

CARDING AND SPINNING

CARDING AND SPINNING OILS, WAXES, FINISHES, LUBRICANTS AND SIZING APPLIED TO FIBRES OR YARNS

3.10.1 Current criterion

The present criterion is divided into two sub-criteria. Criterion a) sets requirements for the biodegradability of the substances constituting the products used during the mechanical processes from fiber production to woven or knitted fabric. Criterion b) sets requirements to the content of aromatic compounds in mineral oils, where these constitute a part of the products used. The two criteria are formulated as follows:

a) At each given manufacturing step where carding and spinning oils, waxes, finishes, or lubricants are applied to fibers or yarns, the substances applied individually or at least 90% (by dry weight) of the component substances of the preparations applied shall be sufficiently biodegradable or eliminable in waste water treatment plants. At least 95% (by dry weight) of the component substances of any sizing preparation applied to fibers or yarns shall be sufficiently biodegradable or eliminable in waste water treatment plants, or else shall be recycled.

b) Mineral oils used shall not contain more than 1ppm of aromatic compounds.

3.10.2 Changes to the criterion

Based on the considerations in the following paragraphs, the first overall change suggested to the current criterion is a new heading, "Auxiliaries and finishing agents for fibers and yarns", which covers the substances more broadly. Secondly, the current criterion 10a on biodegradability has been divided into two criteria, one for sizes (10a) and one for spinning solution additives, spinning additives and preparation agents for primary spinning (10b). The present criterion 10 b) is accordingly renumbered to 10 c), reflecting the division of criterion 10 a) into two criteria.

The substances addressed by the criterion are washed out in the pre-treatment prior to dyeing and contribute in some cases hereby to a significant proportion of the emission to water at the wet processing plant. Environmental requirements to these substances are therefore relevant.

The products used in the mechanical processes can be divided in five main categories:

1. Sizes
2. Spinning solution additives, spinning additives and spinning bath additives
3. Preparation agents for primary spinning
4. Preparation agents for secondary spinning,
5. Coning oils, warping and twisting oils, knitting oils and silicone oils.

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Category 1 - Sizes

According to the draft IPPC reference document from February 2001 (IPPC (Draft February 2001)) sizes are typically based on one of the following chemical groups:

- starch
- starch derivatives
- cellulose derivatives (carboxymethylcellulose, CMC)
- galactomannan derivatives
- polyvinyl alcohol (PVA)
- polymethacrylates
- polyesters.

The type and amount of size applied to the yarn depends on the fiber in question. The amount varies from 0 to 200 g/kg of yarn, giving a potential high contribution to the environmental load of the wastewater.

The biodegradability of the sizes differ, starch being completely biodegradable, starch derivatives being more difficult to biodegrade, while PVA and polyesters are hardly biodegradable, but show a grade of bioelimination.

Category 2 Spinning solution additives, spinning additives and spinning bath additives

Within this group the so-called modifiers are most relevant. They are applied for special viscose qualities in loads about 5 mg/kg fibers. They mainly consist of polyethylene glycol ethers with molecular weights about 1500. During pre-treatment, more than 90% of these substances are washed off.

Category 3 Preparation agents for primary spinning

Preparation agents are applied during the manufacture of chemical fibers, directly after the spinning process. They enable subsequent processes such as drawing, twisting, warping, texturing and further (secondary) spinning.

The preparation agents can be further divided into five main classes, i.e.

- lubricants (slippery agents)
- emulsifiers
- wetting agents
- antistatic agents
- additives (e.g. biocides and antioxidants)

Typical applied lubricants used in the process from fiber to yarn manufacturing are as follows:

- highly refined mineral oils, so-called white oils (mixture of hydrocarbons with C_{12} to C_{50} chain length, having a range of boiling points between 220°C and 450°C); their use is strongly declining
- fatty acid triglycerides (refined natural oils)
- ester oils (e.g. butyl stearate, tridecyl stearate)

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- EO/PO-adducts (Ethylene Oxide/Propylene Oxide (group of copolymers))
- silicones.

Mineral oils are hardly biodegradable, but easily removed by absorption. Due to their low cost, they are still widely used as lubricants.

Ester oils are used as lubricants as an alternative to mineral oils. They are increasingly substituting mineral oils in primary spinning while, in secondary spinning, mineral oils still have the highest market share. Ester oils are usually esters of fatty acids (lauryl, stearyl acid) with fatty alcohols or polyhydroxylic alcohols. Compared to mineral oils, ester oils are more thermally stable, biodegradable and easy to emulsify.

EO/PO copolymers are used as lubricants for texturised chemical fibers because they do not interfere with the process as mineral oils do. The high molecular EO/PO-adducts (sum of EO and PO units more than 15 moles) are non- or hardly biodegradable.

