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Plastic -- Environmental aspects -- General guidelines for their inclusion in standards

塑料 环境因素 标准中环境因素的通则

(ISO 17422:2018, IDT)

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Plastic -- Environmental aspects -- General guidelines for their inclusion in standards

1 Scope

This document establishes general principles for incorporating environmental considerations into the standard system for plastic products. This document aims to minimize adverse environmental impacts, without prejudice to the full suitability of the product and its intended purpose.

The guidance provided in this document is primarily intended for use by standard-setters. In addition, this document is intended to provide guidance for staff who engage in the design and other work and need to consider environmental factors related to plastic.

Note: This document is intended to facilitate the following activities:

a) Use the technology to identify and evaluate the environmental impact of the technical terms in the standard, and minimize its adverse impact;

b) Adopt good practices such as:

1) Avoid contamination through end-of-life programs and appropriate management;

2) Carry out energy saving and consumption reduction according to the intended use (and foreseeable misuse) of the product;

3) Safely use hazardous substances;

4) Avoid technically unreasonable restrictive practices;

5) Promote performance standards rather than exclusion clauses, e.g., based solely on chemical composition standards;

6) Use renewable resources and minimize the use of non-renewable resources if life cycle assessments show good results;

c) Take a balanced approach in the standard development process to address controversial issues such as environmental impact, product functionality and performance, health and safety, and other regulatory requirements;

d) Review existing standards according to technological innovations, and allow improvements in the environmental impact of products and processes;

[Source: ISO 14040:2016, 3.1]

3.7 Life cycle assessment; LCA

The collection and evaluation of inputs (3.13), outputs (3.16), and their potential environmental impacts (3.4) in the life cycle (3.6) of a product system.

[Source: ISO 14040:2016, 3.2]

3.8 Plastic product

Any materials or combinations of materials, any semi-finished or finished products that are within the scope of ISO/TC 61.

Note: ISO/TC 61 (Technical Committee on Plastics of International Organization for Standardization) is mainly responsible for the international standardization of plastic terminology, general methods, thermoplastic products, thermosetting plastic products, plastic products, foam plastics, and fiber-reinforced plastic products.

3.9 Product standard

A standard that specifies the requirements that a product or product group shall meet.

3.10 Renewable resource

Any natural resource existing in the form of material or energy that can be supplemented or replaced in natural processes.

Note 1: Renewable resources include agricultural products, biomass, solar energy, wind energy, water, waterpower, geothermal, tidal energy and regenerated biomass, etc., but do not include recycling or wasted energy.

Note 2: The organic part of municipal waste is considered as renewable energy.

Note 3: Whether the energy stored in the technical system is renewable depends on the nature of the original energy.

Note 4: Criteria for classifying energy as renewable energy vary between jurisdictions, based on local circumstances or other reasons.

3.11 End-of-life

The stage of the product life cycle in which proper waste management is carried out for the discarded final product.

Note: For the recycling and recovery of plastic waste, see ISO 11469 and ISO 15270, and see also Appendix A.

3.12 Energy recovery

A process that usable energy generates through direct and controlled combustion.

Note 1: Solid waste incineration that produces hot water, steam, and/or electricity is a common form of energy recovery.

Note 2: From a technical point of view, the term “Energy recovery” applies to the process that converts all or part of the calorific value or sensible heat of any materials into useful energy.

[Source: ISO 15270:2008, 3.11]

3.13 Input

The materials or energy entering a unit process.

3.14 life cycle inventory analysis; LCI

The stage in a life cycle assessment in which the inputs and outputs throughout the life cycle of the product under study are compiled and quantified.

Note: Life cycle inventory analysis describes product systems rather than isolated products. Life cycle data covers materials, design, performance, usage patterns, waste management, and other factors.

[Source: ISO 14040:2006, 3.3]

3.15 Mechanical recycling

The plastic waste is processed into secondary raw materials or products without significant change in the chemical structure of the material.

Note: This definition generally does not include chemical or plastic raw material recycling processes.

[Source: ISO 15270:2008, 3.21]

3.16 Output

The materials or energy leaving a unit process.

Note: These materials may include raw materials, intermediate products, finished products, emissions, and waste.

4 Environmental factors included in the standard

4.1 General

When developing standards, close coordination is required within and between subdeveloped to reduce adverse impacts on the environment and used to replace existing steps, they should be implemented; and then, abolish the current standard.

The following notes are applicable:

a) Material testing

If any substance specified in the standard becomes an environmental issue deserving full attention, the relevant provisions in material documentation such as Safety Data Sheets (SDSs) should be included. If possible, substances contained in plastic materials should be assessed based on risk assessment by using existing test method standards; the appropriate measures should be taken.

Existing ISO test method standards should be used.

b) Quality testing

Testing shall be carried out according to ISO quality standards.

c) Environmental testing

Testing shall be carried out according to ISO environmental standards.

4.2.3 Minimize the use of materials and energy

The use of materials and energy is affected by many factors, such as test scale, specimen size and number of samples, required levels of reproducibility and repeatability, and power specifications of the test equipment.

Test method standards should be designed to minimize the use of materials and energy without compromising the quality of the results obtained from the tests according to the standards.

If appropriate, guidance on how to minimize material and energy use should be provided to users of the standard.

4.3 Product standards

4.3.1 General

Writers of plastic product standards should add a general introduction to the standard to emphasize that this document and the ISO Guide 64 have been considered at the development of the standard, and this document and ISO Guide 64 will be used as normative references in the future plastics standards.

