INTERNATIONAL STANDARD

ISO 17422

Second edition
2018-06

Plastics — Environmental aspects — General guidelines for their inclusion in standards

Matières plastiques — Aspects liés à l'environnement — Lignes directrices générales pour leur prise en compte dans les normes

Reference number
ISO 17422:2018(E)

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 14, *Environmental aspects*.

This second edition cancels and replaces the first edition (ISO 17422:2002), which has been technically revised. The changes compared to the previous edition are as follows:

— Clause 1 has been revised to include "renewable resources" [item b) 6) of the Note];

— in Clause 3, 3.10 "renewable resource" and 3.11 "end-of-life" have been added;

— terms and definitions formerly in Annex A have been moved to Clause 3, except "life cycle impact assessment (LCIA)" which has been deleted because it is not used in the document;

— subclause 4.3.4 "Renewable resources and energy" has been added;

— a Note has been added to A.4 to provide a new example of energy input;

— the Bibliography has been revised and updated.

Plastics — Environmental aspects — General guidelines for their inclusion in standards

1 Scope

This document provides a structure for inclusion of environmental aspects in standards for plastics products. It proposes an approach which is directed at minimizing any adverse environmental impact without detracting from the primary purpose of ensuring adequate fitness for use of the products under consideration.

The guidance provided by this document is intended primarily for use by standards writers. Over and above its primary purpose, however, this document provides guidance of value to those involved in design work and other activities where environmental aspects of plastics are being considered.

NOTE This document is intended to promote the following practices:

a) the use of techniques for identifying and assessing the environmental impact of technical provisions in standards, and for minimizing their adverse effects;

b) the adoption of good practices such as:

1) procedures for pollution avoidance, e.g. through end-of-life options and its proper management;

2) material and energy conservation in the light of the intended use (and foreseeable misuse) of the product;

3) safe use of hazardous substances;

4) avoidance of technically unjustifiable restrictive practices;

5) promotion of performance criteria rather than exclusion clauses such as are based, for example, only on chemical composition criteria;

6) use of renewable resources and minimization of the use of non-renewable resources, if the life cycle assessment shows favourable;

c) the adoption of a balanced approach in standards development to issues such as environmental impact, product function and performance, health and safety, and other regulatory requirements;

d) the regular review and revision of existing standards in the light of technical innovations, permitting improvement in the environmental impact of products and processes;

e) the application of life cycle analytical approaches wherever applicable and technically justifiable.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
design
creative activity that, based on expressed or implied needs, existing means and technological possibilities, results in the definition of technical solutions for a product that can be commercially manufactured or fabricated into prototypes

3.2
eco-profile
partial *life cycle inventory analysis* (3.14) beginning at the raw material extraction phase and ending at the point where the *plastics product* (3.8) is ready for transfer to the next operator in the supply chain

3.3
environmental aspect
element of an organization's activities, products or services that interacts or can interact with the environment

[SOURCE: ISO 14001:2015, 3.2.2]

3.4
environmental impact
change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's *environmental aspects* (3.3)

[SOURCE: ISO 14001:2015, 3.2.4]

3.5
environmental provision
normative element of a standard that specifies measures for minimizing adverse environmental impact of a test method, material or product

3.6
life cycle
consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to the final disposal

[SOURCE: ISO 14040:2006, 3.1]

3.7
life cycle assessment
LCA
compilation and evaluation of the *inputs* (3.13), *outputs* (3.16) and the potential *environmental impacts* (3.4) of a product system throughout its *life cycle* (3.6)

[SOURCE: ISO 14040:2006, 3.2]

3.8
plastics product
material or combination of materials, semi-finished or finished product that is within the scope of ISO/TC 61

3.9
product standard
standard that specifies requirements to be fulfilled by a product or group of products

3.10
renewable resource
any natural resource in the form of material or energy, which is replenished or replaced on natural processes

Note 1 to entry: Renewable resource includes agricultural products, biomass, solar, wind, water, hydro power, geothermal, tidal energy and renewed biomass etc. and excludes recovered or wasted energy.

Note 2 to entry: Organic fraction of municipal waste is considered as a renewable energy source.

