



EUROPEAN NATURAL AND ORGANIC STANDARDS for COSMETIC INGREDIENTS

Prepared by UNITIS

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This document doesn't prejudge the provisions of the standards leading to the certification of organic and natural finished cosmetics: it is only dedicated to enable the upstream certification of organic and natural cosmetic ingredients so as to make easier and transparent the certification of finished cosmetics.

1. Introduction

There is worldwide a clear and increasing request from consumers for Organic and/or Natural cosmetics and personal care products.

There is consequently a stronger and stronger demand from the cosmetic industry to ingredients manufacturers for Natural and/or Organic certified cosmetics ingredients with the aim to formulate Natural and/or Organic cosmetic products which will satisfy the consumer requests.

For historical reasons, there are in the world many different standards that are leading to certification of Natural and/or Organic cosmetics but a very few are clearly enabling to certify ingredients in a transparent way.

In such an unclear and confused situation, there is consequently a strong need for harmonization of existing standards including a specific procedure for certification of ingredients.

The Standards presented below have been developed at the European level by UNITIS – European Organization of Cosmetic Ingredients Industries and Services – as a new step of contribution to the harmonization of Organic and Natural Standards.

They have been strongly inspired by:

- The specific knowledge and experience of European manufacturers of Natural cosmetic ingredients grouped in UNITIS,
- The understanding of the requirements of the Cosmetic Industry willing to satisfy the demand of consumers in the particular field of Organic and Natural Cosmetics.
- The various provisions concerning ingredients included in major existing European Standards – Cosmos and Natrue – but also in the USA.

The aim of this document is to contribute to the development of a single system of European standards aiming to simplify the work of the industries while clarifying the information delivered to the consumers through a first step of Certification and/or Approval of Organic and/or Natural cosmetic ingredients.

It has been built with the following objectives:

- creation of a clear link between natural resources, organic agriculture and cosmetic ingredients,
- contribution to the consumer safety,
- possibility to address all kinds of cosmetic and personal care ingredients with the best possible quality,
- respect of the people and of the environment,
- to promote the use in cosmetics of renewable raw materials and ingredients instead of petrochemicals,
- settling of transparent rules understandable for all links of the chain, from cosmetic ingredients manufacturers to cosmetic consumers,
- facilitation of the harmonization of the Standards dedicated to the Organic and/or Natural certification of cosmetic and personal care finished products,
- respect of the European Regulations in force to rule cosmetic ingredients manufacturing and marketing.

When, for such purposes, these standards go beyond the requirements set out in European legislation for both cosmetic products and organic foods, it is in a reasonable way, compatible with the technical realities of the cosmetic ingredients industries.

Within such a framework, the final aim of these Standards is to give to cosmetic companies the percentage of Organic and/or Natural content in each certified or approved Organic or Natural cosmetic ingredient.

2. Regulations

There is no existing EU Directive or Regulation ruling the Organic and/or Natural cosmetic ingredients.

However, these Standards are compatible with all relevant European legislation, including:

- The EU REGULATION for COSMETIC PRODUCTS - European Directive 76/768/EEC as amended, Regulation 1223/2009 of 30 November 2009, and other local or national laws where appropriate,
- The EU REACH REGULATION – Regulation n° 1907/2006,
- The EU REGULATION on ORGANIC PRODUCTION AND LABELING OF ORGANIC PRODUCTS – European Regulation n° 834/2007.

The reference to these Standards will not exempt its users to comply with such Regulations when relevant.

3. Scope

These Standards apply to cosmetic ingredients marketed as Organic and/or Natural.

They cover:

- origin and processing of ingredients
- manufacturing
- traceability
- environment
- packaging
- labeling
- certification/approval
- communication
- inspection.

4. Definitions

4.1. « Cosmetic Ingredient » - (taken from Article 5a and 6 of Directive 76/768/EEC):

Cosmetic ingredient shall mean any chemical substance or preparation of synthetic or natural origin used in the composition of cosmetic products.

