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HANDBOOK ON TESTING AND STANDARDIZATION OF PLASTICS 1/

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Block copolymer - Block-Copolymerisat - Copolymère séquencé:

An essentially linear copolymer in which there are repeated sequences of polymeric segments of different chemical structure.

Bulk factor - Füllfaktor - Facteur de contraction (d'une poudre à mouler):

The ratio of the volume of a given mass of moulding materials to its volume in the moulded form. The bulk factor is also equal to the ratio of the density of the material in its moulded form to its apparent density in the unmoulded form.

Calendering - Kalandrieren - Calandrage:

The process of making continuous sheets by hot processing on calenders of at least three rolls.

Casting - Giessverfahren - Coulée:

A moulding process carried out without the use of pressure and mostly at relatively low temperatures.

Catalyst - Katalysator - Catalyseur:

A substance which in small quantity promotes a chemical reaction without becoming a part of the resulting product.

Cellular plastic (foamed plastic) - Schaumkunststoff (Kunststoff mit Zellstruktur) - Plastique alvéolaire (Plastique expansé):

Plastics which contain numerous small bubbles (cells) and have low volumetric weights and high thermal insulating properties. The bubbles (cells) can be interconnected (open-celled plastics) or discrete (closed-celled plastics).

Cement - Kitt - Ciment:

An adhesive containing no solvents or only small portions of them. It usually includes fillers and serves simultaneously to fill thick joints.

Coating - Beschichtung - Enduction:

The process of applying a thin layer of a material in the form of a fluid or a powder upon a substrate. It can also mean the thin layer applied by this process (laminating is not considered coating).

Colourant - Färbemittel - Colorant:

A substance (dye or pigment) which imparts a specific colour to a material when dissolved or dispersed in it.

Compound - Mischung - Composition:

The intimate admixture of a polymer or polymers with other ingredients such as fillers, plasticizers, colourants etc.

Compression moulding - Pressverfahren - Moulage par compression:

A moulding process in which the mould is opened to receive the charge and is subsequently closed to form the material to shape under pressure.

Conditioning - Konditionierung (Klimatisierung) - Conditionnement:

Treating a material in a prescribed manner with the object of making it respond uniformly and reproducibly to subsequent processes or tests, e.g. subjection for a specified time to an atmosphere of prescribed humidity and temperature.

Continuous sheeting - Bahn - Feuille continue:

Plastic sheetings made by a process which does not limit its length.

Copolymer - Copolymer (Mischpolymerisat) - Copolymère:

A polymer in which two or more chemically non-identical monomeric units are present in irregular or unknown sequence.

Cross linking - Vernetzung - Réticulation:

The chemical network bonding between similar or dissimilar linear or branched polymers.

Curing - Härtung - Traitement (Durcissement):

A process normally involving cross linking by which the properties of a thermosetting resin is changed into a final condition by the use of heat, radiation or reaction with chemical additives.

Curing time - Härtungsdauer (Härtezeit) - Durée de cuisson:

The time required to attain the final condition of a thermosetting material at a given temperature.

Degree of cure - Aushärtungsgrad - Degré de cuisson (d'une matière thermodurcissable):

The degree to which a thermosetting plastic has approached the fully cross linked condition.

Decorative sheet - Dekorschichtstoff (Dekorplatte) - Feuille décorative:

Laminates used for decorative purposes, the most important feature of which is outside appearance. It can be single or multi-coloured, patterned or ornamented.

Density (Specific gravity) - Dichte (spezifisches Gewicht) - Densité (Poids spécifique):

The weight in grams of 1 cm^3 of a material. In case of cellular substances distinction has to be made between gross (relative) density and net (absolute) density. The first means the density of the material including existing pores and cavities, whereas the latter is the density of the material itself.

Destaticiser - Antistatikmittel - Agent antistatique:

Substances which prevent the build up of electrostatic charges in plastics or eliminate such charges.

Dispersion - Dispersion - Dispersion:

A heterogeneous system in which a finely divided material is distributed in another material.

Drawing (Deep drawing) - Tiefziehen - Emboutissage:

A process of thermoforming by heating a thermoplastic sheet to softening point. It can be used to increase the superficial area of a rod or sheet or to decrease its cross-sectional area.

Elastomer - Elastomer (Elast) - Elastomère:

A material that at room temperature can be stretched repeatedly to at least twice its original length and, upon immediate release of stress, will return with force to its approximate original length.

Embossing - Prägen - Grainage (Gaufrage):

Depression of a lettering or of a design into the surface of a plastic product by means of a press die or an embossing roll.

Emulsion - Emulsion - Emulsion:

An essentially permanent suspension of one fluid within another immiscible one.

Epoxy equivalent - Epoxydäquivalent - Equivalent d'époxyde:

The amount of resin in grams containing one gram-mole of chemically bonded oxygen (= 16 g) in the form of an epoxy group.

Extender - Streckungsmittel (Extender) - Extendeur:

A liquid or solid substance added to a resin or plastic to adjust viscosity or to reduce cost (e.g. a noncompatible plasticiser included in the formulation of elastomeric plastics).

Extrusion - Strangpressen - Extrusion (Boudinage):

The continuous shaping of a moulding material by passage through a die.

Filler - Füllstoff - Charge:

A relatively inert material added to a plastic in order to modify its properties or to lower costs.

Film - Folie - Feuille mince:

An optional term for thin sheetings of arbitrarily limited thickness (Generally less than 0.5 to 1 mm).

Finishing - Nachbearbeitung - Finissage:

Mechanical or hand operation effected upon a moulded object to give it a finished pattern.

Flow of a moulding powder - Fliessfähigkeit einer Formasse - fluidité (facilité d'écoulement) d'une poudre à mouler:

A qualitative description of the fluidity of a plastic material during the process of moulding. It is designated as high (easy; soft) or low (stiff; hard).

Foaming agent - Treibmittel (Blähmittel) - Matière porogène:

A substance which (under the influence of heat or by chemical transformation) sets free gases which produce vast numbers of very small bubbles in the plastic to which it has been added.

Gel - Gel (Gallerete) - Gel:

A semi-solid system that consists of a network of solid aggregates in which liquid is held, or the initial jellylike solid phase that develops during the formation of a resin from a liquid.

Glass fibre materials - Glasfaserstoffe - Matières en fibre de verre (en verre textile):

Fibres and threads of spinnable glass (fibre glass and glass staple fibre) and laminar products made from them (mats, cloths, knitted fabrics) which are added to synthetic resins in order to increase their strength.

Glueing - Verleimung - Collage:

The joining together of parts of the same or of different kinds effected by means of a glueing seam or joint. A thin layer of polymer solutions or dispersions is applied on the surfaces to be joined and strongthened by evaporation of the liquid portion and/or by a chemical reaction.

Graft copolymer - Propfpolymerization - Copolymère greffé:

A copolymer consisting of a chain polymer to which polymeric side chains of a different chemical nature have been attached.

Hardener - Härter (Härtungsmittel) - Durcisseur:

A substance used to accomplish the setting of certain types of resins.

Impregnation - Imprägnierung (Durchtränken) - Imprégnation:

The controlled penetration of a material or an article with synthetic resins.

Inhibitor - Inhibitor - Inhibiteur:

A substance which retards a chemical reaction.

Injection moulding - Spritzguss - Moulage par injection:

The moulding of a material by injection from a heated cylinder through sprues into the cavity of a closed mould. The moulding material, - in sufficient quantity for several injections - , is softened by heat in the cylinder and hardened in the mould by cooling (if it is thermoplastic) or by heating (if it is thermosetting).

Intermediate product - Halbfabrikat (Halbzeug) - Produit semi-ouvré:

Formed plastic products such as sheets, pipes and rods, that are to undergo further processing.

Laminate - Schichtstoff - Stratifié:

Products made by moulding together two or more layers of material or materials.

Laminated rolled tube - Gewickeltes Rohr - Tube stratifié roulé:

Tube formed by rolling impregnated sheet materials on a mandrel, curing the assembly by heat and then removing the mandrel.

Latex - Latex - Latex:

A colloidal aqueous dispersion of a polymeric material.

Low pressure moulding - Niederdruckpressen - Moulage basse pression:

Moulding process principally used for the manufacture of low pressure laminates, when the moulding pressure is generally not higher than 30 kgf/cm^2.

Lubricant - Gleitmittel - Lubrifiant:

Generally an organic compound (e.g. fat acids or salts of fat acids) added to the moulding material in order to simplify the stripping out of the moulding. These and other lubricants (e.g. silicons) are also used in small quantities upon the surface of the mould. In this case they are called mould release agents (Formtrennmittel - Agent de démoulage).

Machining - Spangebende Bearbeitung - Usinage (avec enlèvement de matière):

Processing of semi-products and finished products of plastics by cutting or grinding tools (e.g. by cutting, sawing, turning, milling, drilling etc).

Melt index - Schmelzindex - Indice de fluidité à l'état de fusion:

The amount (in grams) of a fused thermoplastic material which is pressed under standardized temperature and pressure conditions through a sprue or orifice of specified dimensions within 10 minutes.

Metallising - Metallisieren - Métallisation:

The surface coating of an object with metal.

Moulding material - Formmasse - Matière à mouler:

A material that can be shaped into mouldings or intermediates by the influence of mechanical forces within a certain range of temperature.

Organosol - Organosol - Organosol:

A dispersion of resins in a rather volatile organic liquid which does not dissolve the resin.

Plastic - Kunststoff - Matière plastique:

A material which contains as an essential ingredient a high polymer and which at some stage in its processing into finished products can be shaped by flow. Elastomeric materials, fibres, paints and adhesives are not considered as plastics.

Plasticizer - Weichmacher - Plastifiant:

A liquid or solid substance that forms a homogeneous system with plastics, lowers their softening range and increases their workability and flexibility or extensibility.

Plastisol - Plastisol (Kunststoffpaste) - Plastisol:

A dispersion of resins in a plasticiser.

Polyaddition - Polyaddition - Polyaddition:

Broadly, synonimous with "Addition polymerisation"; in a restricted sense, the chemical reaction in which polymers are formed by additions of monomers other than those containing carbon - carbon unsaturated bonds, when H-atoms change their place (e.g. Epoxy-, Isocyanate- or Lactam-reactions).

Polycondensation - Polykondensation - Polycondensation:

A reaction in which molecules of monomers are linked together with the splitting off of water or other simple molecules.

