TECHNICAL REPORT

IEC TR 62422

First edition
2007-03

Environmental characterization of solid insulating materials

Reference number
IEC/TR 62422:2007(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site (www.iec.ch)**
- **Catalogue of IEC publications**

  The on-line catalogue on the IEC web site (www.iec.ch/searchpub) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.
- **IEC Just Published**

  This summary of recently issued publications (www.iec.ch/online_news/ justpub) is also available by email. Please contact the Customer Service Centre (see below) for further information.
- **Customer Service Centre**

  If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

  Email: custserv@iec.ch
  Tel: +41 22 919 02 11
  Fax: +41 22 919 03 00

TECHNICAL REPORT

IEC TR 62422

First edition
2007-03

Environmental characterization of solid insulating materials

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE S

For price, see current catalogue

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ENVIRONMENTAL CHARACTERIZATION OF SOLID INSULATING MATERIALS

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 62422, which is a technical report, has been prepared by IEC technical committee 15: Solid electrical insulating materials.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
15/346/DTR	15/356/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be:

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

Production, use and disposal of products may cause serious environmental problems. Electrical and electronic products are among those that are suspected to have major impacts to the environment due to their use of energy, the variety of hazardous substances included and their volume on the market. It has to be noticed that the environmental performance of these products is related to the characteristics of the insulating materials.

Environmental aspects are present in each phase of the life cycle of these materials. For example, in some thermosetting resins, volatile hazardous chemical compounds are used in production phase and spread during processing. On the other hand sometimes these additives allow a better insulation performance with a lower indirect impact due to lower electrical losses. Regarding the end of life, if these polymers are deposited at a landfill site, the complete degradation of the material may take more than a century, and during this time span harmful additives may be leached from the landfill site.

In order to minimize adverse environmental impacts of electrotechnical products, insulating materials selection should be conducted by engineers and designers including environmental considerations. The environmental information related to the investigated insulating materials should be collected and processed, by suppliers, according to this document. The evaluation should be developed at the design stage, in respect of specific uses and with a life cycle perspective in mind. This means that the environmental characteristics of the materials used, which are collected and processed according to this document, should be compared with the environmental impacts due to the performance of the product and/or the system, with the product before making material selection, product design, and so on.

In order to optimize the necessary trade-offs between fitness for use and environmental impact minimization, it is important to have appropriate and comparable, i.e. standardized, information on environmental aspects and impacts (direct and indirect) connected with insulating materials entire life cycle. In particular, it is fundamental to have standardized information concerning

– the production phase, such as information related to the consumption of resources and the environmental impact, incurred during intermediate products manufacturing;
– the usage phase, such as information about harmful substances actually released and the insulation performances;
– the end-of-life phase, such as the recyclability, the recoverability, the reusability, and cautions to be taken into account when landfilling or chemically recycling.

The methodological framework for the environmental characterization of insulating materials should be drafted in accordance with Life Cycle Assessment (LCA) (ISO 14040 standard) principles.

ENVIRONMENTAL CHARACTERIZATION OF SOLID INSULATING MATERIALS

1 Scope

This technical report gives framework guidelines for collecting environmental data of insulating materials useful to engineers and designers of electrotechnical products for evaluating environmental impacts.

It also provides a guideline for common format in environmental data reporting. This will enable producers to more easily evaluate the potential environmental impacts of those electrotechnical products using solid insulating materials.

Moreover, it will allow a quick assessment of conformity to relevant electrotechnical product-related environmental regulations.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14020, *Environmental labels and declarations – General principles*

3 Terms and definitions

For the purpose of this document the following terms and definitions apply.

3.1
additive
ingredient mixed into resin to improve properties

NOTE Examples include plasticizers, initiators, light stabilizers and flame retardants.

3.2
disposal
collection, sorting, transport and treatment of waste as well as its storage and tipping above or under ground, or at sea

[EU Directive 75/442/EEC]

3.3
environment
surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation

[ISO 14001:2004, definition 3.5]

3.4
environmental aspect
element of an organization's activities, products or services that can interact with the environment

NOTE A significant environmental aspect is an environmental aspect that has or can have a significant environmental impact.

[ISO 14001:2004, definition 3.6]

3.5
environmental impact
any change to the environment, whether adverse or beneficial, wholly or partly resulting from an organization's activities, products or services

[ISO 14001:2004, definition 3.7 modified]

3.6
incineration (of waste)
burning of waste at high temperatures in the presence of sufficient air to achieve complete combustion, either to reduce its volume or its toxicity

3.7
landfill
engineered deposit of waste into or onto land in such a way that pollution or harm to the environment is minimized or prevented and, through restoration, to provide land which may be used for another purpose

3.8
recovery
any of the applicable operations involving reprocessing in a production process of waste material for the purpose of reclamation of secondary materials or burning them with energy recovery

[EU Directive 75/442/EEC]

3.9
recycling
reprocessing in a production process of the waste materials for the original purpose or for other purposes, but excluding energy recovery which means the use of combustible waste as a means of generating energy through direct incineration with or without other waste but with recovery of the heat

[EU Directive 2002/96/EC]

3.10
recyclability
property of a substance or a material and parts/products made thereof that makes it possible for them to be recycled

NOTE Recyclability of a product is not only determined by the recyclability of the materials it contains. Product structure and logistics are also very important factors.