The following shall not be regarded as ingredients:

- impurities in the raw materials used,
- subsidiary technical materials used in the preparation but not present in the final ingredient.

4.2. « Primary Raw-material »:

Any biomass, including botanicals (plants, algae, fungi), micro-organisms, animal by-products from agricultural production or wild picking, as well as minerals, which are used as raw material in the manufacture of cosmetic ingredients.

Minerals are Primary Raw-materials and salts obtained from naturally occurring substances formed through geological processes, excluding fossil fuel-derived materials.

4.3. « Organic cosmetic ingredient »:

Primary Raw-material, except minerals, which is:

- Organic certified according to Regulation n° (EEC) 834/2007 or other recognized international or national organic standards and certified by an IFOAM accredited or internationally recognized (according to ISO 65) certifier,
- either unprocessed,
- or processed only through accepted physical processes as described in these standards,
- and also meets the other requirements of these standards.

4.4. « Cosmetic ingredient of organic origin »:

Primary Raw-material, except minerals, which is:

- Organic certified according to Regulation n° (EEC) 834/2007 or other recognized international or national organic standards and certified by an IFOAM accredited or internationally recognized (according to ISO 65) certifier,
- processed only through accepted chemical processes or biological as described in these standards.
- and also meets the other requirements of these standards.

4.5. « Natural cosmetic ingredient »:

Primary Raw-material, including minerals, which is:

- either unprocessed,
- or processed using only the physical processes allowed in these standards,
- and also meets the other requirements of these standards.

4.6. « Cosmetic Ingredient of natural origin »:

Primary Raw-material, including minerals, which is:

- processed using only the chemical or biological processes allowed in these standards, and which may include a synthetic moiety,
- and also meets the other requirements of these standards.

4.7. « Mineral Ingredient »:

Mineral Primary Raw-material which is:

- either unprocessed,
- or processed using only the physical processes allowed in these standards,
- or processed using only the chemical processes allowed in these standards,
- or processed through other physical and chemical processes.

4.8. « Manufacturing »:

Group of operations carried out in the factory or the laboratory, for obtaining, preparing, processing and labeling cosmetic ingredients.

4.9. « Extraction solvent »:

Materials used in the process of biomass extraction, including any forms of water or solvents that are:

- organic,
- natural
- of biologically processed organic origin
- of biologically processed natural origin

Extraction solvents include, for instance:

- Water
- Ethanol (Alcohol) of botanical origin,
- Fats and Oils of botanical origin,
- Glycerol derived from fats and oils of botanical origin,
- CO₂.

4.10. « Purification solvent »:

Materials used for their unique dissolving properties which enable the purification of cosmetic ingredient of natural origin.

4.11. « Moiety »:

A specific segment of a molecule defined by functional group or building block.

4.12. « Catalyst »:

A substance used to modify or increase the rate of chemical change in another material, but which is not consumed or incorporated into the final material.

4.13. « Reagent »:

A substance necessary to be added to a Primary Raw-material for its transformation through chemical or biological processes allowed in these standards

4.14. « Contaminant »:

A substance that is:

- not naturally present in the Primary Raw-material, or
- present in quantities greater than those that exist naturally which could lead to pollution (persistence, residues) and toxicity risks.

4.15. « Synthetic additives »:

Additives, in particular preservatives, which can be used to ensure the stability of the product and to contribute to the safety of consumers, when, and as long as no other better technical or regulatory solution is available. Examples of allowed synthetic additives also naturally present in plants are given in Annex 2.

5. Organic and/or Natural Cosmetic Ingredients

Cosmetic ingredients able to be Organic certified and/or Natural approved are the results of the application of manufacturing operations to Primary Raw-materials.

5.1. Primary Raw-materials

Primary Raw-materials cannot be used if they are:

- plant raw materials that are part of the European and international lists of protected species (cf. the Washington Convention or the Berne Convention), except those of Annex II of the Washington Convention controlled under CITES certification,
- plants or plant materials that have been genetically modified,
- raw-materials extracted from living or slaughtered animals.