Polymerization - Polymerisation - Polymérisation:

A chemical reaction in which the molecules of monomers are linked together to form molecules of high molecular weight (polymers). In a restricted sense the chemical reaction in which monomers containing carbon-carbon unsaturated bonds are linked together to form polymers.

Degree of polymerisation - Polymerisationsgrad - Degré de polymérisation:

The (average) number of monomeric units per molecule.

Pot life - Topfzeit - Vie en pot:

The maximum time for which a mixture of resin and hardener remains usable.

Powder density - Schüttdichte (Schüttgewicht) - Masse volumique d'une poudre:

The weight in grams of 1 millilitre of loose powder.

Processing - Spanlose Verarbeitung - Travail sans enlèvement de matière:

Production of semi-finished or finished products from plastics in liquid, powdery or granular state by casting, injection moulding, extrusion, compression moulding etc.

Synthetic resin - Kunstharz - Résine synthétique:

A synthetically produced resin, that is to say a solid or semi-solid material of an indefinite and often high molecular weight with a relatively broad softening or melting range and a conchoidal fracture. Nowadays it is applied in a broader sense, including materials bearing little resemblance to natural resins.

Setting time - Gelierungsdauer (Gelierzeit) - Temps de prise:

The time which a material needs to harden sufficiently for handling.

Sheet - Platte - Feuille:

A form of plastics produced as an individual piece rather than in a continuous length sheeting or cut as an individual piece from a continuous length. A sheet of a very small thickness is called a "film" (Folie - Feuille).

Shelf life (Storage life) - Lagerfähigkeit - Durée limite de stockage:

The maximum storage time for which a material remains usable.

Shrinkage - Schwindung - Retrait (contraction) au moulage:

The difference in dimensions between a moulding and the mould cavity in which it was moulded, both the mould and the moulding being at normal room temperature when measured.

Aftershrinkage of a moulded piece - Nachschwindung eines Formteiles - Retrait postérieur au moulage:

The difference between the dimensions of a moulded piece on the day after its production and its dimensions measured after a subsequent treatment at a specified temperature and time.

Sieve Analysis - Siebanalyse (Korngrössenbestimmung) - Analyse au tamis:

The determination of the proportions of various sizes in powder or granulated materials by passing it through a range of sieves of different meshes.

Solvent - Lösungsmittel - Solvant:

A volatile liquid (boiling point up to 250°C at 760 mm) which dissolves substances without any chemical reaction taking place. (The boiling point is limited to provide a demarcation between solvents and plasticizers.)

Stabilizer - Stabilisator - Stabilisant:

A substance used in the formulation of some plastics to assist in maintaining the properties of the material at their initial values during processing and service life.

Stretching - Reckung - Etirage:

Tensile stress is applied to plastic products (threads, films, etc.) at properly adjusted temperatures, whereby the molecules of the plastics are oriented in the direction of stress and as a consequence the strength of the material in that direction is increased.

Tacticity - Taktizität - Tacticité:

The steric order of the same side groups in respect to the main chain of polymer (atactic, syndiotactic or isotactic).

Thermoforming - Warmumformung - Thermoformage:

Forming of thermoplastic intermediates, such as sheets, rods or tubes with the aid of heat in order to change their shape to a desired configuration.

Thermoplastic - Thermoplast - Thermoplastique:

A material being capable in processing of being repeatedly softened by increase of temperature and hardened by decrease of temperature.

Thermosetting plastic - Härtbarer Kunststoff (Duroplast, Duromer) - Plastique thermodurcissable:

A macromolecular material capable of being changed into a substantially insoluble, infusible, cross linked product, when cured by heat or, loosely, by other means such as radiation, catalysts etc. There are three different stages:

A-stage: A material containing sufficient reactive groups to enable it to become infusible on further reaction, but being still fusible and soluble in certain solvents. Phenolic resins being in this stage, are called "Resols".

B-stage: This is an intermediate stage in the reaction of certain thermosetting resins, in which they swell when in contact with certain liquids and soften by heating, but may not entirely dissolve or fuse. Phenolic resins in this stage are called "Resitols".

C-stage: This is the final stage of the curing process of thermosetting resins, in which the material becomes insoluble in solvents and infusible. Phenolic resins being in this final stage are called "Resits".

Thinner - Verdünnungsmittel - Diluant:

A volatile liquid (boiling point up to 250°C at 760 mm) which at the processing temperature can be completely mixed with the substance to be diluted and is used to adapt consistency or concentration to the processing conditions.

Transfer moulding - Spritzpressen - Moulage par transfert:

The moulding of thermosetting materials by transfer from a heated transfer pot through sprues into the cavity of a heated closed mould, where it is hardened by heat under pressure. (The quantity of material being filled into the transfer pot corresponds to the weight of the moulded piece plus the content of the sprues).

Viscosity - Viskosität - Viscosité:

The property of resistance to flow exhibited within the body of a material (Symbol: η). In testing, the ratio of the shearing stress to the rate of shear of a fluid. Viscosity is usually taken to mean "Neutonian viscosity", in which case the ratio of shearing stress to rate of shearing strain is constant. The viscosity is expressed in Poises, in Centipoises (= 0.01 poise) or in dyn. sec/cm^2. If η is related to the density of the liquid one speaks of the "Kinematic viscosity". The latter is expressed in Stokes (St) or in Centistokes (cST).

Viscosity coefficient - Viskositätskoeffizient - Coefficient de viscosité:

The shearing stress necessary to induce an unit velocity flow gradient in a material. In actual measurement, the viscosity coefficient of a material is obtained from the ratio of shearing stress to shearing rate. This assumes the ratio to be constant and independent of the shearing stress, a condition which is satisfied only by Neutonian fluids. Consequently, in all other cases, values obtained are apparent and represent one point on the flow curve.

Viscosity number (Reduced viscosity) - Viscositätszahl - Indice de viscosité:

If η is the viscosity of the polymeric solution, η_0 the viscosity of the pure solvent and c the concentration of the polymer solution (in grams per ml of solution) the viscosity number $[\eta]$ can be calculated:

$$[\eta] = \frac{\eta - \eta_0}{\eta_0 \cdot c}$$

Limiting viscosity number (Intrinsic viscosity) - Grenzviskositätszahl - Indice limite de viscosité (Viscosité intrinsèque):

This is the limiting value of the viscosity number at infinite dilution:

$$\lim_{c \to 0} [\eta]$$

The "K-value", which is a measure of the degree of polymerization but not identical with it, is frequently used in German literature instead of the viscosity number $[\eta]$. K can be calculated from η/η_0. The relationship between "intrinsic viscosity" and K is:

$$[\eta]_{c=0} = 0{,}0023\ (0{,}075\ K^2 + K)$$

Viscosity (apparent) - Scheinbare Viskosität - Viscosité apparente:

In non-Newtonian behaviour, which is the usual case with plastic materials, the ratio of the shearing stress to the rate of shear varies with the shearing stress. Such ratios are often called the "apparent viscosities" at the corresponding shearing stresses.

4.1 PREPARATION OF SPECIMENS FOR TESTS

4.1.1 Preparation of specimens by injection moulding technique

ASTM D 1130: for general purposes
ISO R 294: for general purposes
DIN 53451: for general purposes
ASTM D 1897: styrene-plastics

4.1.2 Preparation of specimens by compression moulding technique

ISO R 295: for general purposes (thermosetting)
DIN 53451: for general purposes (thermosetting)
ISO R 869: for optical tests
ASTM D 796: phenolics
ASTM D 956: aminoplastics
ASTM D 1928: polyethylene
ISO R 293: thermoplastics

4.1.3 Preparation of specimens by transfer moulding

ASTM D 1896: thermosetting

4.1.4 Preparation of specimens by special techniques

ASTM D 2291: reinforced plastics with oriented glass-fibres
ISO R 870: for optical tests by casting techniques

4.1.5 Conditioning of specimens

ASTM D 618
ASTM E 171
ISO R 291
DIN 50010
AFN T 51-014

In these standards different conditioning procedures are optionally provided:

20°C/65% relative humidity
23°C/50% relative humidity
27°C/65% relative humidity

to suit different climatic conditions

4.1.6 The establishment of controlled climatic conditions in closed rooms:

ASTM E 104
ISO R 483
DIN 50016
DIN 50017
DIN 50018

4.2 ANALYTICAL TESTS

Acid value

ASTM D 1045:	General purposes	mg KOH/g	+	1/
ASTM D 817:	Cellulose acetate	mg KOH/g	+	
DIN 53729:	Cellulose acetate	mg KOH/g	+	
ISO R 1061:	Cellulose acetate	%	(+)	
BS 2782-407 B:	Polyester	mg KOH/g	+	
DIN 53402:	Plasticiser	mg KOH/g	+	

1/ The quoted methods determine the content of free acids expressed by the amount of KOH (in mg) necessary for neutralisation. By analogy these methods can be used also for other products than those listed above.

Analysis of Resins

DIN 53748:	Phenolics
DIN 53749:	Aminoplastics

The above mentioned standards include information on the complete analyses of the synthetic resins mentioned and of plastics made from them.

Ammonia and ammonium compounds

ASTM D 834/B:	Phenolic mouldings (quant.)	%	+
ISO R 120:	Phenolic mouldings (quant.)	%	+
BS 2782-402 A:	Phenolic mouldings (quant.)	%	+
DIN 53707:	Phenolic mouldings (quant.)	%	+
ASTM D 834/A:	Phenolic mouldings (qual.)	-	+
ISO R 172:	Phenolic mouldings (qual.)	-	+
DIN 53708:	Phenolic mouldings (qual.)	-	+

Ash content

ASTM D 817:	Cellulosics	%	(+)	2/
ISO R 872:	Cellulosics	%	(+)	
BS 2782-107K:	Fibreglass	%	(+)	2/
DIN 53395:	Fibreglass	%	(+)	
AFN T 51-023:	Fibreglass	%	(+)	
ISO R 247:	Rubber	%	+	2/
DIN 53568/1:	Rubber	%	+	
DIN 53568/2:	Rubber	%	0	
AFN T 52-048:	PVC	%	0	
AFN T 52-044:	PVC	%	0	

2/ Results obtained according to these standards are not always directly comparable because upon ashing in some cases the residue and in other cases the loss of weight is determined. By conversion the ash content is obtained as follows:

Weight of the sample (100%) - loss in weight (in %) = ash content (in %).