Note 3 to entry: Whether the energy stored in a technical system is renewable or not depends on the nature of the original energy source.

Note 4 to entry: Criteria to categorize an energy source as renewable differ amongst jurisdictions, based on local environmental or other reasons.

3.11
end-of-life
life cycle stage of a product when a proper waste management is applied for discarded end-user products

Note 1 to entry: For plastics waste recycling and recovery, see ISO 11469 and ISO 15270. See also Annex A.

3.12
energy recovery
production of useful energy through direct and controlled combustion

Note 1 to entry: Solid-waste incinerators producing hot water, steam and/or electricity are a common form of energy recovery.

Note 2 to entry: From a technical point of view, the term "energy recovery" applies to any process where the calorific value or the sensible heat of a material is wholly, or partially, converted into useful energy.

[SOURCE: ISO 15270:2008, 3.11, modified — Note 2 to entry has been added.]

3.13
input
material or energy which enters a unit process

3.14
life cycle inventory analysis
LCI
phase of *life cycle assessment* (3.7) involving the compilation and quantification of *inputs* (3.13) and *outputs* (3.16) for a product throughout its *life cycle* (3.6)

Note 1 to entry: As life cycle inventory analysis describes a product system and not the product in isolation, the life cycle data cover factors including materials, design, performance, use pattern and waste management.

[SOURCE: ISO 14040:2006, 3.3, modified — Note 1 to entry has been added.]

3.15
mechanical recycling
processing of plastics waste into secondary raw material or products without significantly changing the chemical structure of the material

Note 1 to entry: This definition does not generally cover chemical or feedstock recycling processes applied to plastics.

[SOURCE: ISO 15270:2008, 3. 21, modified — Note 1 to entry has been changed.]

3.16
output
material or energy which leaves a unit process

Note 1 to entry: Such material includes raw materials, intermediate products, finished products, emissions and waste.

4 Inclusion of environmental aspects in standards

4.1 General

In the preparation of International Standards, close co-ordination within and among sub-committees and working groups responsible for different plastics products or processes is necessary in order to create a coherent approach to the incorporation of environmental provisions. Appropriate co-ordination will ensure that such activity on environmental provisions will neither retard nor inhibit the normal standards development process.

Any plan to prepare a new standard or to revise an existing standard with inclusion of environmental provisions should define, as far as possible, both the purpose of the standard and its expected major users. This exercise will help to determine how the standard is likely to be used, for example for quality control or for conformity assessment, to identify the relevant environmental aspects and to assess the users' level of expertise, needs and expectations.

Standards should be drafted with a view to providing provisions which eliminate or reduce any identified environmental hazards, and, where possible, these provisions should be expressed in terms of verifiable preventive measures. Requirements for preventive measures should be expressed precisely, clearly and with technical accuracy, and the requirements for verification should be clearly stated.

Whenever appropriate, the standard should state what environmentally relevant information has to be provided to persons involved with the product or process.

NOTE Terminology of plastics is defined in ISO 472. This document additionally includes environmental terms.

4.2 Test method standards

4.2.1 General

International Standards for the testing of plastics products should also provide scope for application of ISO Guide 64 by drawing attention to the importance of product sustainability issues such as resource conservation and pollution prevention.

Where such issues are already being addressed (for example within ISO/TC 61/SC 5, *Physical-chemical properties,* ISO/TC 61/SC 6, *Ageing, chemical and environmental resistance and* ISO/TC 61/SC 14, *Environmental aspects*, etc.), this fact should be brought to the attention of the users of the standards by means of an introductory statement within the text of the standard. Standards writers should take this into account whenever existing standards are being revised or new ones are being prepared.

To avoid unnecessary proliferation of tests, standards writers should consider combining, or selecting between, similar test methods that are used for measuring identical product properties.

4.2.2 Minimization of adverse environmental impact

When test method standards are being written or revised, their associated environmental impact should be evaluated; test equipment and procedures should be reviewed to minimize adverse environmental impact. Such reviews should not in any way compromise the fitness for purpose of the test apparatus or procedure. Once a new test method standard with reduced adverse environmental impact has been developed in replacement of an existing procedure, it should be validated and, thereafter, the existing test method standard withdrawn.