Primary Raw-materials of animal origin may be used as long as:

- they are produced by animals but are not a part of the animal,
- they have been obtained from animals used for food purpose, provided it contributes to waste recycling,
- they have been obtained using only the processes allowed in these standards, and
- the animals are not part of the European or international lists of protected species (these are listed in the Washington Convention or the Berne Convention), except those of Annex II of the Washington Convention controlled under CITES certification.

It has to be ensured that the animal Primary Raw-materials used come from animals whose welfare has been protected.

5.2. Manufacturing processes

5.2.1. Approved manufacturing processes

Approved manufacturing processes that can be applied to Primary Raw-materials, are:

- Physical processes listed in Annex 1-A
- Chemical and biological processes listed in Annex 1-C

The following criteria have been used to select these processes:

- processes which help to respect natural active substances that are present in ingredients,
- processes which encourage good waste management and energy use and take into account ecological balance.

Chemical processes listed in Annex 1-C have been selected while considering the principles of the "Green chemistry" reminded in Annex 4. Catalysts, reagents and purification solvents used in these chemical processes will be also selected while considering the principles of the "Green Chemistry". See in annex 4.

Any other process is not acceptable: the most significant examples of forbidden processes are given in Annex 1-B.

5.2.2. Genetically modified organisms (GMOs)

Botanical, animal by-products and their derivatives which have been genetically modified are forbidden, except traces possibly coming from Primary Raw-materials and within the limit of 0.9% maximum, according to the European regulations.

5.2.3. Irradiation

Any kind of ionizing irradiation is forbidden.

5.3. Manufacturing conditions

It is recommended to manage manufacturing conditions that are inspired by the concept of Good Manufacturing Practices and, for instance:

5.3.1. Storage

Storage must be clearly labeled in dedicated areas so as to avoid any confusion or risk to the integrity of ingredients.

5.3.2. Manufacturing

Different manufacturing processes must be separated to prevent contamination of organic or natural ingredients or be operated after a thorough cleaning of equipment according to this standard.

Quality Assurance System must include:

- complete traceability from Primary Raw-materials to the final cosmetic ingredient,
- manufacturing procedures throughout all stages,
- control analysis, manufacturing and storage records.

5.3.3. Packaging

5.3.3.1. To minimize the direct and indirect environmental impacts of packaging during its life cycle, it is requested to:

- minimize the amount of material used,
- maximize the amount of material that can be reused or recycled,
- use materials with recycled content where possible.

5.3.3.2. Following materials cannot be used in packaging:

- polyvinyl chloride (PVC)
- polystyrene foam.

5.3.4. Cleaning and Hygiene

Cleaning materials must comply with these standards.

In addition, the following disinfection materials may be used: vegetable derived alcohol, iso-propyl alcohol, amphoteric surfactants, hydrogen peroxide, mineral acids and alkalis and any other ingredients listed as accepted in these standards.

5.3.5. Waste management

Manufacturing operations must be assorted with all possible measures enabling to reduce the environmental impact of manufacturing waste.

5.4. Biodegradability

Cosmetic ingredients with surfactant properties must be tested for biodegradability with more than 70 % according OECD 301.

5.5. Precautionary

When there is scientifically confirmed evidence that an ingredient, technology or process could pose a health or environmental risk, then the precautionary principle will apply and the ingredient will no longer be allowed.

6. Certification/Approval

6.1. Organic Certification of cosmetic ingredients

6.1.1. Principle

Organic Certification of cosmetic ingredients can be obtained for:

- Organic Certified Primary Raw-materials unprocessed: in such case, the cosmetic ingredient is 100% Organic,
- Organic Certified Primary Raw-materials processed through the approved physical processes listed in Annex 1-A of these Standards: in such case, the cosmetic ingredient can be 100% or partially Organic according to the calculation rules detailed in point 6.1.2.1.,
- Organic Certified Primary Raw-materials processed through the approved chemical and biological processes listed in Annex 1-C of these Standards: in such case, the cosmetic ingredient can be partially Organic according to the calculation rules detailed in point 6.1.2.2.,
- also meeting all other requirements of these Standards.

