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Environmental characterization of solid insulating materials

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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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ENVIRONMENTAL CHARACTERIZATION OF SOLID INSULATING MATERIALS

FOREWORD

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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- withdrawn,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.

A widely accepted practice is to rely on the bottom-up procedure wherever possible and to use top-down data only to cover data gaps or for verification purposes.

Although the inventory looks at first sight like a mere accounting procedure that contains no methodological problems, it is a complex task. The analyst's choice of methodology or his approach to close wide data gaps can have a significant influence on the final result of the study.

This TR aims to increase the availability of specific data and therefore to reduce the contribution and the uncertainty introduced in performance evaluation by the use of generic top-down data.

4.4 Impact assessment

In this phase of the analysis for any included process, many different elementary interactions with the environment such as emissions to air, water, and soil, or the use of resources have to be listed. Interactions need to be grouped together (e.g. by means of impact classification and characterization) to make this problem tractable.

The number and type of impacts included depends on the goal of the study, the anticipated relevance of each impact class for the system analyzed, data availability, and other factors.

4.5 Interpretation

The aim of the interpretation phase is to reach conclusions and recommendations in accordance with the defined goal and scope of the study. Results from the LCI and Life Cycle Impact Assessment (LCIA) are combined together and reported in order to give a complete and unbiased account of the study. The interpretation is to be made iteratively with the other phases.

5 Material Category Requirements (MCR)

The environmental information required for insulating materials used in electrotechnical products should be the result of a gate-to-gate life cycle inventory combined with other simple information.

When the contribution of the insulating material to the total environmental impact of the final product is negligible, more generic environmental information of insulating material groups may be applied.

In order to harmonize and simplify the insulating solid materials environmental characterization and data collection, a common initialization step is needed.

This initialization step will standardize

- reference flow
- system boundaries
- data quality requirements
- allocation rules

(see Annex A - Material category requirements (MCR) – Examples)

In order to collect information on environmental aspects of insulating materials, a special focus should be given to the substances and energy flows relevant to the potential impact evaluation parameters of the system.

6 Material Environmental Information Data Sheet (MEIDS)

6.1 General

Presentation of the results of environmental data collection shall be performed according to ISO 14020 standard principles, in a Material Environmental Information Data Sheet (MEIDS).

Where a risk of specific know-how disclosure is perceived by the organization, then the sensible information can be disclosed by MEIDS referring to a more generic term, material or substance.

These shall be reported according to the following structure (see Annex B - Material Environmental Information Data Sheet – Example):

a) general information; including information about the implementation of any environmental management system and the use of tools for product environmental impact assessment;

b) scope; declaring the boundaries of the investigated system;

c) process description; including a flow chart of the related processes;

d) environmental profile; may include information about the manufacturing processes and a content declaration, according to IEC/PAS 61906, with the list and the amount of materials. The environmental profile shall present the resource use, pollutant emission and the subsequent potential environmental impact due to the manufacturing phase - from raw material acquisition to the manufactured product at the factory gate (“from cradle to gate”), according to the following minimum criteria classification.

6.2 Resource use

- Non-renewable resources
  - without energy content
  - with energy content
- Renewable resources
  - without energy content
  - with energy content
- Electricity consumption (to be expressed as net consumption)

6.3 Pollutant emissions (expressed in terms of potential environmental impact)

It is not necessary to list all the emission evaluated, it is required to simply report the cumulative results by means of the following potential impacts:

- Emission to air of gases contributing to greenhouse effect (expressed as the sum of global warming potential in kg of CO_2 equivalents, 100 years)
- Emission to air of gases contributing to ozone-depletion (expressed as the sum of ozone-depleting potential in kg of CFC_{11} equivalents, 20 years)
- Emission to air of gases contributing to acidification (expressed as the sum of acidifying potential in mol H^+)
- Emission to air of gases contributing to the creation of ground-level ozone (expressed as the sum of ozone-creating potential, kg of C_2H_4 equivalents)
- Emission to water of substances contributing to oxygen depletion (expressed as the sum of oxygen consumption potential in g of O_2)

The characterization factors to use for converting data from the life cycle inventory analysis into impact categories for global warming (emissions of green-house gases), stratospheric ozone depletion (emissions of ozone-depleting gases), acidification (emissions of acidifying gases), ground-level ozone creation (emissions of photochemical oxidant gases) and eutrophication (emissions of substances to water contributing to oxygen depletion) are listed in Requirements for Environmental Product Declarations, EPD (MSR 1999:2).