Chlorine content

ASTM D 1303:	All types of plastics	%	+
DIN 53474:	All types of plastics	%	+
AFN T 51-026:	PVC	%	+

Epoxy equivalent

ASTM D 1652:	Epoxy resins	g	+	3/
BS 2782-407 A:	Epoxy resin.	g	+	
DIN 16945:	Epoxy resins	g	+	

3/ The "epoxy equivalent" is calculated from the amount of n/10 HBr consumed for titration:

$$\text{Epoxy equivalent} = \frac{\text{synthetic resin (in g)}}{\text{n/10 HBr (in ml)}} \quad 10$$

Contents

Ester content

ASTM D 1045:	Plasticizers and others	mg KOH/g	+	4/
DIN 53401:	Plasticizers and others	mg KOH/g	+	
DIN 53730:	Cellulose acetate	mg KOH/g	0	

4/ Instead of determining mg KOH/g sometimes the ester content is given as a percentage calculated on the basis of an arbitrary mono-basic acid (often defined as acetic acid content).

Extraction

ISO R 599:	Polyamid	%	0	
ISO R 118:	Polystyrene	%	(+)	5/
BS 2782-403 A:	Polystyrene	%	(+)	
DIN 53718:	Polystyrene	%	(+)	
AFN T 57-004:	Polystyrene	%	(+)	
ISO R 922:	Polypropylene	%	0	
ASTM D 2222:	Vinyl resins	%	0	
DIN 53710:	Phenolic mouldings	%	0	
ASTM D 494:	Phenolic mouldings	%	(+)	5/
ISO R 59:	Phenolic mouldings	%	(+)	
BS 2782-401 A:	Phenolic mouldings	%	(+)	
DIN 53700:	Phenolic mouldings	%	(+)	
AFN T 51-004:	Phenolic mouldings	%	(+)	

5/ It is evident that results can only be compared if the materials as well as the solvents used for extraction are the same.

Free formaldehyde in thermoset mouldings

DIN 7708:	Aminoplastic mouldings	mg/l	0	
BS 2782-402 C:	Phenolic mouldings (colorimetric method)	%	(+)	6/
BS 2782-402 D:	Phenolic mouldings (gravimetric method)	%	(+)	6/

6/ On principle there is no difference using a colorimetric or gravimetric method. In practice, however, the latter method should be used in case of a high formaldehyde content if the highest possible accuracy of results is demanded.

Free Phenol in phenolic mouldings

ISO R 119:	Phenolic mouldings	%	+
BS 2782-402 B:	Phenolic mouldings	%	+
DIN 53704:	Phenolic mouldings	%	+

Resin content

ISO R 308:	Phenolic mouldings	%	+	1/
DIN 53710:	Phenolic mouldings	%	+	1/
AFN T 57-020:	Phenolic mouldings	%	+	1/
AFN T 53-053:	Resins (dispersion in water)	%	0	
BS 2782-107 D:	Phenolic resins (solutions)	%	0	
BS 2782-107 E:	Aminoplastic resins (solutions or dispersion)	%	0	

1/ These standards refer to extraction procedures and determine the portion dissolved in the extraction solvent whereas all other testing methods measure the volatile matter and calculate the resin content from the difference between the weighed-in quantity and the loss in weight. If also fillers are present, they are determined together with the synthetic resin; the amount of filler has to be found out separately and subtracted from the total residue.

Styrene content in styrene polymers and copolymers

ISO R 173:	Styrene polymers and copolymers	%	+
BS 2782-403 B:	Styrene polymers and copolymers	%	+
DIN 53719:	Styrene polymers and copolymers	%	+
AFN T 51-007:	Styrene polymers and copolymers	%	+

Volatile matter

DIN 53713:	For general purposes	% (-)	0
ISO R 585:	Cellulosics	% (-)	+
BS 2782-107 G:	Cellulosics	% (-)	+
DIN 53723:	Cellulosics	% (-)	+
BS 2782-107 A:	Polystyrene	% (-)	0
BS 2782-107 F:	PVC plastified	% (-)	0
AFN T 52-045:	PVC plastified	% (-)	0
ISO R 960:	Polyamide	% (-)	0
BS 2782-107 B:	Phenolic resins (100°C)	% (-)	0
BS 2782-107 C:	Phenolic resins (135°C)	% (-)	0
AFN T 56-106:	Cellular plastics	% (-)	0
DIN 5318:	Solutions of resins	% (+)	0
AFN T 53-054:	Emulsion of resins	% (-)	0
ASTM D 2288:	Plasticiser	% (-)	0

The symbol % (-) refers to the percentage weight-loss after a specific heat treatment. The results include all volatile constituents of the specimen and, depending on the intensity of the heat treatment, all volatile matter split off during the process of cure.

The symbol % (+) refers to the percentage of residue after a specific heat treatment.

4.3 PHYSICAL TESTS

Bulk factor

ASTM D 1895:	Moulding materials (powder or granulate)	+
ISO R 171:	Moulding materials (powder or granulate)	+
BS 2782-501 C:	Moulding materials (powder or granulate)	+
DIN 53466:	Moulding materials (powder or granulate)	+

Density of liquids

ASTM D 1045:	General purposes	g/ml	(+)	8/
DIN 51757:	General purposes	g/ml	(+)	

8/ Although the methods are different, the results can be compared provided that measurements are made at the same temperature.

Density of solids

True density

ASTM D 792:	Plastics	g/ml	+	9/
BS 2782-509 A:	Plastics	g/ml	+	
DIN 53479:	Plastics	g/ml	+	
ASTM D 1505:	Plastics	g/ml	+	
BS 2782-509 B:	Plastics	g/ml	+	
BS 2782-509 C:	Plastics	g/ml	+	

9/ Though the methods are basically different (displacement method, suspension method, density gradient technique), the results are mutually comparable.

1. INTRODUCTION

The results of a test on a material depend not only on the type but also on the shape and size of the sample and its history. But even more important is the exact method of carrying out the test. Test methods including the preparation and preconditioning of the sample have been drawn up by numerous standardization organizations (usually national in character). Attempts to eliminate differences between various standard tests have been made by the ISO (International Standards Organization) and the IEC (International Electrical Commission) but so far with only limited success.

In the handbook the tests laid down by various standards organizations to determine various characteristics of plastic material are mentioned by reference numbers and those which give results that are strictly comparable, are specially indicated. Merely giving the results in different systems of measurement (units) does not necessarily mean the results are not comparable, provided of course the units can be converted.

It is clearly impractical to give details of how each test according to each standard is carried out; so reference must be made to the texts of the various standards handbooks. Test methods of the following organisations are included:

American Society for Testing Materials	(ASTM)
International Standards Organisation	(ISO)
British Standards Institute	(BS)
Deutsche Normenausschuss	(DIN)
Association Française de Normalisation	(AFN)

Tests must be drawn up in such a way that the properties of a plastic material and objects made from it can be determined.

Tests can be looked at in one of two ways: they either show whether a product is suitable for some given application or whether it has the properties it should have as a result of its particular method of manufacture.

Density of solids

Apparent density

ASTM D 1622:	Cellular plastics	g/ml	+	9/
ISO R 845:	Cellular plastics	g/ml	+	
DIN 53420:	Cellular plastics	g/ml	+	
AFN T 56-107:	Cellular plastics	g/ml	+	
ASTM D 1895 A:	Powder and granules	g/l	+	10/
ISO R 60:	Powder and granules	g/l	+	
BS 2782-501 A:	Powder and granules	g/l	+	
DIN 53468:	Powder and granules	g/l	+	
AFN T 51-003:	Powder and granules	g/l	+	
AFN T 52-042:	PVC (powder)	g/l	+	11/
ISO R 1068:	PVC (powder)	g/l	+	
ASTM D 1895:	Materials with long fibres	g/l	(+)	12/
ISO R 61:	Materials with long fibres	g/l	(+)	
BS 2782-501 B:	Materials with long fibres	g/l	(+)	
DIN 53467:	Materials with long fibres	g/l	(+)	

9/ Though the methods are basically different (displacement method, suspension method, density gradient technique), the results are mutually comparable.

10/ Slight differences regarding equipment hardly influence the results; anyhow a certain scattering has to be taken into account. The values are also frequently quoted in g/ml.

11/ The results of these two standards cannot be compared with those of the others (referred to under 10/), because the powder is compressed.

12/ As a consequence of the bulky character of these materials the results scatter considerably. Sometimes the unit of measure is also g/ml.

Melting point

BS 2782-103 B:	Resins; plastics	°C	+	13/
DIN 53181:	Resins; plastics	°C	+	
BS 2782-103 A:	Resins; plastics	°C	0	
ASTM D 2117:	Semi crystalline plastics	°C	+	13/
BS 2782-103 D:	Semi crystalline plastics	°C	+	
ISO R 922:	Polyamide (air sealed)	°C	+	13/
BS 2782-103 C:	Polyamide (air sealed)	°C	+	

13/ Though the melting point is a true physical property of a material and therefore should not be influenced by the method of determination used, in case of macromolecular materials no exact melting point but only a certain melting range can be determined.

Sieve Analysis

ASTM D 1921:	General purposes	0
DIN 53477:	General purposes	0
AFN 52-043:	Vinyl chloride polymers	0
ASTM D 1705:	Vinyl chloride polymers	0

Thickness

ASTM D 374:	Sheets and films	mm;	in	+	14/
ASTM E 252:	Sheets and films	mm;	in	+	
BS 2782-512 A/B:	Sheets and films	mm;	in	+	
DIN 53353:	Leather cloth	mm		+	
DIN 53370:	Films	mm		+	
AFN T 54-007:	Sheets and films	mm		+	
AFN T 56-121:	Cellular plastics	mm		+	

14/ Thickness measurements can be carried out with different methods (e.g. with thickness gauges, by non-contact gauging, by calculation of thickness from weight and density of the sample). Results are comparable, but the attainable accuracy is not the same in all cases, especially for soft sheets of small thicknesses.