6.1.2. Rules for calculation

The calculation rules presented below have been defined so as to enable cosmetic ingredients manufacturers to determine for each cosmetic ingredient the percentages of its Organic, Organic origin, Natural, Natural origin and Synthetic contents and communicate such figures to cosmetic companies.

This transparency will enable to guarantee at all levels that the Organic content in finished cosmetic products does not include indirectly any non Organic substances.

6.1.2.1. The calculation of the Organic percentage contained in the cosmetic ingredient manufactured from Organic Primary Raw Materials processed through approved physical processes listed in Annex 1-A of these Standards, is as follows:

- Extracts without remaining extraction solvents - as defined point 4.9 - (e.g. dry extracts, juices, essential oils obtained by steam distillation or extracts obtained by CO₂, pressure, ...):

An extract without remaining extraction solvent obtained from an organic certified Primary Raw-material with an extraction solvent accepted in these standards is 100% Organic.

- Extracts with remaining extraction solvents (water, glycerol, alcohol, vegetal oil, hydrolates/distillates...):

Organic percentage = $100 \times (\text{weight of organic fresh Primary raw-material} + \text{weight of organic extraction solvent}) / (\text{weight of organic fresh Primary raw material} + \text{weight of all extraction solvents} + \text{weight of synthetic additives})$

To get the equivalent fresh weight of dried plants in the calculation of organic content of extracts, it is possible:

- either to use the actual dry to fresh ratio for the material, if justified by a measure
- or to use the following ratios:
 - Wood, bark, seeds, nuts and roots 1/2.5
 - Leaves, flowers and aerial parts 1/4.5
 - Water fruits 1/8

The percentage cannot exceed 100%.

- Special case: concentrated dried plant juices or gels

It is possible to reconstitute concentrated dried plant juices or gels to their natural state, providing no other additive or carrier is added.

In that case, the reconstituted material is considered as 100% organic.

6.1.2.2. The calculation of the Organic percentage contained in the cosmetic ingredient manufactured from Organic Primary Raw Materials processed through approved chemical or biological processes listed in Annex 1-C of these Standards, is made:

- either through the proportion (by weight) of the Organic Primary Raw-material in the cosmetic ingredient, taking into account the chemical reagents used to make that ingredient:

Organic percentage = $100 \times (\text{Molecular weight of Moiety of the final ingredient coming from organic Primary Raw-material}) / (\text{Molecular weight of final ingredient})$

- or using ASTM D6866 – Standard Test Methods for determining the biobased content of solid, liquid and gaseous samples using radiocarbon analysis : $^{14}\text{C} / ^{12}\text{C}$
 - The percentage cannot exceed 100%
 - The yield of the chemical reaction should be at a minimum of 50%, computed on the quantity of organic primary raw material used.

6.1.3. Special factors

■ Synthetic additives :

Certain synthetic additives, in particular preservatives, can be used as long as there are no effective natural alternatives available to ensure the stability of the product and to contribute to the safety of consumers, provided:

- they are substances naturally present in plants,
- they are recognized as safe.

Examples are listed in Annex 2, but:

An Organic Certified cosmetic ingredient cannot contain more than 2% of such synthetic additives.

► **Contaminants:**

Contaminants as defined in 4.14 are not allowed.

► **Water:**

Water used as an extraction solvent must comply with hygienic standards and may be:

- drinkable water
- spring water
- water obtained by osmosis
- distilled water
- sea water.

It may be filtered or softened.

Water cannot be calculated as Organic.

► **Minerals:**

Minerals and mineral ingredients cannot be calculated as Organic.

6.1.4. Certification Procedure

The Certification of Organic cosmetic ingredients can be obtained only through Audits on the production sites.