4.3.2 Product features

When designing products made of or containing plastic, oversimplification of material selection criteria should be avoided. The balance should be kept between the product's primary functional requirements and potential adverse environmental impacts identified according to the product/application system.

4.3.3 Environmental aspects in product standards

Environmental optimization approaches during the development of plastic product standards typically include the following steps:

a) Pre-select materials to ensure appropriate technical and environmental performance throughout their expected service life;

b) Screen functional materials to eliminate or minimize major adverse environmental impacts in the overall product life cycle;

c) Minimize material usage per unit produced;

d) Make the maintenance and cleaning easy if appropriate.

Only by considering the complete life cycle can the most suitable environmental properties for using a material in a specific application be determined. The scope and boundaries of LCA covered in the ISO 14040 series of standards are described in Appendix A of this document.

Note 1: The measurement accuracy of material properties and characteristics may not be absolute or related to actual end-use performance requirements. Therefore, when comparing the life cycle assessment of the alternative designs or materials, a certain degree of subjective assessment may be required.

Note 2: References to the standard and other references relevant to the design environment aspects of the plastic product standard are listed in References, including ecological information data.

4.3.4 Renewable resources and energy

From an environmental point of view, the use of renewable resources, including renewable substances and energy resources, is recommended.

a) Plastic products are also produced from renewable resources.

b) To a certain extent, biodegradable plastic products can also be returned to the natural biocarbon cycle.

4.3.5 Standard drafters

Drafters of plastic product standards should take into account the potential environmental needs of the standard users. In particular, due consideration should be given to the needs of standard drafters when making environmental provisions for

Technical requirements such as strength, toughness, thermal conductivity, and electrical conductivity should also be considered so that the final product meets the intended purpose. These factors will automatically exclude many materials, and there will eventually be a list of available materials.

A.4 Considerations for plastic manufacturing and raw materials

A unique feature of plastics is that they are essentially composed of fossil fuel feedstocks (oil and natural gas); since these feedstocks can also be used as a fuel, energy terms are often used to describe the feedstock.

For example, the total energy input required for a polyethylene manufacturing plant is the sum of the energy consumed in the production process and the inherent fuel energy of the ethylene feedstock remaining in the polymer product. Therefore, the total energy required to produce 1 kg of LDPE can be obtained as follows:

--- Processing energy, 30 MJ/kg;

--- Raw material energy, 51 MJ/kg;

--- Total energy, 81 MJ/kg.

Note: These values are examples. Differences in raw material sources or processing may result in different values. For example, it has been reported in the literature that the total energy required to produce 1 kg of low-density polyethylene is as follows:

--- Processing energy, 36.7 MJ/kg;

--- Raw material energy, 46.2 MJ/kg;

--- Total energy, 82.9 MJ/kg.

A.5 Scrap Management

The raw material energy available in the product can eventually be recovered, and there are usually two options:

a) Mechanical recycling: The purpose is to pass the main production energy by using the material as many times as possible to make the energy exist longer.

b) Energy recovery: In this case, the goal is to recover as much raw material energy as possible.

Therefore, two factors need to be considered:

--- The process energy of a material represents the maximum energy that can be used in any recovery process before the energy of the material is not worth recovering.

--- No matter how many times the plastic is mechanically recycled, the raw material energy remains the same. Therefore, mechanical recycling and energy recovery are not mutually exclusive.

Note: The hydrocarbon feedstock for polymer production provides the carbon backbone that commonly exists in most synthetic polymers. In terms of mass, there is little difference if the hydrocarbon feedstock is methane (natural gas) or crude oil. When describing the raw material in terms of energy, the change of the raw material type causes the energy to change significantly. For example, the calorific value of methane is 54 MJ/kg, and 1 kg of methane provides 12/16=0.75 kg of carbon. This is equivalent to the carbon energy of 54/0.75=72 MJ/kg. In contrast, crude oil typically has a calorific value of about 45 MJ/kg, using pentane as a substitute for naphtha, 1 kg of pentane provides 60/72=0.83 kg of carbon. This is equivalent to the carbon energy of 45/0.83=54 MJ/kg. Thus, apparently, using natural gas as a feedstock provides about 33% more energy than using crude oil as a feedstock to provide the carbon of same quality.

Due to this effect, feedstock energy should not be expressed as a single parameter, but as a pair of parameters identifying oil-based and gas-based feedstocks, respectively. In addition, in all comparisons, even between similar polymers, attention should be paid to ensure the feedstock energies are compared on an equivalent basis, and the mixture of oil and gas feedstocks varies over time and changes according to the specific synthesis process.

A characteristic of most plastics is that they are burned at the end of their useful life and a portion of the raw material energy is recovered. The perception that feedstock energy is a measure of energy available for recovery is incorrect. Feedstock energy is a measure of the energy associated with the input to a polymer production system, calculated from the mass of the input multiplied by its calorific value. This differs from the calorific value of the final polymer; there are two reasons:

--- Materials are inevitably lost during polymer production. These losses may be small but still occur.

--- Chemical changes often occur in the production process, some of which may have a significant impact on the final result. For example, in PVC production, a hydrogen atom in the hydrocarbon monomer is replaced by a chlorine atom, and in some polymers such as PET, oxygen is added to the polymer. These factors cause the calorific value of the final polymer to be different from the energy of the feedstock. Therefore, the feedstock shall not be used as a measure of energy recovery potential. A relevant parameter for energy recovery is the calorific value of the final polymer.

A.6 Recycling

It is well known that recycling is environmentally friendly and products should be designed to be easily recycled. In the design of plastic parts, if maintenance is not considered, recycling should be considered. However, one of the main advantages of

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