Viscosity

ASTM D 1243:	General purposes	$[\eta]$	+	15/
BS 188:	General purposes	$[\eta]$	+	
DIN 51550:	General purposes	$[\eta]$	+	
DIN 51562:	General purposes	$[\eta]$	+	
DIN 53015:	General purposes	$[\eta]$	+	
DIN 53016:	General purposes	sec	0	
ASTM D 1601:	Polyethylene (dilute solution)	$[\eta]$	0	
BS 2782-404 B:	Polystyrene (dilute solution)	$[\eta]$	0	
ASTM D 817:	Cellulose acetate (dilute solution)	$[\eta]$	+	15/
DIN 53728:	Cellulose acetate (dilute solution)	$[\eta]$	+	
DIN 53726:	PVC (dilute solution)	$[\eta]:K$	+	15/
ISO R 174:	PVC (dilute solution)	$[\eta]:K$	+	
BS 2782-404 A:	PVC (dilute solution)	$[\eta]$	(+)	
ASTM D 1243:	PVC (dilute solution)	$[\eta]$	(+)	
ISO R 307:	Polyamide (dilute solution)	$[\eta]$	+	15/
BS 2782-404 C/D:	Polyamide (dilute solution)	$[\eta]$	+	
DIN 53727:	Polyamide (dilute solution)	$[\eta]$	+	
AFNOR T 51-019:	Polyamide (dilute solution)	$[\eta]$	+	
ISO R 600:	Polyamide (concentrated solution)	η	(+)	16/
DIN 53728:	Polyamide (concentrated solution)	η	(+)	
ASTM D 789:	Polyamide (concentrated solution)	η	(+)	

15/ If dilute polymer solutions in solvents of low solvation tendency are used, the results are comparable provided that measurements are made at the same temperature. The greater the solvation tendencies are, the higher are the values obtained.

16/ Viscosity values determined on concentrated solutions are no longer true physical property values and can therefore only be compared if <u>all</u> experimental conditions are the same.

Apparent viscosity

ASTM D 1823:	Plastisols;	Organosols	~η	0
ASTM D 1824:	Plastisols;	Organosols	~η	0
BS 1733	Plastisols;	Organosols	sec	0

4.4 TECHNOLOGICAL TESTS

Degree of cure of thermoset plastics

ASTM D 494:	Phenolic mouldings	%	+	
ISO R 59:	Phenolic mouldings	%	+	
BS 2782-401 A:	Phenolic mouldings	%	+	
DIN 53700:	Phenolic mouldings	%	+	
DIN 53499:	Phenolic mouldings		(+)	17/
DIN 53499:	Aminoplastic mouldings		(+)	
BS 1322:	Aminoplastic mouldings			

17/ Different additives (dyestuffs, acids etc.) are used for the "boiling water tests"; in so far as equal additives and boiling times are concerned it is possible to compare the results.

Flow (Molt Index)

ASTM D 731:	Thermosetting materials			0	
BS 2782-105 B:	Thermosetting materials			0	
DIN 53465:	Thermosetting materials			0	
BS 2782-105 D:	Resin impregnated glass fabric			0	
ASTM D 1238:	Polyolefines	g/10 min	(+)		18/
ISO R 292:	Polyolefines	g/10 min	(+)		
BS 2782-105 C:	Polyolefines	g/10 min	(+)		
DIN 53735:	Polyolefines	g/10 min	(+)		
AFN T 51-016:	Polyolefines	g/10 min	(+)		
ASTM D 569:	Thermoplastic mouldings			+	19/
BS 2782-105:	Thermoplastic mouldings			+	
ASTM D 1703:	Thermoplastic mouldings	Poise		0	

18/ The procedures of the five standards are all based on the same principle. Results are comparable if the measurements are carried out under the same pressure and temperature conditions.

19/ These two testing methods are based on the pressure/flow/temperature function which is determined with the help of Rossi-Peak apparatus.

Reactivity and setting time of thermosetting resins

ISO R 584:	Polyester resins at 25°C	min	+	20/
DIN 16945:	Polyester resins at 25°C	min	+	
BS 2782-111 C:	Polyester resins at 82°C	min	0	
AFN T 51-022:	Polyester resins at 82°C	min	0	
BS 2782-111 D:	Polyester resins at different temperatures	min	0	
BS 2782-111 D:	Epoxy resins at different temperatures	min	0	
BS 2782-111 A:	Phenolic resins at 130°C	min	0	
BS 2782-111 B:	Phenolic resins at 150°C	min	0	

20/ All testing methods provide data of curing rates of catalysed resin systems as well as of the degree of exothermicity. The latter is established by the maximal temperature which can be measured.

Shrinkage of mouldings

ASTM D 955:	Thermoplastic mouldings	%	(+)	21/
AFN T 51-012:	Thermoplastic mouldings	%	(+)	
ASTM D 955:	Thermoset mouldings	%	(+)	
BS 2782-106 A-B:	Thermoset mouldings	%	(+)	
DIN 53464:	Thermoset mouldings	%	(+)	21/
AFN T 51-012:	Thermoset mouldings	%	(+)	
ASTM D 551:	Thermosets for electrical insulation	%	(+)	

21/ Shrinkage values can only be compared if they are determined on specimens of equal shape and size as well as prepared under the same conditions.

For the former as much information as possible on the product must be gained on the mechanical, thermal, and electrical properties, their dependence on temperatures and the preconditioning of the samples. For the latter, control tests (often a single one) and comparison of the result with a standard may be sufficient.

Some tests necessarily involve destruction of the samples, others involve a change in the samples brought about by exposure to various external influences, heating in water etc. Tests have to be designed so that they reproduce as clearly as possible the condition to which the material is to be exposed, but must however be capable of strict specification in order to obtain reproducible results. In general, preference is given to non-destructive methods of testing.

The tables of testing methods are shown in five columns.

Column 1 An abbreviation of the standardising institution and the number of the appropriate standard

Column 2 Type of material to which the standard applies

Column 3 Unit in which the result is expressed

Column 4 Comparability. Symbols indicate as follows:

+ results comparable,

(+) results only comparable if the same experimental conditions are used for testing,

0 results not comparable.

If two or more standards for the same test give comparable results, they are bracketed together. Note must be taken however as to whether they are + results or (+) results.

Aftershrinkage of thermoset mouldings and laminates

ASTM D 1042:	Thermoset mouldings	%	0	
BS 2782-106 C:	Thermoset mouldings	%	0	
DIN 53464:	Thermoset mouldings	%	0	
AFN T 51-012:	Thermoset mouldings	%	0	22/
ASTM D 1299:	Thermoset laminates	%	0	
AFN T 54-008:	Thermoset decorative laminates	%	0	

22/ Aftershrinkage depends on shape and size of the specimens, on the way they have been produced and on the temperature and time of aftertreatment. As the last two named factors are usually left to the discretion of the tester a meaningful comparison of aftershrinkage values determined according to different standards is impossible.

5. MECHANICAL PROPERTIES - DEFINITION OF TERMS

Ball indentation hardness - Kugeldruckhärte - Dureté à la bille:

The indentation depth of a steel ball of standard size pressed under standard conditions on the surface of the specimen. The ball indentation hardness (in kgf/cm^2) is the quotient of the load and the area of the spherical indentation. In the case of plastics the ball indentation hardness is determined under load whereas in the case of metals it is determined after removal of the load ("Brinell-hardness").

Bearing stress - Ausreiss-Spannung - Contrainte de portage:

This is the applied load divided by the bearing area. The latter is the diameter of the hole multiplied with the thickness of the specimen.

Bearing strength - Nadel-Ausreissfestigkeit - Résistance de portée:

The ability of a material to withstand bearing stress. It is reported at that point of the stress-strain curve where the tangent is equal to the bearing stress divided by n percent (usually 4%) of the bearing hole diameter. The test is based on the smallest force which has to act on a pin pierced through the test specimen in order to tear out the pin hole. This force can be of the tensile or the compression type.

Bending (flexibility) - Biegsamkeit - fléchissement:

The ability of a material to withstand bending under specified conditions. In the case of rigid plastics the bending is determined under a specified load whereas in the case of flexible plastics the smallest bending radius is measured which does not produce cracks or breaking of the specimen.

Breaking load - Bruchlast - Charge de rupture:

The load at which fracture occurs.

Cold flow - Kalter Fluss - Fluage à froid:

The slow deformation of a stressed material at temperatures within the working range of the material.

Compressive strength - Druckfestigkeit - Résistance à la compression:

The ability of a material to withstand compressive stress. Usually the compressive strength (gradually increased during the test) is calculated from the maximum load and the original cross section area of the specimen. In the case of materials which do not fail in compression by a brittle fracture, the compressive strength is replaced by the stress corresponding to an arbitrarily chosen strain.

Creep - Kriechen - Fluage:

The slow deformation of a stressed material.

Creep recovery - Kriecherholung - Recouvrance (du fluage):

The time-dependant portion of the de rease in strain following unloading of a specimen.

Instantaneous recovery in creep (Elastic recovery in creep) - Momentane Kriecherholung - Recouvrance instantanée en fluage:

The decrease in strain occurring immediately upon unloading a specimen before any creep recovery takes place.

Creep strength - Kriechfestigkeit - Résistance au fluage:

The stress that cuases a given creep in a given time in a given environment.

Deformation under load by compression - Stauchung - Raccourcissement par compression:

The compression of a specimen effected by load (expressed in % of the initial height of the specimen).

Delamination - Trennung der Schichten eines Schichtstoffes (Spaltung) - Délamination d'un stratifié (Cleavage):

Breakdown of the structure of laminated plastics by the separation of the layers. The separation of the layers can be produced either by peeling tensile stress (mainly in the case of flexible laminates) or by splitting with a compression loaded wedge (in case of rigid laminates).

Elasticity - ElastizitÄt - Elasticité:

The property of recovering original shape and size after deformation. The mechanism may be either rubberlike elasticity (entropy elasticity) or steellike elasticity (energy elasticity).

Elastic limit - ElastizitÄtsgrenze - Limite élastique:

The greatest stress which a material is capable of sustaining without any permanent strain remaining upon complete release of the stress.

Modulus of elasticity (in tension, in compression or in flexion) - ElastizitÄtsmodul (Zug-, Druck- oder Biegemodul) - Module d'élasticité (en tension, en compression ou en flexion):

The ratio of stress to strain in a material over the range for which this value is constant (range of Hooke's law). The modulus of elasticity in tension is also called Young's modulus.

Elongation - Dehnung - Allongement:

The increase in length under tension (usually expressed in % of the original length of the specimen).

Elongation at maximum load - Dehnung bei HÖchstkraft - Allongement correspondant à la charge maximale:

Elongation of a specimen at the moment at which the stress-strain curve reaches the maximum tensile stress.

Elongation at break - Reissdehnung (Bruchdehnung) - Allongement à la rupture:

Elongation during the tensile test just before the specimen breaks.

Fatigue - ErmÜdung - Fatigue:

The process of progressive localized permanent structural change occurring in a material subjected to fluctuating stresses and strains which may culminate in cracks or complete fracture.

Fatigue limit - Grenz-Wechselfestigkeit - Limite de fatigue:

The limiting value of the median fatigue strength if the number of cycles (n) becomes very large. Values tabulated as "Fatigue Limits" are frequently (but not always) number of stress cycles S_n for 50% survival at n cycles of stress in which mean stress $(S_m) = 0$.