6.2. Natural Approval of cosmetic ingredients

6.2.1. Principle

Natural Approval of cosmetic ingredients can be obtained for:

- Primary Raw-materials unprocessed: in such case, the cosmetic ingredient is 100% Natural,
- Primary Raw-materials processed through the approved physical processes listed in Annex 1-A of these Standards: in such case, the cosmetic ingredient is 100% Natural according to point 6.2.2.1.
- Primary Raw-materials processed through the approved chemical and biological processes listed in Annex 1-C of these Standards: in such case, the cosmetic ingredient can be either 100% of Natural origin or partially Natural according to the calculation rules detailed in point 6.2.2.2.,

also meeting all other requirements of these Standards.

6.2.2. Rules for calculation

The calculation rules presented below have been defined so as to enable cosmetic ingredients manufacturers to determine for each cosmetic ingredient the percentages of its Natural, Natural origin and Synthetic contents and communicate such figures to cosmetic companies.

This transparency will enable to guarantee at all levels that the Natural content in finished cosmetic products does not include indirectly any non Natural substances.

6.2.2.1. The calculation of the Natural percentage contained in the cosmetic ingredient manufactured from Primary Raw Materials processed through approved physical processes listed in Annex 1-A of these Standards, is as follows:

An extract with or without remaining extraction solvent obtained from a Primary Raw-material with an extraction solvent accepted in these standards is 100% Natural.

6.2.2.2. The calculation of the Natural percentage contained in the cosmetic ingredient manufactured from Primary Raw Materials processed through approved chemical and biological processes listed in Annex 1-C of these Standards, is made:

- either through the proportion (by weight) of the Primary Raw-material in the cosmetic ingredient, taking into account the chemical reagents used to make that ingredient:

Natural percentage = $100 \times (\text{Molecular weight of Moiety of the final ingredient coming from Primary Raw material}) / (\text{Molecular weight of final ingredient})$

- or using ASTM D6866 – Standard Test Methods for determining the biobased content of solid, liquid and gaseous samples using radiocarbon analysis : $^{14}\text{C} / ^{12}\text{C}$
 - The percentage cannot exceed 100%
 - The yield of the chemical reaction should be at a minimum of 50%, computed on the quantity of natural primary raw material used.

6.2.3. Special factors

■ Synthetic additives :

As a temporary exception, certain synthetic additives, in particular preservatives, can be used as long as there are no effective natural alternatives available to ensure the stability of the product and the safety of consumers, provided:

- they are substances occurring in nature,
- they are recognized as safe in finished cosmetic or personal care products.

Examples are listed in Annex 2, but:

A Natural Approved cosmetic ingredient cannot contain more than 2% of such synthetic additives.

■ Synthetic solvents:

- By exception, synthetic solvents used for extraction and purification of physically and chemically processed natural ingredients are accepted if no renewable alternative is acceptable.
- Synthetic solvents are listed in Annex 3.
- After use, these substances must be completely removed or at least removed to such an extent that they are only contained in technologically unavoidable and technologically ineffective trace concentrations in the finished ingredient.

■ Water :

Water used as an extraction solvent must comply with hygienic standards and may be:

- drinkable water
- spring water
- water obtained by osmosis

- distilled water
- sea water

It may be filtered or softened.

Water can be calculated as natural in calculations according to 6.2.2.

► Minerals:

Minerals and mineral ingredients can be calculated as Natural provided there are unprocessed or processed through physical or chemical and biological processes allowed in these standards.

6.2.4. Certification Procedure

The Approval of Natural cosmetic ingredients can be obtained only through application by Approbation Files.

6.3. Summary

INGREDIENT TYPE	% OF ORGANIC or NATURAL content in the COSMETIC INGREDIENT	
	ORGANIC	NATURAL
ORGANIC	X% to 100 %	100 %
ORGANIC ORIGIN	X%	X %
NATURAL	-	100 %
NATURAL ORIGIN	-	X %

In case of addition of synthetic additives, especially preservative systems, this percentage has to be reduced in proportion of the quantity of added synthetic additives according to points 6.1.3. & 6.2.3.

