronopol</td>
<td></td>
<td>Nipaguard® BPX, TBK, PBI</td>
</tr>
<tr>
<td></td>
<td>Methylchloro isothiazolinone &amp;</td>
<td></td>
<td>Nipaguard® CMB</td>
</tr>
<tr>
<td></td>
<td>Methyliso-thiazolinone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Methyldibromo Glutaronitrile</td>
<td></td>
<td>Nipaguard® DCB and TBK</td>
</tr>
<tr>
<td></td>
<td>Iodopropynyl Butylcarbamate</td>
<td></td>
<td>Nipaguard® IPF, IPP2, PBI</td>
</tr>
<tr>
<td><strong>Alcohols</strong></td>
<td>Phenoxyethanol</td>
<td>Phenoxytol®</td>
<td>Phenonip®, Nipaguard® TBK, DCB, IPP2, BPX, PBI</td>
</tr>
<tr>
<td></td>
<td>Benzyl Alcohol</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Organic acids</strong></td>
<td>Benzoic acid</td>
<td>Benzoic acid</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other preservatives</strong></td>
<td>Piroctone Olamine</td>
<td></td>
<td>Nipaguard® PO 5, POM, POB</td>
</tr>
</tbody>
</table>
Paraben Preservatives

- Nipagin® M, Nipagin® A, Nipasol® M, Nipabutyl®
- Nipastat®, Nipasept®, Phenonip®, Phenonip® XB, Phenonip® ME
Esters of p- Hydroxybenzoic Acids

Paraben Esters: methyl, ethyl, propyl, butyl

- Nipagin® M, Nipagin® A, Nipasol® M, Nipabutyl®

Used in Blends

- Nipastat®, Nipasept®, Phenonip®, Phenonip® XB, Phenonip® ME

Disadvantages

- Low water solubility (Except Sodium Salt Esters)
- Some nonionic emulsifiers may reduce the activity
- Slightly weak antibacterial activity
- Incompatible with some proteins

Advantages

- Over 70 years global use with an excellent safety record
- Stable and effective over a wide pH range
- Heat stable
- Combinations of esters exhibit increased activity
- Approved worldwide in personal care
Formaldehyde Donors

- DMDM Hydantoin
- Imidazolidinyl Urea
- Diazolidinyl Urea
- Sodium Hydroxymethyl Glycinate
# Formaldehyde Donors

<table>
<thead>
<tr>
<th>Single preservative</th>
<th>Blend</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nipaguard® DMDMH</td>
<td></td>
<td>Inexpensive, Water soluble, Low oil solubility, Broad spectrum activity, Active at low concentrations, Active between pH 4 – 8, Non-volatile, Good heat stability</td>
<td>Formaldehyde Donor</td>
</tr>
<tr>
<td>DMDM Hydantoin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nipa Biopure® 100</td>
<td>Imidazolidinyl Urea</td>
<td>Water soluble, Low oil solubility, Good antibacterial activity, Active between pH 4 – 9, Non-volatile, Easier to handle than formaldehyde, Low formaldehyde release (not activity-dependant)</td>
<td>Poor antifungal activity, Some formaldehyde release, Poor heat stability, Relatively expensive</td>
</tr>
<tr>
<td>Nipa Biopure® 200</td>
<td>Nipaguard® PDU</td>
<td>Water soluble, Low oil solubility, Good antibacterial activity, Active between pH 4 – 9, Non-volatile, Easier to handle than formaldehyde, Low formaldehyde release (not activity-dependant)</td>
<td>Poor antifungal activity, Some formaldehyde release, Poor heat stability, Relatively expensive, not globally approved</td>
</tr>
<tr>
<td>Diazolidinyl Urea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nipaguard® SMG</td>
<td>Sodium Hydroxymethyl glycinate</td>
<td>Water soluble, Active between pH 3.5 – 12, Compatible with anionic, cationic, nonionic surfactants, Compatible with proteins and other natural ingredients</td>
<td>Formaldehyde Donor, Poor anti-yeast activity</td>
</tr>
</tbody>
</table>
Halogenated Preservatives

\[
\text{HOCH}_2\text{C} = \text{CCH}_2\text{OH} \quad \text{Cl} - \text{N} - \text{CH}_3
\]

\[
\text{Br} - \text{C} = \text{CCH}_2\text{OH} \quad \text{NO}_2
\]

\[
\text{I} - \text{C} = \text{CCH}_2\text{O} - \text{C} - \text{NH(CH}_2\text{)}_3\text{CH}_3
\]
## Halogenated Preservatives