6.4 Waste generation

- Hazardous waste
- Other waste

6.5 Additional information

These are related to use phase from distribution from the factory gate to recycling or final waste handling (“from gate to grave”) - in which the information should be based on generic data based on the functional unit and result in a quantitative or qualitative description of the environmental performance.

The information required for the use phase is usually of a more general nature than that included in the production phase.

A recycling declaration may be included, with information on aspects that are important for dismantling of products recycling and reuse of materials and products, e.g. in the form of

- information on suitable procedures for recovery of materials. Examples of information of this nature may be about how composite materials could appropriately be separated, and data of the melting points and energy contents of materials in goods;
- information on a suitable method for reuse of the materials (or parts of the product) and its proper handling as waste at the end of its life cycle;
- information on how the material should be handled, during service and maintenance, and what to do to reduce the environmental impact during the use of the product.

Annex A
(informative)

Material category requirements (MCR) – Examples

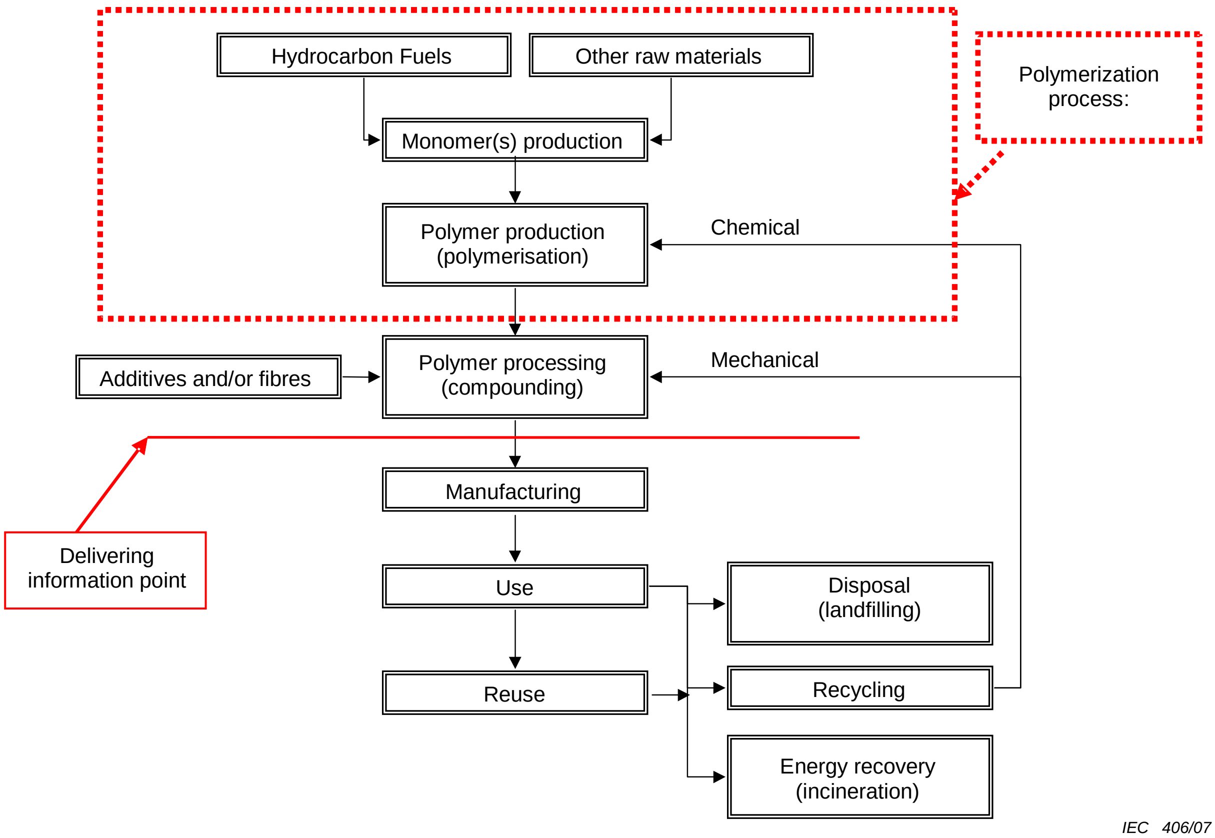
A.1 Polymeric materials requirements

A.1.1 Reference flow

The reference quantity (flow) for the calculation shall be the unit of mass of the insulating material as provided to the customer (e.g. 1 kg of granulated thermoplastic). In order to be consistent in comparison, a reference technical functionality should be assigned to various materials, depending on the chemical-physical transformations according to specific characterization values (e.g. compression, impact strength) defined by specific relevant standards.