7. Labeling & communication

7.1. Cosmetic Ingredients under Organic Certification

- The Organic ingredient can be labeled with the term “ Organic “ but only with the logo of the body owning these standards,
- The body responsible for certification and control must be mentioned through the phrase: “ Certified by “
- The Organic percentage of the ingredient must be indicated as well as the organic origin, natural, natural origin and synthetic percentages contained in the ingredient.

A list of certified Organic ingredients will be published by the owner of these Standards.

7.2. Cosmetic Ingredients under Natural Approval

- The Natural ingredient can be labeled with the term “ Natural “ but only with the logo of the body owning these standards,
- The body responsible for Approval and control must be mentioned through the phrase: “ Approved by “
- the Natural percentage of the ingredient must be indicated as well as the natural origin and synthetic percentages contained in the ingredient.
- A list of certified Natural ingredients will be published by the owner of these Standards.

7.3. Supporting literature

Any reference to Organic or Natural cosmetic ingredients in advertising or supporting literature must be made by compliance with the appropriate rules in 7.1. or 7.2.

7.4. Use of the name or logo of these Standards

The use of the Cosmetics Organic and Natural Standards logo or name in literature, advertising, publicity, etc..., can be done:

- In a company name or brand name only if all the ingredients of the company or brand are certified or approved,
- Only in conjunction with the cosmetic ingredients that are certified or approved, and,
- Only in a way that does not mislead the users.

8. Inspection/control system

8.1. Inspection and Organic Certification

To label their cosmetic ingredients as Organic according to these standards, companies must:

- have submitted their manufacturing operation and ingredients to inspection and certification by an authorized inspection/certification body. This includes any sub-contracted manufacturing entities that are used to process the cosmetic ingredients.
- hold a valid operational certificate from that body.
- undergo an on-site annual inspection cycle which may include possible unannounced inspections and other additional inspections, and,
- allow the inspection/certification body to take samples and carry out analysis (according to standard procedures) for possible contaminants either on a random basis or in case of suspicion.

8.2. Control and Natural Approval

To label their cosmetic ingredients as Natural according to these standards, companies must:

- have submitted a fully documented file on their manufacturing operation and ingredients to control by an authorized inspection/certification body. This includes any sub-contracted manufacturing entities that are used to process the cosmetic ingredients.
- hold a valid operational certificate from that body.
- undergo regular controls aiming to verify the validity of the file.

9. Inspection/certification Bodies

So as to be authorized as inspection/certification/approval bodies for the application of these standards, specialized organizations must cumulatively:

- be accredited to ISO 65,
- be accredited according to the EN 45011 standard,
- have cosmetics inspection/certification/approval in the scope of their ISO 65 accreditation - or at least have applied for inclusion of cosmetics in the scope which must be granted within 18 months,
- have submitted a file for accreditation to the owner of the standards,
- be authorized in writing by the owner of these standards to proceed to inspection/certification/approval,
- accept and respect the inspection procedures prepared by the owner of these standards,
- accept during ongoing authorization control by the owner of these standards including any investigations it may undertake in case of complaint or suspicion,
- cooperate with the owner of these standards so as to guarantee the respect of these standards and full transparency of their implementation,
- not make interpretations of these Standards and refer to the owner when interpretations are necessary.
- guarantee the absolute confidentiality of the information received from ingredients' manufacturers for 10 years at least.

10. Use of the Standards

These standards can be used for ingredient certification/approval by any certifying body which conforms with the criteria mentioned in point 9. and obtains the formal agreement of Unitis.

They have been also conceived in order to contribute to the harmonization of existing cosmetic standards for their ingredient part.

ANNEX 1 - A

Approved Physical processes

EXTRACTION (solvents, hyper frequency processes, ultrasounds)

BLEACHING (on an inert support conforming to these standards)

DEODORIZATION (on an inert support conforming to these standards)

GRINDING/CRUSHING

CENTRIFUGATION

SETTLING AND DECANTING

DRYING

DETERPENATION (if physically fractionated)

DISTILLATION

FILTRATION

FREEZING

PURIFICATION (dialysis, crystallization, ion exchange, ...)