The following considerations apply.

a) Material testing

Any substance specified in a standard that becomes the subject of well-founded environmental concern should include the relevant clauses taken from appropriate material documentation such as safety data sheets (SDSs).

Whenever possible, a substance which is incorporated in a plastics material shall be assessed according to risk assessment and appropriate measures should be taken.

Existing ISO test methods standards shall be applied.

b) Quality testing

According to ISO quality standards.

c) Environmental testing

According to ISO environmental standards.

4.2.3 Minimization of material and energy usage

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

Test method standards should be designed with a view to minimizing material and energy usage without compromising the quality of the test result obtained through use of the standard.

Where appropriate, guidance should be given to the user of the standard on how to minimize the use of material and energy.

4.3 Product standards

4.3.1 General

Writers of plastics product standards should incorporate a general introductory statement highlighting the fact that this document (i.e. ISO 17422) and ISO Guide 64 have been taken into account in the preparation of the standard. In addition, this document (i.e. ISO 17422) and ISO Guide 64 should be cited systematically as informative references within future plastics product standards for the benefit of the users of such standards.

4.3.2 Product functionality

Designing a product made of, or incorporating, plastic should avoid over-simplification of material-selection criteria. A balance should be maintained between the overriding functional requirements of the product and the potential adverse environmental impacts that are to be determined in the context of the product/application system.

4.3.3 Environmental aspects in product standards

Optimization of an environmental approach in the development of plastics product standards will usually involve the following stages:

a) the pre-selection of those materials ensuring appropriate technical and environmental performance throughout the intended service life;

b) short-listing of functional materials that eliminate or minimize major adverse environmental impacts throughout the product life cycle;

c) minimization of the quantities of materials used per unit produced;

d) ease of maintenance and cleaning where appropriate.

The environmental characteristics of the most appropriate material to use in a specific application can be determined only by taking into consideration the complete life cycle. The scope and limitations of life cycle assessment, the subject of the ISO 14040 series of standards, within the context of this document are discussed in Annex A.

NOTE 1 The precision of measurement of material properties and characteristics cannot always be absolute or correlate to actual end-use performance requirements. Because of this, some degree of subjective assessment can be needed in comparing life cycle assessments of alternative designs or materials.

NOTE 2 Standards and other references relevant to environmental aspects of design in plastics product standards, including eco-profile data, are given in the Bibliography.

4.3.4 Renewable resources and energy

The use of renewable resources, including renewable materials and energy resources, is also recommendable for considerations of environmental aspects.

a) Plastics products can also be produced by using renewable resources.

b) Biodegradable plastic products can be returned to a certain extent to a natural biological carbon cycle.

4.3.5 Writers of standards

Writers of International Standards for plastics products should consider the potential environmental needs of the users of these standards. In particular, due consideration should be given to the needs of standards writers and specifiers developing environmental provisions for products incorporating or made from plastics; such products are within the scope of other ISO and IEC Technical Committees, as well as within national and industrial technical committees and organizations.

NOTE 1 Examples of such needs could be guidance on environmental impact assessment in applications sectors for plastics film and sheeting and also adhesives, or guidance on waste management options, including sorting and recycling plastics films and sheets.

NOTE 2 Provision of such guidance is already common practice among producers of plastics. This is done, for example, within the Product Stewardship chapter of the Responsible Care Initiative, in safety data sheets (SDSs) and within the context of product sustainability programmes.

Annex A
(informative)

Scope and limitations of life cycle assessment

A.1 General considerations

It is important to recognize that neither the standards writer nor the product manufacturer or designer can control the complete life cycle of a product. Thus, they are obliged to take into account the likely behaviour of the other participants in the life cycle.

For example, there would be little environmental advantage to be gained by developing a standard for a returnable plastic bottle that is technically capable of 500 use cycles if the bottle is likely to be discarded as waste after only 50 cycles because it is scratched and aesthetically unacceptable to consumers, or because it is known that, on average, bottles only last 5 cycles before vanishing from the system because they are not collected and returned.