Fatigue life - Wechselfestigkeit (Festigkeit bei Wechselspannung) - Resistance à la fatigue:

The number of cycles of stress or strain of a specified character that a given specimen sustains before failure of a specified nature occurs.

Flexural strength - Biegefestigkeit - Résistance à la flexion:

The ability of a material to withstand flexural stress. In testing this is the maximum stress in the outer fibre at the moment of crack or break.

Flexural stress at a given deflection - Biegespannung bei vorgegebener Durchbiegung (Grenzbiegespannung) - Résistance à la flexion à flèche:

In case of materials showing under load a marked creep the flexural stress at a given deflection is measured instead of the flexural stress at break.

Flexural yield strength - Biegespannung an der Fliessgrenze - Résistance à la flexion au seuil d'écoulement:

The stress at a point on a load-deflection curve at which the load does not increase with an increase in deflection.

Folding - Falzen - Pliage:

The ability of a material to endure sharp bends ((folds) without breaking at the bend or fold.

Folding endurance - Falzfestigkeit (Falzzahl) - Résistance au pliage répété:

The number of double folds (folds to both sides) which a specimen can endure before breaking at the fold.

Impact strength - Schlagzähigkeit - Resistance au choc:

The ability of a material to withstand shock loading. (The expenditure of energy necessary to cause breaking of an unnotched or notched specimen). In practice three different test methods are used:

(a) Impact test (Charpy) - Schlagversuch nach Charpy - Essai au choc methode Charpy:

A specimen supported as a simple beam is hit in the centre by an impact pendulum of known potential energy. The consumed energy is calculated from the amplitude of the pendulum reached after breaking of the specimen.

(b) Impact test (Ized) - Schlagversuch nach Ized - Essai au choc methode Ized:

The specimen is fixed on one end. The free end of the specimen is submitted to bending stress by means of a sledge hammer.

(c) Falling ball test - Kugelfalltest - Essai au choc à la bille:

A marginally supported plate shaped specimen is struck with a freely falling steel ball. The height of free-fall and/or the falling weight is increased until cracks in the specimen or breaking of the specimen occurs.

Indentation hardness - Eindruckhärte - Dureté par pénétration:

The ability of a material to resist indentation. The term "Indention hardness" has no quantitive meaning except in terms of a particular test in which the size and shape of the indentor, the indenting load and other conditions of the test are specified.

Logarithmic decrement of mechanical damping - Logarithmisches Dekrement der mechanischen Dämpfung - Décrément logarithmique de l'atténuation mécanique:

In case of oscillating deformations the logarithmic decrement of mechanical damping is the natural logarithm of the ratio of two subsequent amplitudes of oscillation.

Poisson's ratio - Poisson'sche Zahl - Coefficient de Poisson:

The ratio of transverse strain to the corresponding axial strain resulting from uniformly distributed axial stress below the proportional limit of the material.

Above the proportional limit, the ratio of transverse strain to axial strain will depend on the average stress and on the stress range for which it is measured and, hence, should not be regarded as Poisson's ratio. If this ratio is reported, nevertheless, as a value of "Poisson's ratio" for stresses beyond the proportional limit, the range of stress should be stated. Poisson's ratio will have more than one value if the material is not isotropic.

Proportional limit - ProportionalitÄtsgrenze - Limite proportionnelle:

The greatest stress that a material is capable of sustaining without any deviation from proportionality of stress to strain (Hooke's law).
See also figure 1.

Rockwell hardness - RockwellhÄrte - Indice de dureté Rockwell:

The indentation depth of a steel ball of standard size pressed under standard conditions on the surface of the specimen. The Rockwell hardness is expressed in scale units.

According to the hardness of the material various loads and types of scales are provided. Using scales E, L, M and R measurements are carried out after removal of the load. On the other hand "« Rockwell-hardness" is measured under load.

Sécant modules - Sekantenmodul - Module sécant:

The slope of the secant drawn from the origin to any specified point on the stress-strain curve (see figure 1).

4.4.74

2. ABBREVIATIONS OF CHEMICAL NAMES

(Recommended by: ISO R 1043
BS 3502
DIN 7728)

ABS	**Acrylnitrile-butadiene-styrene**
CMC	**Carboxymethyl cellulose**
CA	**Cellulose acetate**
CAB	**Cellulose acetate butyrate**
CAP	**Cellulose acetate propionate**
CF	**Cresol-formaldehyde**
CN	**Cellulose nitrate**
CP	**Cellulose propionate**
CS	**Casein**
EC	**Ethyl cellulose**
EP	**Epoxy**
MF	**Melamine-formaldehyde**
PF	**Phenol-formaldehyde**
PA	**Polyamide**
PC	**Polycarbonate**
PCTFE	**Polychlorotrifluoroethylene**
PDAP	**Poly-diallylphthalate**
PE	**Polyethylene**
PETP	**Poly-(ethylene terephthalate)**
PIB	**Polyisobutylene**
PMMA	**Poly-(methylmethacrylate)**
POM	**Polyoxymethylene**
PP	**Polypropylene**
PS	**Polystyrene**
PTFE	**Poly-(tetrafluoroethylene)**
PUR	**Polyurethane**
PVAC	**Poly-(vinyl acetate)**
PVAL	**Poly-(vinyl alcohol)**
PVB	**Poly-(vinyl butyral)**
PVC	**Poly-(vinyl chloride)**
PVCA	**Poly-(vinyl chloride acetate)**
PVDC	**Poly-(vinylidene chloride)**
PVF	**Poly-(vinyl fluoride)**
PVFM	**Poly-(vinyl formal)**
SAN	**Styrene-acrylonitrile**
SB	**Styrene-butadiene**
SI	**Silicone**
UF	**Urea-formaldehyde**
UP	**Unsaturated polyester**

3. SYSTEMS OF MEASURING - UNITS OF MEASUREMENT AND CONVERSION FACTORS

(The quoted conversion factors are values satisfactory for practice but not for scientific calculations)

Linear measures:

1 foot (ft) = 30.48 cm
1 inch (in) = 2.54 cm
1 mil = 0.001 in
= 0.00254 cm

Square measure:

1 square foot (sq.ft) = 929 cm^2
1 square inch (sq.in) = 6.45 cm^2

Volume measures:

1 cubic foot (cu.ft) = 28.317 cm^3
= 28.317 ml
1 cubic inch (cu.in) = 16.39 cm^3
= 16.39 ml

Units of weight:

1 pound (lb) = 0.454 kg
1 ounce (oz) = 0.0284 kg

Units of force:

1 Dyne (dyne) = 1 gcm/sec^2
= 1.02×10^{-6} kgf
1 Newton (N) = 10^5 dyne
1 kilogramforce (kgf) = 1 Kilopond (kp)
= 9.807×10^5 dyne
= 9.807 N

Units of pressure:

1 Kilogramforce per square cm (kgf/cm^2)
(in German kp/cm^2 instead of kgf/cm^2)
= 1 Bar (bar)
= 10 N/cm^2
= 1.0197 kgf/cm^2
= 10^6 $dyne/cm^2$
= 750 Torr

1 Torr (Torr) = 1 mm of mercury column
= 1.36 cm of water column
= 1.36×10^{-3} kgf/cm^2

1 Pound per square inch (psi) = 7.03×10^{-2} kgf/cm^2
= 6.89×10^{4} dyne/cm^2
= 0.689 N/cm^2

Energy equivalents:

1 Joule (J) = 10^7 Erg (erg)

1 kilogramforce centimetre (kgfcm) = 1 kpcm
= 9.81×10^{-2} J

1 footpoundforce (ftlb) = 1.36 J
= 13.8 kgfcm

1 kilogram calorie (Kcal) = 4.187×10^{3} J
= 4.27×10^{4} kgfcm
= 3.97 Btu

1 British thermal unit (Btu) = 0.253 kcal

1 kilowatt hour (KWh) = 3.67×10^{7} kgfcm
= 8.6×10^{2} kcal

Units of temperature:

Thermal expansion:

x° F = $\frac{5}{9}$ $(x-32)^{\circ}$C

in/in.$^{\circ}$F = $\frac{5}{9}$ cm/cm$^{\circ}$C

Coefficient of thermal conductivity:

x Btu/in. sec. $^{\circ}$F = 1.24 x cal/cm. sec.$^{\circ}$C

x Btu/ft. h. $^{\circ}$F = 1.488 x kcal/m.h.$^{\circ}$C

4. PROCESSING PROPERTIES AND ANALYTICAL METHODS; DEFINITION OF TERMS

See also:

ISO R 472 (with supplements):	Definition of terms
ASTM E 6:	Definitions
ASTM D 883:	Definitions
BS 1755:	Definitions
DIN 7732:	Definitions
ISO R 194:	List of equivalent terms
BS 3502:	List of plastic trade names
DIN 7730:	List of plastic trade names

Accelerator - Beschleuniger - Accélérateur:

A substance used in small portions in order to support the efficacy of catalysts.

Acid value - Säurezahl - Indice d'acide:

The number of milligrammes of KOH required to neutralize the alkali-reactive groups in 1 g of material under the conditions of test.

Adhesive - Klebstoff - Adhésif:

A general term for non-metallic materials that can join bodies by superficial adhering and internal strength, the structure of the body being unchanged. Adhesives soluble in water are called "Glues" (Leim, Colle).

Annealing (Stoving after bake) - Wärmenachbehandlung (Temperung) - Etuvage après cuisson:

Subsequent heat treatment of already shaped products in order to compensate for internal stresses.

Antioxidant - Antioxydans - Antioxydant:

A substance used to retard deterioration caused by oxidation.