BLENDING

PRESSING (cold and hot) / SQUEEZING

STERILIZATION WITH THERMAL AND UV TREATMENTS

SIFTING/SIEVING

ROASTING

VACCUM TREATMENTS

LYOPHILIZATION

ANNEX 1 - B

Forbidden Processes

Any other processes besides those listed in Annex 1-A above are not accepted.
It is further specified that the following processes are not acceptable:

BLEACHING (on a support of animal origin)

DEODORISATION (on a support of animal origin)

DETERPENATION (if not physically fractionated)

IONIZING IRRADIATION

TREATMENTS WITH ETHYLENE OXIDE

ANNEX 1 - C

Approved Chemical or Biological processes

ACYLATION
C-ALKYLATION
AMIDATION
AMINATION
CALCINATION of plants residues / CARBONIZATION (resins, fatty organic oils) / PYROLYSIS
CONDENSATION / ADDITION
ESTERIFICATION – TRANSESTERIFICATION
ETHERIFICATION
FERMENTATION
GLYCOSIDATION
HYDRATION
HYDROGENATION - HYDROGENOLYSIS
HYDROLYSIS
IONIC EXCHANGE
NEUTRALIZATION
OXYDATION / REDUCTION
PHOSPHORYLATION
SAPONIFICATION
SULPHATION / SULPHATATION

ANNEX 2

Examples of allowed Synthetic additives also naturally present in plants

BENZOIC ACID, its salts and its ethyl ester

BENZYL ALCOHOL

DEHYDROACETIC ACID and its salts

FORMIC ACID

4-HYDROXYBENZOIC ACID and its salts and methyl
or ethylesters

PROPIONIC ACID and its salts

SALICYLIC ACID and its salts

SORBIC ACID and its salts

ANNEX 3

Allowed synthetic Solvents

ACETONE

ETHANOL

**BUTANOL OR ISOBUTANOL ETHYL OR BUTYL OR
ISOPROPYL ACETATE**

HEXANE/PREFERABLY HEPTANE

ISOPROPANOL

METHANOL

METHYL ETHYL KETONE

ANNEX 4

Green Chemistry Principles

1. **Use renewable feedstocks:** Use raw materials and feedstock that are renewable. Renewable feedstocks are often made from agricultural products or are the wastes of other processes.
2. **Maximize atom economy:** Design synthesis so that the final product contains the maximum proportion of the starting materials.
3. **Use catalysts, not stoichiometric reagents:** Minimize waste by using catalytic reactions. Catalysts are used in small amounts and can carry out a single reaction many times.
4. **Increase energy efficiency:** Run chemical reactions at ambient temperature and pressure whenever possible.
5. **Avoid temporary modification:** Avoid using blocking or protecting groups or any temporary modifications if possible. Derivatives use additional reagents and generate waste.
6. **Analyze in real time to prevent pollution:** Include in-process real-time monitoring and control during synthesis to minimize or eliminate the formation of by-products.
7. **Prevent waste:** Design chemical synthesis to prevent waste.
8. **Design products to degrade after use:** Design products to break down to innocuous substances after use so that they do not accumulate in environment.
9. **Design less hazardous chemical syntheses:** Design synthesis with the aim to use and generate substances with no toxicity to humans and the environment.
10. **Design chemical products:** Design safer products to be fully effective.
11. **Use safer solvents:** Avoid using solvents, separation agents, or other auxiliary chemicals. If solvents are necessary, use more innocuous chemicals and recycle them.
12. **Minimize the potential for accidents:** Design chemicals and their forms (solid, liquid, or gas) to minimize the potential for chemical accidents including explosions, fires, and releases to the environment.

Adapted from: Paul Anastas and John Warner in **Green Chemistry: Theory and Practice** (Oxford University Press: New York, 1998).