A.1.2 System boundaries

Data related to the polymerisation are usually available (e.g. Plastics Europe source) so that these processes can be excluded from the analysis, if they are not under the control of the organization providing the information.



The analysis should be focusing on the compounding process and its environmental aspects (see Figure 1).

Figure 1 – Schematic diagram showing the main life cycles stages of a typical polymeric insulating material

Only rarely are polymers used in the pure state. Usually plastics are compounded with various additives such as fillers, plasticizers, lubricants, stabilizers, pigments etc. to give the finished products special physical properties or other desirable characteristics. For example, plastics normally contain 4-8 additives, and rubbers considerably more (10-15). Cellular plastic is defined as having many cells (open, closed or both) dispersed throughout its mass, usually produced by having gas or air injected into the plastic to form a foam. Thermosetting resins are usually converted from a liquid to a solid using an initiator.

The relevant substance flows (if providing a significant contribution to the environmental impact) to be considered in data collection are the following:

- Fillers

Fillers are used to make the material cheaper, or to improve its mechanical properties. Fillers can be many different types of material, such as minerals (e.g. talc, chalk) metal oxides, wood powder, carbon black and glass fibres.

- Plasticizers

Plasticizers are used to enhance flexibility and/or processability of polymers. Plasticizers are predominantly used in PVC and rubbers. Common plasticizers are phosphate esters, trimellitates, adipates, waxes, chlorinated paraffins and phthalates.

- Flame retardants and synergists

Flame retardants and synergists are added to improve the fire resistance of polymers. These may, for instance, include halogenated organic compounds, phosphorous-based organic compound, minerals. Other flame retardants are among others (chlorinated) alkyl phosphates, antimony trioxide, chlorinated paraffins, melamine or brominated polystyrene. Further flame retardants are minerals such as aluminium trihydrate and magnesium hydroxide, silicone resins, or in tumescent systems based on melamine and ammonium polyphosphate.

- Pigments and colorants

They are used for colouring polymer materials. Pigments are for example inorganic compounds such as titanium dioxide, calcium carbonate and zinc oxide or compounds based on metals. Colorants are normally based on soluble organic compounds such as azo-compounds, phthalocyanins, naphthalenes and anthrachinon.

- Antioxidants

They are added in small amounts (<0,5 %) to protect polymers from degradation by oxidation. Common antioxidants are phenol-derivates, amines, phosphites and thioesters.

- UV stabilizers

They are added to prevent degradation induced by UV light. Common UV stabilizers are amine-derivates, benzotriazoles, benzophenons and carbon black.

- Heat stabilizers

They are used to improve thermal endurance and might consist of Cu-halides or antioxidants.

- Lubricants or processing aids

They are incorporated into polymers to improve the flow of material during processing. Lubricants are most often used in PVC but their use in engineering plastics is increasing. Common lubricants are hydrocarbons, fatty acids, esters and metal salts thereof (calcium- and lead stearate), fluoropolymers, talc.

- Antistatics

They are used to prevent polymer surfaces from becoming electrostatically charged and attracting dust and dirt or generating sparks in areas where flammable or explosive materials are handled. Antistatics are widely used in electr(on)ic products. Generally, antistatics are based on amines, quaternary ammonium compounds, phosphate esters or poly(ethylene glycol). In addition, graphite, carbon black, metallic fibres or metallic glass are used.

- Biocides

They are, for obvious reasons, poisonous in order to have the intended effect on mould, fungi and bacteria. Common biocides are oxybispheno oxarsine (OBPA) and octyl isothiazolone.

- Blowing agents

Used for foaming plastics, they are materials with low boiling points, or substances which can form gas upon heating. Examples are alkanes, azo compounds and CFC or HCFC. Information on blowing agents should be collected with particular attention to their completeness and accuracy.

- Specific rubber additives

The vulcanization process involves the use of many different additives such as vulcanizing agents, accelerators, activators and prevulcanization (scorch) inhibitors. Sulphur is the most common vulcanization agent but peroxides are also often used. Examples of accelerators are sulphenamides, guandines, thiazoles, thiurames, dithiocarbamates and xanthates. To activate the accelerator, zinc oxide and stearic acid are usually added. As vulcanization should not occur before the product has been shaped, prevulcanization inhibitors such as salicylic acid or nitrosodiphenyl amine are also added to the rubber formulation.