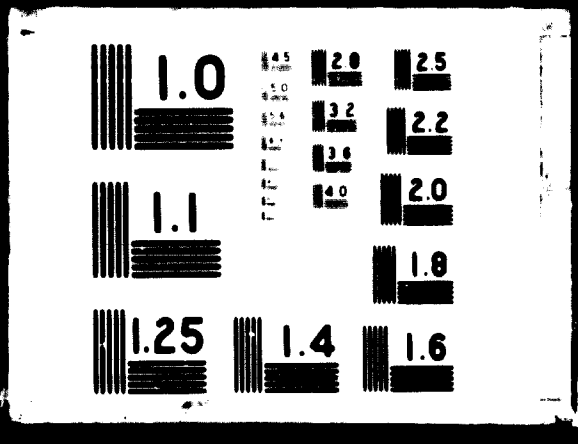
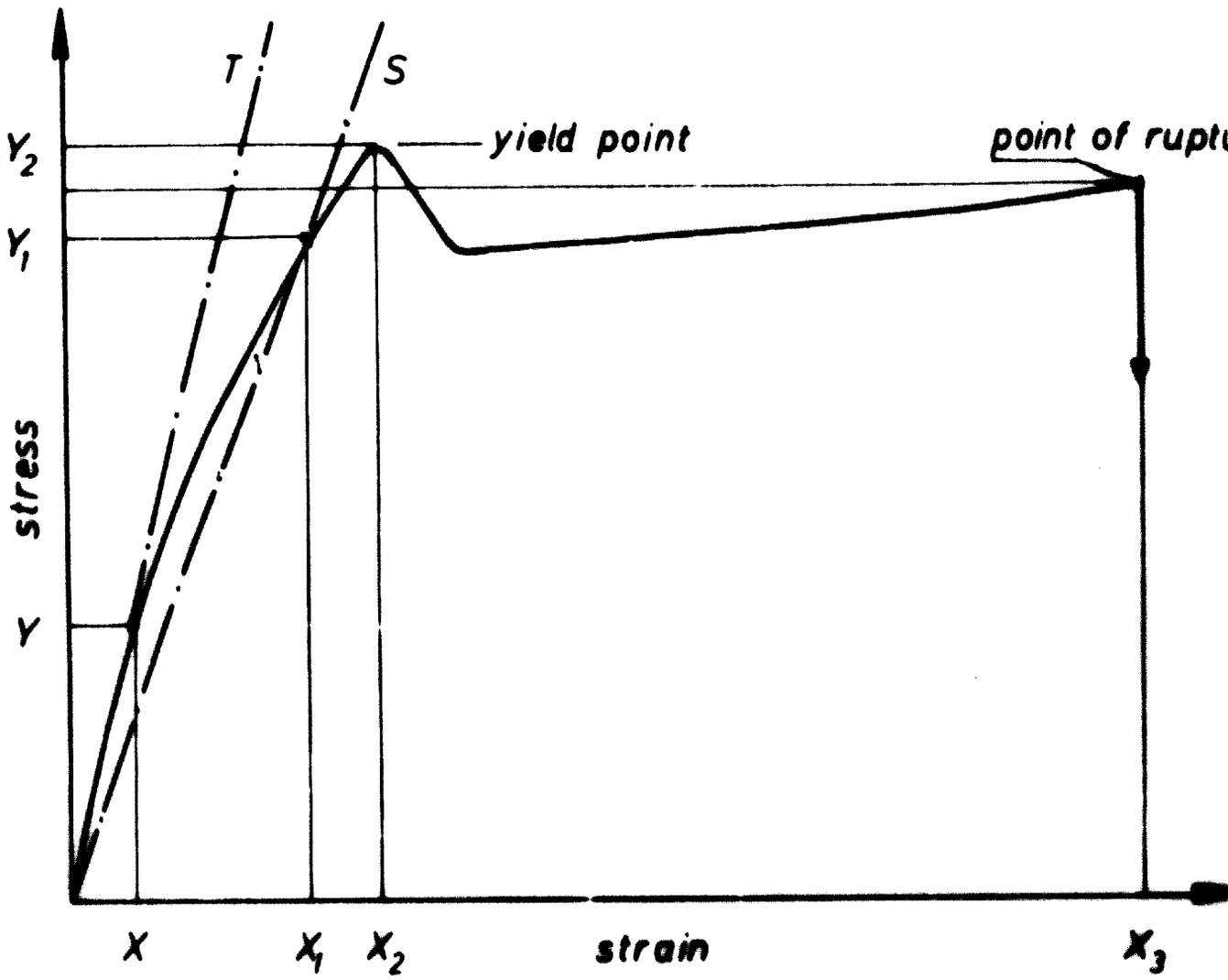


Figure 1

Scheme of a stress-strain curve



T ..... Tangent Modulus (Y/X)

S ..... Sécant Modulus (Y_1/X_1)

Yield point (stress: Y_2 ; strain: X_2)

X_3 ..... Strain at break

Y ..... Proportional limits

Flexural Strength

ASTM D 790:	Rigid plastics	p.s.i.	(+)	26/
ISO R 178:	Rigid plastics	kgf/cm^2	(+)	
BS 2782-304:	Rigid plastics	kgf/cm^2	(+)	
DIN 53452:	Rigid plastics	kgf/cm^2	(+)	
AFN T 51-001:	Rigid plastics	kgf/cm^2	(+)	
DIN 53452:	Rigid plastics (small specimens)	kgf/cm^2	0	
DIN 53423:	Cellular plastics (rigid)	kgf/cm^2	0	

26/ On principle the procedures are the same but there are some differences regarding specimen dimensions and widths between the supports. If experimental conditions are kept approximately equal the results are comparable.

Folding Endurance

ASTM D 643:	Films	number	0	
ASTM D 2176:	Films	number	0	
DIN 53359:	Leather cloth	number	0	
DIN 53522:	Vulcanized rubber	scale value	+	27/
ISO R 173:	Vulcanized rubber	scale value	+	
DIN 53522:	Vulcanised rubber	number	+	28/
ISO R 173:	Vulcanised rubber	number	+	

27/ These two standards are based on the determination of resistance to flex cracking.

28/ These two test methods measure the resistance to crack growth.

Hardness

ASTM D 1706:	Plastics	scale value	(+)	29/
ISO R 868:	Plastics	scale value	(+)	
DIN 53505:	Vulcanized rubber:	scale value	(+)	
ASTM D 2240	Plastics and rubber	scale value	(+)	
ASTM D 785:	Plastics	scale value	(+)	30/
ISO R 80:	Plastics	scale value	(+)	
BS 891:	Plastics	scale value	(+)	
DIN 50103:	Plastics	scale value	(+)	
DIN 53456:	Plastics	kgf/cm^2	0	
AFN T 51-024:	Plastics	N/mm^2	0	
DIN 53519:	Vulcanized rubber	scale value	+	31/
ISO R 48:	Vulcanized rubber	scale value	+	
BS 2782-307:	PVC plasticised	scale value	0	
DIN 53576:	Cellular plastics (soft)	kgf	(+)	32/
AFN T 56-111	Cellular plastics (soft)	kgf	(+)	

29/ All four standards use as a measuring device a durometer (Shore hardness; three types: A,C and D). Results are comparable if obtained with durometers of the same type.

30/ These methods yield scale values according to Rockwell (E-, L-, M- and R- scale): a comparison of results is only possible if they are based on the same Rockwell-scale.

31/ The results of these two methods are expressed in units of the "IRH-scale".

32/ Results are comparable if identing tools of the same dimensions are used.

Impact Strength (Charpy method)

(a) Unnotched specimens

ASTM D 256:	Rigid plastics	ftlb/in	0
ISO R 179:	Rigid plastics	kgfcm/cm^2	+
BS 2782-306 D:	Rigid plastics	kgfcm/cm^2	+
DIN 53453:	Rigid plastics	kgfcm/cm^2	+
AFN T 51-035:	Rigid plastics	kgfcm/cm^2	+

(b) Notched specimens

ASTM D 256 B:	Rigid plastics	ftlb/in	+	11/
BS 2782-306 E:	Rigid plastics	ftlb/in	+	
ISO R 179:	Rigid plastics	kgfcm/cm^2	0	
DIN 53453:	Rigid plastics	kgfcm/cm^2	0	
AFN T 51-035:	Rigid plastics	J/cm^2	0	

11/ Results are comparable but it should be mentioned that the unit of measure is related to the width of the specimen whereas in most other cases the unit of measure is related to the cross section area of the specimen.

Impact Strength (Isod method; Dynstat method)

(a) Unnotched specimens

DIN 53453:	Rigid plastics (Dynstat*)	$kgfcm/cm^2$	0

(b) Notched specimens

ASTM D 256 A:	Rigid plastics	ftlb/in	+
ISO R 180:	Rigid plastics	kgfcm/cm	+
BS 2782-306 A:	Rigid plastics	kgfcm/cm	+
DIN 53453:	Rigid plastics (Dynstat*)	$kgfcm/cm^2$	0

* The Dynstat method is provided for very small test specimens and differs essentially from the Isod method.

Remark: Results of Isod method cannot be compared with those of the Charpy method because experimental devices as well as units of measurement are completely different.

Impact Strength (Falling Dart method)

BS 2782-306 B/C:	Rigid plastics	kgfom	0	
AFN T 54-013:	Decorative sheets	mm	0	
ASTM D 1709:	Films	gf	(+)	34/
BS 2782-306 F:	Films	kgf	(+)	34/

34/ A comparison of the results is possible if films of equal thickness are tested.

Tensile Impact Energy to Break

ASTM D 1882:	Rigid plastics	ftlb/s.i.	(+)	35/
DIN 53448:	Rigid plastics	kgfcm/cm^2	(+)	35/

35/ A comparison of the results is only admissible if the thicknesses of the specimens are the same.

Modulus of Elasticity

(a) Tension

ASTM D 638:	Rigid plastics	kgf/cm^2 (p.s.i.)	+
BS 2782-302 A:	Rigid plastics	kgf/cm^2 (p.s.i.)	+
DIN 53457:	Rigid plastics	kgf/cm^2	+
BS 2782-302 C:	PVC (plasticized)	kgf/cm^2	0

(b) Compression

ASTM D 695:	Rigid plastics	kgf/cm^2 (p.s.i.)	+
DIN 53457:	Rigid plastics	kgf/cm^2	+

(c) Bending

ASTM D 790:	Rigid plastics	kgf/cm^2 (p.s.i.)	+
BS 2782-302 D:	Rigid plastics	kgf/cm^2 (p.s.i.)	+
DIN 53457:	Rigid plastics	kgf/cm^2	+
ASTM D 747:	Rigid plastics	scale	0
AFN T 51-018:	Rigid plastics	N/mm^2	0

(d) Shearing

ASTM D 2236:	Rigid plastics	kgf/cm^2 (p.s.i.)	+
ISO R 537:	Rigid plastics	kgf/cm^2	+
DIN 53445:	Rigid plastics	kgf/cm^2	+

Shear Strength

ASTM D 732:	Plastics (thickness between 0.05 and 0.5 in)	kgf/cm^2 (p.s.i.)	(+)	36/
BS 2782-305 A/B:	Plastics	kgf/cm^2	(+)	36/
ASTM D 2344:	Reinforced plastics	kgf/cm^2 (p.s.i.)	(+)	36/
DIN 53422:	Cellular plastics (rigid)	kgf/cm^2	+	
AFN T 56-104:	Cellular plastics (rigid)	kgf/cm^2	+	

36/ Results are only comparable if the relative rate of shear is the same.