A.2 Subdivisions of environmental aspects

A.2.1 Quantitative environmental aspects

They include such factors as energy, raw materials and the solid, liquid and gaseous wastes that are commonly calculated in life cycle inventory analyses. These aspects can be conveniently evaluated using a matrix similar to that shown in Table A.1 which permits incorporation of the various input and output parameters arranged horizontally and the various stages of the product life cycle arranged vertically. This representation can make it easier to appreciate where and when in the product life cycle environmental effects can occur and how they could be mitigated.

NOTE For standards other than product standards, such as test method standards, this matrix cannot be appropriate as shown. In such cases, it is intended to be replaced with another format.

Table A.1 — Evaluation of quantitative environmental aspects

Environmental aspects (inputs and outputs)	Product life cycle			
	Manufacturing and premanufacturing phase	Distribution phase including packaging	Use phase	End-of-life phase
	A	B	C	D
Renewable and non-renewable raw material consumption				
Renewable and non-renewable energy consumption				
Emissions to air Ozone depletion Global warming				
Emissions to water Ecotoxicity				
Emissions to soil Ecotoxicity				

Table A.1 *(continued)*

Environmental aspects (inputs and outputs)	Product life cycle			
	Manufacturing and premanufacturing phase	Distribution phase including packaging	Use phase	End-of-life phase
	A	B	C	D
Noise				
Waste management options				
Risks to the environment from accidents or misuse				

A.2.2 Qualitative environmental aspects

They are those which there is currently no satisfactory way of quantifying (e.g. biodiversity) and those which there is unlikely ever to be any way of quantifying (e.g. aesthetics).

A.2.3 Global aspects

Greenhouse gas emissions produce a global effect (planetary warming and its consequences).

A.2.4 Regional aspects

Industrial and domestic emission of acidic gases and their contribution to acid rain is a regional effect.

A.2.5 Local aspects

Emissions from a site are generally a local issue.

Because of the very large number of environmental aspects that can be identified, the standards writer or product designer shall inevitably choose those which are thought to be of the greatest significance. This choice involves subjective judgement. For example, deciding whether the emission of greenhouse gases is more important than the incidence of acid rain is subjective, and it would be even more subjective to decide, for example, that greenhouse gases are 10 times more important than acid rain. It is important to recognize, however, that, as the relevant branches of science or technology advance, subjectivity can progressively be eliminated from the judgement.

A.3 Design parameters

Introducing environmental provisions into the standardization or design process is an important factor in the choice of materials and products. It is important to remember, however, that the consideration of environmental effects is only one of a number of factors that should be taken into account.

Technical requirements such as strength, toughness, thermal conductivity and electrical conductivity should also be taken into account so that the final product satisfies the purpose for which it is intended. Such factors automatically eliminate many materials so that eventually there will be a shortlist of materials that could be used.

A.4 Plastics manufacturing and feedstock considerations

A unique feature of plastics is that they are essentially made from fossil-fuel feedstocks (oil and gas) and, because these feedstocks can also be used as a fuel, it is common practice to describe feedstock in energy terms.

The total energy input required in a polyethylene manufacturing plant, for example, is the sum of the energy used up in the production process plus the intrinsic fuel energy of the ethylene feedstock which remains within the polymer product. Thus, the total energy required to produce 1 kg of low-density polyethylene is typically given by:

— process energy 30 MJ/kg;

— feedstock energy 51 MJ/kg;

— total energy 81 MJ/kg.

NOTE These values are intended as examples. Differences in feedstock sources or processes result in different values. For example, the total energy required to produce 1 kg of low-density polyethylene was reported in Reference [17]:

— process energy 36,7 MJ/kg;

— feedstock energy 46,2 MJ/kg;

— total energy 82,9 MJ/kg.

A.5 End-of-life management

The feedstock energy that remains available within the product is ultimately recoverable, and there are generally two options.

a) Mechanical recycling: The aim here is to spread the primary production energy over as many uses of the material as possible.

b) Energy recovery: The aim in this case is to recover as much of the feedstock energy as possible.

It follows from this that there are two factors to be considered.

— The process energy of a material represents the maximum energy that can be used in any recycling process before it becomes energetically unfavourable to recycle that material.