Silicones are used as lubricants for elastomeric fiber (elastan). They show the highest level of COD of all lubricants and they are hardly biodegradable. An additional disadvantage is that they are difficult to emulsify and to remove from the fiber. APEO are usually used to remove them but a quite high percentage (approximately 40 %) still remains on the fiber after washing, giving rise to air emissions in the subsequent high-temperature treatments.

Emulsifiers can be anionic and non-ionic surfactants. Wetting agents are usually short-chain alkyl phosphates. Mono- and diesters of phosphorous pentoxides are in use as anti-electrostatic agents as well as amphoteric surfactants. "Additives" cover a wide range of substances, with biocides being of most interest. They are handled separately in the criterion on biocides.

Category 4 Preparation agents for secondary spinning

For these agents there is no clear definition. IPPC suggests a division into "conditioning agents" as a term for preparation agents for secondary spinning of synthetic fibers, the composition being similar to that of the preparation agents used for primary spinning of staple fibers and with a load of 1-5 g/kg fibers.

"Spinning lubricants" is suggested as a term for preparation agents for wool. Here, many recipes are in use, mostly containing white oils and ester oils (30-40%) and non-ionic surfactants. Oil-free systems are also available.

Category 5 Coning, warping, twisting and knitting oils

Oils for coning, twisting and warping consist of 70-95% white oils and 5-30% non-ionic surfactants, especially fatty alcohols and fatty acid ethoxylates. The load of coning oils varies for polyester from 5-30 g/kg, for common polyamide the load is about 5 g/kg. It is reported that imported fabric can have loads of coning oils above 50 g/kg.

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Knitting oils consist of highly refined mineral oils with additives. Due to machine losses, up to 5 g/kg of these oils remain on the knitted fabric.

Two of the Competent Bodies reported difficulties in showing compliance for knitting oil and oils in general with the current criterion 10b on aromatic compounds in mineral oils. For knitting oils, alternatives based on animal or vegetable oils had been sought for and tested, but the results have not been sufficiently good in technical terms.

The criterion requires that the content of aromatic compounds must not exceed 1ppm or 1 mg/kg. According to the IPPC-note the mineral oils for these purposes are highly refined oils (white oils). The IPPC does not give any information on the content of aromatic compounds in these mineral oils.

Comparing with the Nordic Swan label a similar criterion could be found for spinning and knitting oils. However, this criterion restricts the content of polycyclic aromatic hydrocarbons (PAH, which constitute a part of the aromatic compounds) only. The content of PAH in spinning and knitting oils must be less than 1%. This limit seems to be in accordance with the limits experienced from the applications as obtainable. Furthermore information from a manufacturer of knitting oils reports that the normal content of PAH in mineral oils is between 1- 3% but closest to the 1% (Vickers (2000)).

Based on the above information it is proposed to combine category 2 and 3 substances and establish a criterion regarding their biodegradability. Category 4 substances (preparation agents for secondary spinning) are thus exempted from the requirements. Finally, requirements regarding category 5 substances focus on the content of PAH in mineral oils.

3.10.2.1 Criterion 10 a. Sizes

The new criterion 10a is formulated as follows:

“Size: At least 95% (by dry weight) of the component substances of any sizing preparation applied to yarns shall be sufficiently biodegradable or eliminable in wastewater treatment plants, or else shall be recycled.

Assessment and verification: In this context, a substance is considered as “sufficiently biodegradable or eliminable”:

The applicant shall provide appropriate documentation, safety data sheets, test reports and/or declarations, indicating the test methods and results as above, and showing compliance with this criterion for all sizing preparations used.”

3.10.2.2 Criterion 10 b. spinning solution additives, spinning additives and preparation agents for primary spinning

The new criterion 10b is formulated as follows:

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“Spinning solution additives, spinning additives and preparation agents for primary spinning (including carding oils, spin finishes and lubricants): At least 90% (by dry weight) of the component substances shall be sufficiently biodegradable or eliminable in waste water treatment plants.

This requirement does not apply to preparation agents for secondary spinning (spinning lubricants, conditioning agents), coning oils, warping and twisting, waxes, knitting oils, silicone oils and inorganic substances.

Assessment and verification: “sufficiently biodegradable or eliminable” is as defined above in part (a). The applicant shall provide appropriate documentation, safety data sheets, test reports and/or declarations, indicating the test methods and results as above, and showing compliance with this criterion for all such additives or preparation agents used.”

The main difference between the current and the suggested criterion is thus the clear division into different types of auxiliaries and finishing agents. Furthermore, the requirements to testing are more precisely defined, thereby helping the Competent Bodies and their applicants through the application procedure.

3.10.2.3 Criterion 10c. Mineral oils

On the basis of the information above the following criterion 10c is proposed:
“The content of polycyclic aromatic hydrocarbons (PAH) in the mineral oil proportion of a product shall be less than 1.0% by weight.

Assessment and verification: The applicant shall provide appropriate documentation, safety data sheets, product information sheets or declarations, indicating either the content of polycyclic aromatic hydrocarbons or the non-use of products containing mineral oils.