- Antifogging additives

Generally non ionic surfactants (e.g. glycerol esters, polyglycerol esters, sorbitan esters, ethoxylated sorbitan esters), these additives prevent or reduce the condensation of water in the form of small droplets which resemble fog. They function as mild wetting agents which spread over to the plastic surface and lower the surface tension of water, thereby causing it to spread into a continuous film.

- Curing agents

The act of converting a thermosetting resin into a more stable solid is called curing. The mechanism by which curing occurs is polymerizations or cross-linking. The chemical chosen to react with the resin is referred to as the curing agent (or hardener or catalyst etc.) The selection of the curing agent depends on many parameters and will determine, to a large extent, the performance of the final thermosetting material.

A.1.3 Allocation rules

The allocation of common environmental aspects during manufacturing of material shall be made in proportion to the manufacturing area (electrical energy) and volume (thermal energy) used for each different insulating material group.

The annual share of common environmental aspects for a certain insulating material group shall then be distributed on the amount per year of that material group.

A.1.4 Data quality requirements

Site-specific data shall be used for processes under control of the organization providing the information.

The mix of electricity used can be approximated as the official one in the country of manufacture if site-specific data cannot be obtained. The mix of electricity should be reported.

Hazardous waste is defined according to reference standard (e.g.: by EU Directives 91/689/EEC and 75/442/EEC for European countries).

A.1.5 Transport contribution

Transport to manufacturer with actual transportation and distance from the suppliers.

A.2 Ceramics insulating materials

A.2.1 Reference flow

The reference flow for the calculation shall be the unit of mass of the insulating material as provided to the customer (e.g. 1 kg of electrical porcelain). In order to be consistent with LCA a reference technical functionality should be assigned to various materials, depending on the chemical-physical transformations according to specific characterization values (e.g. compression, impact strength) defined by specific ISO standards.

A.2.2 System boundaries

Ceramic insulators are used principally to hold conductive elements in position and to prevent them from coming in contact with one another. Many types of ceramic materials have been developed for this purpose, and each one embodies physical and chemical processes so different that it is practically impossible, at least from a life cycle perspective, to sketch a generally representative production flow.

Data related to the raw materials extraction and powder production are available in certain cases from various sources (e.g. aluminium or glass producers association) so that these processes can be excluded from the analysis, if they are out of control of the organization providing the information.

The analysis shall be focusing on the manufacturing process and its environmental aspects; however, similar products, but belonging to different classes of ceramic insulators, can be manufactured by different technologies.

It is difficult to individuate typical relevant substance flows to be considered in data collection because each type of insulator requires its own raw materials and process additives, for that reason each flow that belongs to the following insulating materials should be accounted.

- Electrical porcelains

Two main types of siliceous ceramics are on the market: clay-based and talc-based. Both of them are produced from naturally occurring minerals (typically kaolinite and talc, respectively, with addition of fluxes and fillers) that have been purified to only a limited extent. Classical ceramic production technologies are applied in the manufacturing process: forming by extrusion or slip casting, drying, glazing, and firing. Clay-based ceramic insulators are chiefly used for the distribution of electrical power at high voltage (i.e. rod insulators, high-power electrical fuse holders, supports for high-power wire-wound resistors, high-power capacitors).

- Alumina

α-alumina, in powder form, is a by-product of aluminium production, and practically all the powder for the production of the alumina ceramics is produced in this way, even though the product thus obtained contains impurities, which may be harmful for some applications. The less pure aluminas are blended with silicates so that they can be sintered at 1 350 °C or less, while the highest-purity materials require a temperature of 1 750 °C at atmospheric pressure or hot-pressing. The best known use for a 95 % alumina ceramic is in spark plugs. Alumina insulators are also widely used in electronic circuits packaging as multilayer ceramic substrates instead of plastic-based laminates whenever more demanding applications are required (i.e. automotive control or space technologies).

- Beryllia

It is similar in properties and manufacturing processes to alumina and it is used in high-power klystrons and power diodes.

A.2.3 Allocation rules

The allocation of common environmental aspects during manufacturing of material shall be made in proportion to the manufacturing area (electrical energy) and volume (thermal energy) used for each different insulating material group.

The annual share of common environmental aspects for a certain insulating material group will then be distributed on the amount per year of that material group.

A.2.4 Data quality requirements

Site-specific data shall be used for processes under control of the organization providing the information.

The mix of electricity used can be approximated as the official one in the country of manufacture if site-specific data cannot be obtained. The mix of electricity should be reported.