Tear Resistance

ASTM D 624 A/B:	Vulcanised rubber	lb/in	(+)	
BS 2782-308A:	Rubber and lastics	kgf/cm	(+)	37/
BS 1763:	PVC sheeting	gf/mil	(+)	
ASTM D 1004:	Films	lbs	0	

37/ Results are comparable if specimens of approximately the same thickness are used.

Shear stress - Scherspannung - Contrainte de cisaillement:

The stress or component of stress acting tangential to a given plane.

Shear strength - Scherfestigkeit - Résistance au cisaillement:

The ability of a material to withstand shear stress. The shear strenghth is calculated from the maximum load during a shear or torsion test and is based on the original cross-section area of the specimen.

Shear modulus: see Torsional modulus.

Strain - Verformung - Déformation:

The change, due to force, in the size of a body referred to its original size. It is a non-dimensional entity, but is frequently expressed in cm per cm or in % of the original size.

Stress - Spannung - Contrainte:

The intensity at a point in a body of the internal forces or components of force that act on a given plane through the point. It is expressed in force per unit of area (kgf/cm^2 or p.s.i.).

Normal stress - Perpendikularspannung - Contrainte normale:

The stress or component of stress acting perpendicular to a given plane (symbol: σ).

Stress relaxation - Spannungrelaxation - Relaxation en contrainte:

The time-dependant decrease in stress when the specimen is held at constant strain.

Stress-strain curve - Kraft-Verformungsdiagramm - Courbe contrainte-déformation:

A diagram in which corresponding values of stress and strain are plotted against each other (see figure 1). How far stress-strain curves can be influenced by experimental conditions (thickness of the specimen, strain rate etc.) and how important it is therefore to preserve exactly the experimental conditions specified in the standards is demonstrated in figure 2, where tests on a high density polyethylene are given.

Tear Propagation Resistance

(a) Elmendorf Test

ASTM D 1922:	Films	gf	+	38/
BS 2782-308 B:	Films	gf	+	

(b) Graves Test

ASTM D 624 C:	Vulcanised rubber	lbs/in	+
DIN 53515:	Rubber and plastic films (sheets)	kgf/cm	+
DIN 53575:	Cellular plastics (elastic)	kgf/cm	+
APM T 56-109:	Cellular plastics (elastic)	kgf/cm	+

(c) Slotted strip Test

ASTM D 1938:	Films and sheets	kgf	+
DIN 53356:	Leather cloth	kgf	+
DIN 53507:	Vulcanised rubber	kgf/cm	0

38/ The Elmendorf test has been developed for paper but can also be applied to plastic films of relatively low extensibility.

Tensile Strength

ASTM D 638:	Plastics	p.s.i.	(+)	39/
ISO R 527:	Plastics	kgf/cm^2	(+)	
BS 2782-301:	Plastics	kgf/cm^2	(+)	
DIN 53455:	Plastics	kgf/cm^2	(+)	
AFN T 51-034:	Plastics	kgf/cm^2	(+)	
ASTM D 651:	Electrical insulation materials	p.s.i.	(+)	
ISO R 37:	Vulcanized rubber	kgf/cm^2	(+)	39/
ASTM D 412:	Vulcanized rubber	kgf/cm^2	(+)	
DIN 53504:	Elastomer	kgf/cm^2	(+)	
DIN 53371:	Films	kgf/cm^2	(+)	39/
ASTM D 1923:	Films (thin sheetings)	kgf/cm (p.s.i.)	(+)	
ASTM D 882:	Films	kgf	(+)	
DIN 53354:	Leather cloth	kgf	(+)	
ASTM D 1623:	Cellular plastics, rigid	kgf/cm^2 (p.s.i.)	(+)	39/
AFN T 56-103:	Cellular plastics, rigid	kgf/cm^2	(+)	
DIN 53571:	Cellular plastics (soft)	kgf/cm^2	(+)	39/
AFN T 56-108:	Cellular plastics (soft)	kgf/cm^2	(+)	
ASTM D 1708:	Plastics (small specimens)	p.s.i.	0	
ASTM D 2289:	Plastics (with high strain rates)	p.s.i./	0	

39/ Results are comparable only if they are determined under equal conditions of specimen length and strain rate.

Time dependance of mechanical properties

(a) Tensile stress

ASTM D 674:	Plastics	in/in; (%)	(+)	40/
ISO R 899:	Plastics	cm/cm; (%)	(+)	40/
DIN 53444:	Plastics	kgf/cm^2	(+)	40/
DIN 53441:	Plastics		0	

(b) Compressive stress

ASTM D 621:	Plastics	%	0	
ASTM D 674:	Plastics	%	0	
DIN 53517:	Vulcanised rubber	%	0	
DIN 51955:	Plastic flooring	mm	0	
DIN 53572:	Cellular plastics (flexible)	%	+	
AFN T 56-112:	Cellular plastics (flexible)	%	+	

(c) Dynamic stress

ASTM D 671:	Plastics		(+)	41/
AFN T 51-018:	Plastics		(+)	41/
DIN 53574:	Cellular plastics (flexible)		(+)	42/
AFN T 56-114:	Cellular plastics (flexible)		(+)	42/

40/ The results refer to creep behaviour depending on time (according to ASTM D 674 also at various temperatures). A comparison of the results is only possible if tensile stress, temperature and duration of test are the same.

41/ The fatigue in case of alternating bending stresses is appropriately illustrated by graphical representations of the dependences between stress (or strain) and the number of load cycles. A comparison of results is only meaningful if specimens of equal shape are tested at equal stress or strain amplitude and at approximately equal frequency. These conditions are particularly important for thermoplasts because in case of alternating stress at longer duration an internal warming of the specimen occurs, which influences essentially its physical appearance and consistency.

42/ A comparison of characteristic spring curves before and after dynamic stress is suitable for the determination of the fatigue of flexible cellular plastics at dynamic compression or shear stresses.

6. THERMAL PROPERTIES - DEFINITION OF TERMS

Brittleness temperature - Sprödigkeitstemperatur - Température de fragilité:

It is the temperature at which plastics and elastomers exhibit brittle failure under specified impact conditions.

Burning rate - Geschwindigkeit der Brandfortpflanzung - Vitesse de la propagation du feu:

It is the rate at which burning spreads in a specimen ignited in a specific way.

Coefficient of cubic thermal expansion - Kubischer Ausdehnungs-Koeffizient - Dilatation thermique en volume:

The reversible change in volume of a material per volume unit per degree change in temperature.

Coefficient of linear thermal expansion - Linearer thermischer Ausdehnungskoeffizient - Coefficient de dilatation thermique linéaire:

The reversible change in length of a material per unit length per degree change in temperature.

Flammability - Entflammbarkeit - Inflammabilité:

Behaviour of a specimen if it is exposed to a flame or to a temperature prevailing in a flame (temperature between 750° and about 1000°C).

Glass transition temperature (Second order transition point) - Glasumwandlungstemperatur (Umwandlungspunkt zweiter Ordnung) - Température de transition vitreuse:

The temperature which characterizes the transition of amorphous and partially crystalline polymers from their solid state to a viscous or rubbery one or vice versa. This transition generally occurs over a relatively narrow temperature region and is similar to the solidification of a liquid to a glassy state; it is not a phase transition. Not only do hardness and brittleness undergo rapid changes in this temperature region but other properties such as thermal expansibility and specific heat also change rapidly.

Incandescence resistance - Glutbeständigkeit - Résistance à la incandescence:

Behaviour of a rod shaped specimen which is in direct contact with an incandescent body.

Resistance to heat - Hitzebeständigkeit - Résistance à la chaleur:

The highest temperature which a material can temporarily or permanently withstand without appreciable deterioration of its properties.

Self ignition temperature - Selbstentzündungstemperatur - Température d'autoinflammation:

The minimum initial temperature at which the self-heating properties of a material lead to ignition. Self ignition temperature depends on specimen size, heat loss conditions and other variables, e.g. moisture content.

Softening range - Erweichungsbereich - Zone de ramollissement:

The temperature range in which a plastic changes from a rigid to a soft state.

Specific heat - Spezifische Wärme - Chaleur spécifique:

The quantity of heat which must be supplied to the mass unit of a material in order to raise its temperature by one degree.

Temperature of deflection under load - Formbeständigkeit in der Wärme - Température de fléchissement sous charge:

The temperature at which a specimen submitted to a given bending stress and heated according to a specific temperature programme reaches a certain deflection.

Temperature of thermal decomposition with evolution of flammable gases - Zersetzungstemperatur, bei der brennbare Gase abgespalten werden - Température de décomposition thermique avec formation de gas combustibles:

It is the temperature at which a material under specified conditions decomposes only at which flammable gases are evolved.

Thermal conductivity - WÄrmeleitfÄhigkeit WÄrmeleitzahl - Conductivité thermique:

The rate of heat flow under steady conditions through unit area per unit temperature gradient in the direction perpendicular to the area.

Vicat softening point - Erweichungspunkt nach Vicat (Vicatzahl) - Température de ramollissement Vicat:

The temperature at which a standard flat-ended needle under a specified load and a uniform rate of temperature rise penetrates a specimen to a defined depth.

6.1 THERMAL TESTS

Brittleness Temperature

ASTM D 746:	Plastics and elastomers	°F; °C	+	)
ISO R 974:	Plastics and elastomers	°C	+	)
ASTM D 1790:	Films	°F; °C	0	
BS 2782-104 A:	PVC plasticised	°C	0	
BS 2782-104 C:	PVC plasticised	%	0	

Ignition Temperature

ASTM D 1929:	Plastics	°F; °C	(+)	43/
ISO R 871:	Plastics	°C	(+)	
DIN 53436:	Plastics	°C	(+)	

43/ Since in these experiments the temperature of self-ignition as well as of flash ignition is determined, a comparison of the results is only possible if related to the same ignition method.

Incandescence Resistance

ASTM D 757:	Plastics (self extinguishing)	°F	(+)	
BS 2782-508 B:	Plastics (self extinguishing)	°C	(+)	
ISO R 181:	Plastics (self extinguishing)	°C	(+)	44/
DIN 53459:	Plastics (self extinguishing)	°C	(+)	
AFM T 51-015:	Plastics (self extinguishing)	°C	(+)	

44/ The cross section areas of the test specimens are slightly different depending on the standard used; results are reported as "quality coefficient" or as "incandescence resistance" and are approximately equal according to size.