— No matter how many times a plastic is mechanically recycled, the feedstock energy remains unchanged. Thus, mechanical recycling and energy recovery are not mutually exclusive options.

NOTE The hydrocarbon feed in polymer production provides the carbon backbone common to most synthetic polymers. Measured in units of mass, it makes little difference if this hydrocarbon feedstock is methane (natural gas) or crude oil. However, when feedstock is described in terms of energy, the type of feedstock can produce significant variations. For example, the calorific value of methane is 54 MJ/kg and 1 kg of methane will provide 12/16 = 0,75 kg of carbon backbone. This corresponds to an energy of 54/0,75 = 72 MJ/kg of carbon. In contrast, crude oil typically has a calorific value of the order of 45 MJ/kg and, using pentane as a surrogate for naphtha, 1 kg of pentane will provide 60/72 = 0,83 kg of carbon. This corresponds to an energy of 45/0,83 = 54 MJ/kg of carbon. Clearly, therefore, supplying carbon for use as a material using natural gas as the source will lead to a feedstock energy some 33 % higher than supplying the same carbon using crude oil.

Because of this effect, feedstock energy should not be represented as a single parameter but as a pair of parameters separately identifying oil-based and gas-based feedstock. Furthermore, in all comparisons, even between similar polymers, care should be taken to ensure that this feedstock energy is compared on an equivalent basis given that the mix of oil and gas feedstock changes with time and can vary based on the specific synthesis process.

One feature of most plastics is that at the end of their useful lives they can be burned and a proportion of the feedstock energy can be recovered. One common misconception is that feedstock energy is a measure of the energy available for recovery. This is not correct, however. Feedstock energy is a measure of the energy associated with the inputs to a polymer production system and so is calculated as the mass of the inputs multiplied by their calorific values. This will be different from the calorific value of the final polymer for two reasons.

— During polymer production, there will inevitably be losses of material. These losses can be small but do nevertheless occur.

— There will frequently be chemical changes during the production process, and some of these changes can exert a significant effect on the final results. For example, in PVC production, one of the hydrogen atoms in the hydrocarbon monomer is replaced with a chlorine atom and, in some polymers, such as PET, oxygen is incorporated into the polymer itself.

Such factors lead to the calorific value of the final polymer being different from the feedstock energy. It is therefore important that feedstock is *not* used as a measure of the potential for energy recovery. The relevant parameter for energy recovery is the calorific value of the final polymer.

A.6 Recyclability

It is widely believed, often with little justification, that recycling is generally environmentally beneficial and that products should be designed so that they are readily recyclable. The option of recycling should always be considered, if not maintained, in the design of plastic components. It is important, however, to remember that one of the major benefits of plastics is that design can often yield more beneficial environmental impact than that provided by recycling.

NOTE For example, it has been shown that, if a polypropylene (PP) film is coated with a 2,5 µm layer of poly (vinylidene chloride) (PVDC), its permeability to oxygen is reduced by a factor of 50. The alternative to a 35 µm polypropylene film carrying such a coating would be a 1 750 µm film without coating. In this case, the film would not fulfil all of the requirements specified for the application such as low mass and high flexibility. It follows that using a barrier layer leads to both a better answer to the technical requirements for the application and a greater environmental benefit than using a thicker, stiffer and heavier film, which is less fit for the application even if it is the more readily recyclable. Thus, when assessing the option of recycling, it is essential to maintain the design focus on fitness for purpose as well as on the overall environmental impact including the contribution that would come from exercising the recycling option.

A.7 Environmentally sound material selection criteria

The choice of the most appropriate materials in a specific application inevitably results from making comparisons between and among potential alternatives.

There is as yet no generally accepted scientific way available of summarizing the various environmental parameters into a single parameter or index. Consequently, comparisons shall be made using selected parameters that are chosen because they are thought to be of environmental significance. The selection of these parameters is largely subjective, and so it is important that the reasons for their choice are clearly stated.

It should be remembered that a life cycle inventory analysis is a description of a system, not of a product and most certainly not of a material. The life cycle data take into account such diverse factors as materials, design, performance, use, disposal and recycling. Such life cycle systems can be compared only when they perform equivalent functions.