Hazardous waste is defined according to reference standard (e.g.: by EU Directives 91/689/EEC and 75/442/EEC for European countries).

A.2.5 Transport contribution

Transport to manufacturer with actual transportation and distance from the suppliers.

Annex B
(informative)

Material Environmental Information Data Sheet – Example

General information

Company Name: …………………………………………………………………………………………

Division:
………

Address: ……………………………………………………………………………………………

Contact Person: ……………………………………………………………………………………

e-mail: …………………………………………………… **Phone:** …………………………………

Do you have an Environmental Management System?
Yes No
Do you use any tools to quantify/assess the environmental impact?
Yes No

Scope

Name of material: ……………………………………………………………………………………

Year of reference: ……………………………………………………………………………………

Region of reference: …………………………………………………………………………………

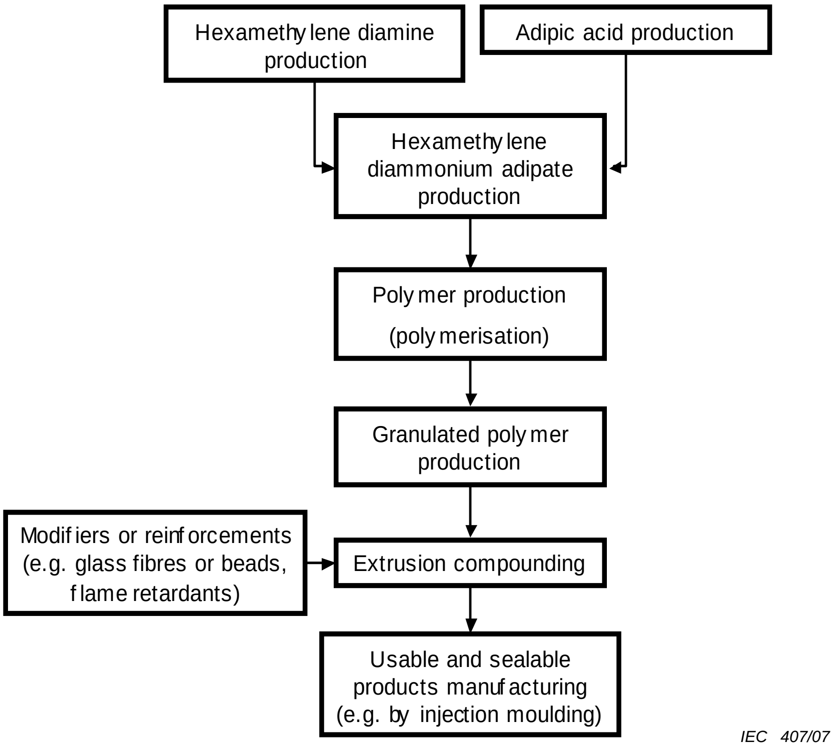
Technology of reference: ……………………………………………………………………………

Process description

The essential precursors of PA 66 are hexamethylene diamine and adipic acid that produce hexamethylene diammonium adipate (also known as PA 66 salt) when they are combined in water; then, they are polymerized at high temperature, and finally granulated. Additives are admixed by extrusion compounding with the pristine polymer to obtain the modified PA which is granulated again. Processing of this material, by injection moulding, leads to the final product. For convenience, in the diagram the details about the production of the two precursors are omitted.

The schematic flow diagram of the principal operations leading to usable and sealable products made of modified PA 66 are reported in the flow chart description.

Flow chart description



Environmental profile

1. Is the raw materials production included in the analysis?

   Yes No

   If no, list the input raw material of your process according to IEC/PAS 61906.

2. Resource use:

   List of non-renewable resources
   without energy content (kg) …………
   with energy content (MJ) ………….
   List of renewable resources
   without energy content (kg) …………
   with energy content (MJ) …………
   Electricity consumption (MJ) ……………

3. Pollutant emissions (expressed in terms of potential environmental impact):

   Potential greenhouse impact (kg CO_2 equivalent) ………………
   Potential ozone-depletion impact (kg CFC_{11} equivalent) ……………
   Potential acidification impact (mol H^+ equivalent) ……………….
   Potential contribution to the creation of ground-level ozone (kg C_2H_4 equivalent) ……
   Potential contribution to oxygen depletion (kg O_2 equivalent) ………………

4. Waste generation:

   Hazardous waste (kg) ……………
   Other waste (kg) ………………

5. Additional information:

   Information of environmental relevance for the use phase

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   Information of environmental relevance for the EoL phase

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