<table>
<thead>
<tr>
<th>Single preservative</th>
<th>Blend</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bronopol</td>
<td><strong>Nipaguard® BPX, PBI</strong></td>
<td>Excellent bactericidal activity, Particularly effective against Pseudomonas, Water soluble, Compatible with proteins and nonionics</td>
<td>Poor fungicidal activity, Poor stability above pH 8, Associated with nitrosamine formation, Detectable formaldehyde release, Not Globally Approved</td>
</tr>
<tr>
<td>Methylchloroisothiazolinone &amp; Methylisothiazolinone</td>
<td><strong>Nipaguard® CMB</strong></td>
<td>Broad spectrum activity, Active at very low concentrations, Compatible with nonionics, Incompatible with amides and amines, Incompatible with proteins, like Keratin</td>
<td>Skin sensitizer, Restrictive concentration limit of 15 ppm, Hazardous to handle as supplied, Poor stability above pH 8, Heating should be avoided, Reluctance to use in leave-on products</td>
</tr>
<tr>
<td>Iodopropynyl Butylcarbamate</td>
<td><strong>Nipaguard® IPF, IPP2, PBI</strong></td>
<td>Extremely powerful fungicidal activity, Compatible with nonionics and proteins, Active at very low usage concentrations</td>
<td>Virtually insoluble in water, Very poor bactericidal activity, Can cause discoloration, Strongly restricted in EU (different max. use concentration [rinse-off, leave on, deo], oral/lip care not allowed, baby care with exemptions)</td>
</tr>
</tbody>
</table>
## Alcohols

- Phenoxyethanol
- Benzyl alcohol

<table>
<thead>
<tr>
<th>Single preservative</th>
<th>Blend</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenoxyethanol</td>
<td>Phenonip®, XB, ME, Nipaguard® IPP2, BPX, PBI, PO5, POB, POM</td>
<td>Good activity against Pseudomonas, Low toxicity, Compatible with nonionics and proteins, Used as Solvent in blends to boost overall activity</td>
<td>High concentrations required if used alone</td>
</tr>
<tr>
<td>Phenoxytol®</td>
<td>Nipaguard® CMB</td>
<td>Good activity against gram positive and moulds, Low toxicity, Compatible with nonionics and proteins, Combinations with parabens improves efficacy</td>
<td></td>
</tr>
<tr>
<td>Benzyl alcohol</td>
<td>Nipaguard® CMB</td>
<td></td>
<td>High concentrations required if used alone, 7th amendment labeling, list of 26 allergens</td>
</tr>
</tbody>
</table>
**Piroctone Olamine based Preservative Blends**

Advantages

- Broad spectrum activity
- Low toxicity
- Compatible with nonionics and proteins
- Suitable for leave-on and rinse-off
- Globally approved

Disadvantages

- Can be deactivated by iron ions and aluminium ions
- Low water solubility if used without synergistic solvent

Used in blends

**Nipaguard® PO 5, POB, POM**
**Nipaguard® PO Blends**

- Blended with Phenoxyethanol to combine the excellent antifungal activity of Piroctone Olamine with the antibacterial activity of Phenoxyethanol
  - Benzoic Acid and Methylparaben added to increase efficacy
- Broad spectrum activity, effective against most bacteria, yeasts and moulds
- Suitable for a variety of cosmetic formulations
- Active at low use concentrations

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nipaguard® PO 5</td>
<td>95%</td>
<td>phenoxyethanol</td>
<td>5% piroctone olamine</td>
</tr>
<tr>
<td>Nipaguard® POB</td>
<td>80%</td>
<td>phenoxyethanol</td>
<td>15% benzoic acid</td>
</tr>
<tr>
<td>Nipaguard® POM</td>
<td>80%</td>
<td>phenoxyethanol</td>
<td>15% methylparaben</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5% piroctone olamine</td>
</tr>
</tbody>
</table>
**Nipaguard® PO Blends - Registration Status for Cosmetics**