[IEC Guide 109:2003]

4 Methodological framework

4.1 General

The environmental performance of electrotechnical products should be described based on a Life Cycle Thinking (LCT) approach. LCT approach considers a product's life-cycle and aims for a reduction of its cumulative environmental impacts. Although being based on the same principles as a Life Cycle Assessment (LCA), it is more qualitative and does not require the thorough data analysis that full scale LCA relies on. Considering the life cycle of a product allows implementation of a range of simple comparative measures with great benefits to the environment.

The main aspects to be considered in this LCT approach, as for LCA, are as follows:

- definition of goal and scope of the study;
- compiling an inventory analysis of relevant inputs and outputs of the product system;
- evaluating the potential environmental impacts associated with these inputs and outputs;
- interpreting the results of the inventory analysis and impact assessment phases in relation to the objectives of the study.

4.2 Goal and scope definition

4.2.1 General

According to the ISO standards, goal and scope definition must be explicitly stated in an LCA. The goal contains some background information on the study, and describes in detail the object of the study.

If the aim of an LCA is the comparison of different technologies providing the same service, good LCA praxis requires uniform scopes with particular attention to the following aspects.

4.2.2 Functional unit

The functional unit of the study shall be the electrotechnical product including the selected insulating materials.

4.2.3 System boundaries

In a real economy the relations between sectors, companies and processes are very complex and for the model they have to be simplified in many respects. One of the most important simplifications in LCA is the introduction of system boundaries and cut-off criteria. Without these boundaries, the inventory of nearly any process would require an analysis of the whole national economy. The boundaries now systematically cut off processes that have not a significant influence on the results for the process in focus.

4.2.4 Allocation rules

In multi-output processes, environmental impacts have to be allocated to the different outputs in a "fair" way. The methods available can in general be classified in two groups: substitution or system enlargement, and allocation keys. In the substitution approach, all but one of the outputs is assumed to replace the same commodity/service from an optional process, and the original process is credited with the environmental impacts from this replaced process. System enlargement is equivalent; here the environmental impacts from the optional process are added to those processes that the multi-output process is compared to. When using an allocation key, however, the total environmental impacts of the multi-output process are allocated according to appropriate properties of the commodities/services produced, such as mass, heating value or economic value (market price).

4.2.5 Data quality requirements

Data quality is a relevant matter in LCA studies and its consolidation may absorb most of the time spent for the study if no guidelines are provided.

The following data quality requirements are usually considered:

– precision: measure of the variability of the data values for each data category expressed (e.g. variance);

– completeness: percentage of locations reporting primary data from the potential number in existence for each data category in a unit process;

– representativeness: qualitative assessment of degree to which the data set reflects the true population of interest (i.e. geographical coverage, time period and technology coverage);

– consistency: qualitative assessment of how uniformly the methodology is applied to the various components of the analysis;

– reproducibility: qualitative assessment of the extent to which information about the methodology and data values allows an independent practitioner to reproduce the results reported.

It is useful to classify data quality according to these definitions:

– “primary data” is understood to be those data that were gathered in the field and hence guarantee the highest degree of representativity of the system analyzed;

– “secondary data” is understood as those data that were used to complete the model for the system being examined and that were taken from data base or studies previously conducted and published.

4.3 Life-Cycle Inventory (LCI)

In this step, all material and energy flows that are relevant to the system are described and integrated. It is usually the most labour-intensive part of an LCA. As a result of this step, all inputs and outputs of the system are represented, normalized to the functional unit.

In the inventory all processes are characterized by their (useful) output and by a vector containing the following parameters:

- Inputs (materials)
- Ancillaries (e.g. energy)
- Use of other services (disposal of by-products, transports, infrastructure)
- Direct elementary interaction with the environment in the form of
  - emissions
  - use of resources

The resulting set of vectors represents a set of linear equations that can be solved in order to determine all elementary interactions with the environment that are induced by any of the processes.

Generally, inventory input data can be derived in two ways: the bottom-up approach is based on technology-specific data; it is also called process chain analysis. In the top-down approach, sector-wide indicators (such as total energy use) and input-output tables (that describe the interaction of sectors in a national economy) are used to generate more generic data, like average emission factor.