- **Europe, Annex VI, 76/768/EEC:**
  Piroctone Olamine: max. concentration of 1 % for rinse-off products and 0.5 % for leave-on products;
  Phenoxyethanol: Maximum concentration 1% in cosmetic product
  - Nipaguard® PO 5: Maximum concentration 1.05 % in cosmetic product
  - Nipaguard® POB: Maximum concentration 1.25 % in cosmetic product
  - Nipaguard® POM: Maximum concentration 1.25 % in cosmetic product

- **USA:** not restricted - CIR available for Phenoxyethanol, no CIR available for Piroctone Olamine

- **Japan:** approved for use as a preservative,
  - leave-on and rinse-off cosmetics, is 0.05 % and it must not be applied on mucous membranes.
  - preservative blends based on Piroctone Olamine can all be used within a use concentration of 1.0 % for Nipaguard PO 5, POB and POM
Organic Acids

**Benzoic Acid**

<table>
<thead>
<tr>
<th>Single Preservative</th>
<th>Blend</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic acids</td>
<td>Benzoic acid used in blend Nipaguard® POB</td>
<td>Effective against both yeast and mold, Low toxicity, Globally approved, “Natural” preservatives, Benzoic acid is a very stable compound</td>
<td>Only active in acidic form, Not active as salts, Salts are easier to incorporate than corresponding acids, pH &lt; 5 needed, Weak bactericidal activity, UV instability of Salicylic acid, Inactivation of Benzoic acid by nonionics</td>
</tr>
</tbody>
</table>
Why blend Preservatives?

- To move closer to the ideal preservative
- To broaden the spectrum of activity (yeast, mould, gram+ve and gram-ve bacteria)
- Improve effectiveness over the single actives (synergism)
- Improve application in different formulations
- To improve safety by reducing the concentrations required of any single component
- To improve cost-effectiveness
- To offer more flexibility and choice to the customer
To Broaden Spectrum of Activity
Typical Clariant Blends

- Parabens + Phenoxyethanol - Phenonip®
- Methylparaben + Ethylparaben + Phenoxyethanol – Phenonp® ME
- Parabens (except butylparabens) + Phenoxyethanol - Phenonip® XB
- Parabens + Bronopol + Phenoxyethanol - Nipaguard® BPX
- Parabens + Diazolidinyl Urea - Nipaguard® PDU
- CMIT + MIT + Benzyl Alcohol - Nipaguard® CMB
- IPBC + Phenoxyethanol - Nipaguard® IPP2
- IPBC + PEG-4 Laurate - Nipaguard® IPF
- Piroctone Olamine + Phenoxyethanol – Nipaguard® PO5
- Piroctone Olamine + Phenoxyethanol + Benzoic Acid – Nipaguard® POB
- Piroctone Olamine + Phenoxyethanol + Methylparaben – Nipaguard® POM
Problem Ingredients in Cosmetic Formulations

Microbial Nutrients
- Aloe
- Dipropylene Glycol
- Plant Extracts
- Sodium Hyaluronate
- Vitamins

Preservative Inactivators
- Cellulose gum
- Lecithin
- Nonionics (e.g. Polysorbates)
- Xanthan gum
- UV- Filters

Preservative Absorbers
- Kaolin
- Silica
- Talc
- Titanium dioxide
Headspace Preservation

The following preservatives are particularly successful in additional safeguarding of the headspace - the space between the packaging and the product - using Benzyl Alcohol or Phenoxyethanol in addition to the main preservative

- Nipaguard® BPX
- Nipaguard® CMB
- Nipaguard® IPP2
Headspace Preservation

The following preservatives are particularly successful in additional safeguarding of the headspace - the space between the packaging and the product-releasing formaldehyde in formulations:

- Nipaguard® DMDMH
- Nipa Biopure®100
- Nipa Biopure® 200
- Nipaguard® SMG
The Future of Preservatives

- Legislation/ Safety
- Customer/ Consumer Perception / Media Coverage
- Cost
- New Innovations - Naturals, Heavy metals, etc.
- Non Gov’t Organizations & Pressure Groups

- Watch out for Changing Market