Thermal conductivity

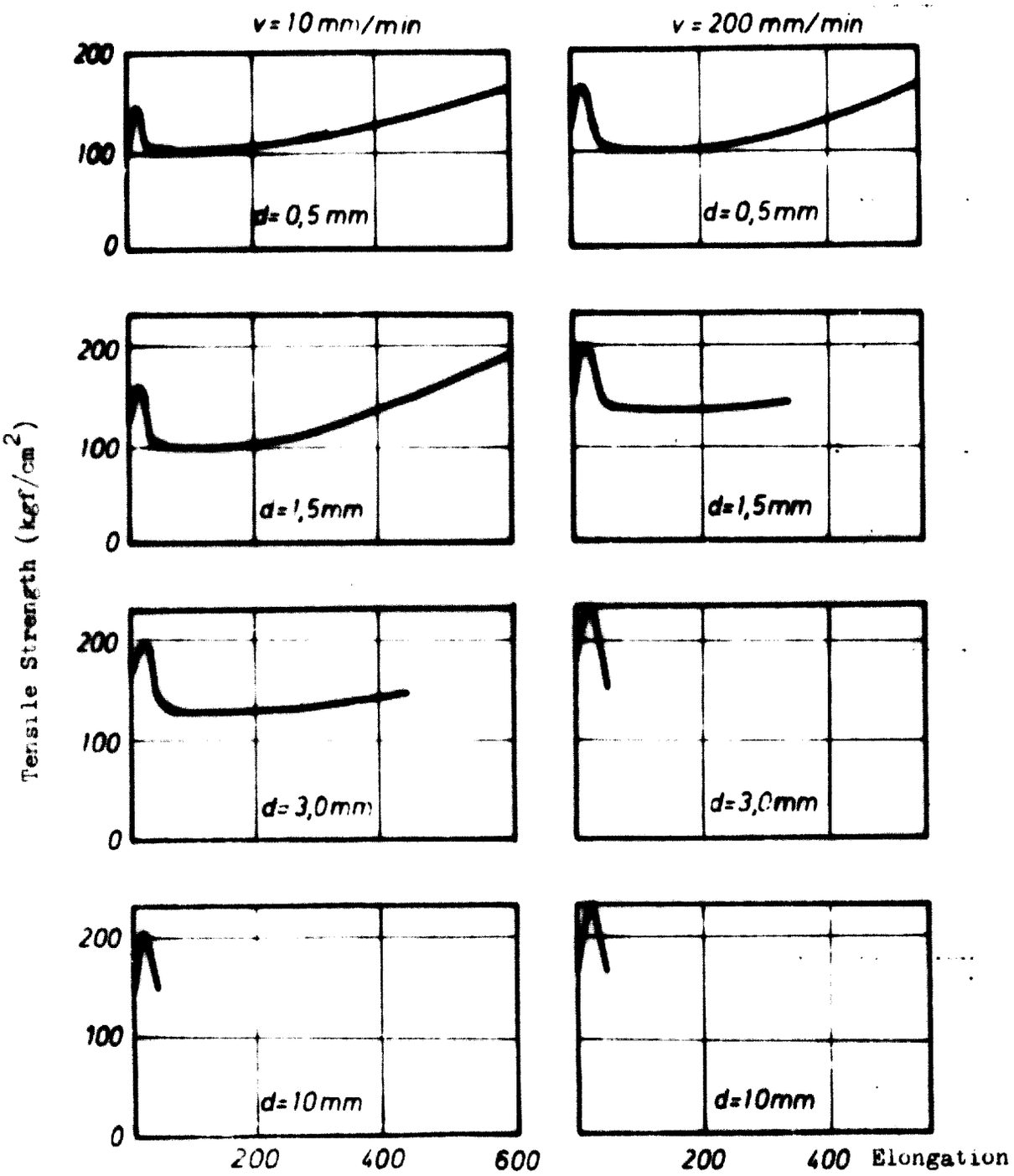
ASTM C 177:	Sheets and plates	(+)	45/
BS 874:	Sheets and plates	(+)	
DIN 52612:	Sheets and plates	(+)	
DIN 52613:	Tubes	(+)	
ASTM D 2326:	Cellular plastics (rigid)	(+)	

45/ In general the thermal conductivity of a substance is expressed in (cal/cm.sec.°C) or in (kcal/m.h.°C); in American or British standards another unit of measure (BTu. in/sqft.hr.°F) is frequently used. A comparison of the results is possible if they are expressed in the same unit of measurement.

It should be noted however that the experimentally determined value for the thermal conductivity is valid only within a certain temperature range.

Figure 2

Stress-strain curves of rods (50mm long, 10mm broad) of HD-Polyethylene at 20°C



v ..... strain rate

d ..... thickness of the specimen

Thermal decomposition

DIN 53381:	PVC and PVC compounds	min	(+)	
ISO R 182:	PVC and PVC compounds	min	(+)	46/
BS 2782-109A:	PVC and PVC compounds	min	(+)	
DIN 53381:	PVC and PVC compounds	min	(+)	
ISO R 305:	PVC and PVC compounds	min	(+)	47/
ASTM D 2115:	PVC and PVC compounds	min	(+)	
ASTM D 793:	PVC and PVC compounds	mg HCl	0	

46/ The criterion is the interval of time before HCl is split off (proved by Congo-red paper). The testing temperature is different depending on the composition of the mixture (in most cases about 177° to 180°C).

47/ Test procedures are similar to those summed up under 46/. The criterion is the interval of time before the first discolouration occurs. Discolouration however differs not only in intensity but also in colour shade.

Thermal Expansion

(a) Coefficient of linear thermal expansion

ASTM D 696:	Plastics	cm/cm

(b) Coefficient of cubic thermal expansion

ASTM D 864:	Plastics	cm^3/cm^3

Temperature of deflection under load

ASTM D 648:	Plastics	°F;	°C	(+)	48/
ISO R 75:	Plastics		°C	(+)	
DIN 53461:	Plastics		°C	(+)	
AFNOR T 51-005:	Plastics		°C	(+)	
BS 2782-102 G:	Plastics		°C	(+)	
BS 2782-102 H:	Plastics		°C	(+)	
DIN 53458:	Plastics		°C	0	
BS 2782-102 C:	Plastics		°C	0	
ASTM D 1637:	Plastic sheetings		°C %	0	

48/ Results are mutually comparable if bending stress, specimen thickness and deflection are equal.

Vicat softening point

ASTM D 1525:	Plastics	°C	(+)	49/
ISO R 306:	Plastics	°C	(+)	
BS 2782-102 D:	Plastics	°C	(+)	
BS 2782-102 F:	Plastics	°C	(+)	
BS 2782-102 J:	Plastics	°C	(+)	
DIN 53460:	Plastics	°C	(+)	
AFN T 51-021:	Plastics	°C	(+)	

49/ All these standards are based on the same procedure. The results can be compared if the experiments are carried out under equal conditions (selection of the load as well as of the indentation depth).

Temperature dependence of plastics properties

DIN 53446:	General			50/
ASTM D 759:	Plastics	0	0	51/
BS 2782-102:	Plastics	% °C	0	
ASTM D 674:	Plastics	% °C	0	52/
ASTM D 1637:	Plastic sheetings	% °C	0	52/
ASTM D 758:	Plastics	ftlb/in (°C)		53/
ASTM D 1043:	Plastics	°C	(+)	
ISO R 458:	Plastics	°C	(+)	
BS 2782-104 B:	Plastics	°C	(+)	54/
DIN 53447:	Plastics	°C	(+)	

50/ This standard contains general information on the determination of relationships between temperature, time and property values.

51/ This standard refers to the determination of the temperature dependence of tensile or compressive stress. Either stress or deformation values at certain predetermined temperatures are measured or the temperature is determined at which those properties attain a specified value. It is very informative to represent graphically the property values corresponding to a certain temperature range.

52/ The elongation or compression of the specimen under permanent load in dependence on stress and temperature is measured.

53/ The standard refers to the temperature dependence of impact resistance.

54/ All these standards are based on the torsion test according to Clash and Berg. Furthermore with the help of this method the dependence on temperature in the torsional modulus is determined. Mostly however the temperature is measured at which the torsional modulus attains a specified value.

6.2 INFLAMMABILITY

Under the influence of fire the behaviour of plastics is affected by numerous outside factors and by some specific properties of the materials. Important are not only the flash point, the heat at combustion and the formation of gases promoting or inhibiting combustion but also the ratio between weight and surface area of the test specimen as well as its position (horizontal, vertical or inclined) and consequently the possibilities of removing the products at combustion and of supplying fresh air. The complexity of these circumstances and the impossibility of expressing inflammability in a rational system of measurement makes it necessary to develop a great number of quantitative test methods which enable a descriptive representation of the inflammability. This will refer less to the material itself but rather of the actual product under consideration. Therefore tests must be subdivided between material and product tests cannot be avoided. Besides the ignition and incandescence tests which measure the flash point or the incandescence resistance of the specimen in direct contact with an incandescent rod of 950°C other methods are also used which determine the ignition either by contact with a defined flame over a certain time or by means of a heating wire wound around the specimen.

(a) Inflammability (horizontal position of specimen)

ASTM D 229:	Electrical insulating materials	sec %	0
ASTM D 635:	Plastics (rigid)	inch/min	0
BS 2782-508 A:	Plastics (rigid)	inch/min	0
ASTM D 1692:	Cellular plastics (rigid)	inch/min	0

(b) Inflammability (inclined position of specimen)

BS 2782-508 D:	Sheets (rigid)	cm^2/sec	0
ASTM D 1433:	Films	inch/min	0

(c) Inflammability (vertical position of specimen)

ASTM D 568:	Films	inch/min	+
BS 2782-508 B:	Films	inch/min	+
BS 1763:	Films	inch/min	+
BS 476/2:	Films	inch/min	+
BS 2782-508 B:	PVC (extruded sheets)	inch/min	+
DIN 53438:	Plastics (rigid)	sec	0

(d) Inflammability (other types of material tests)

BS 2782-508 C:	Films	inch	0	55/
DIN 53382:	Films	min	0	56/
BS 1330:	Plastics	visual	0	57/
DIN 4102:	Building materials	kg; °C	0	58/
ASTM E 160:	Building materials	%	0	59/
ASTM E 162:	Building materials		0	60/
ASTM E 84:	Building materials	scale	0	61/
BS 476/1:	Building materials		0	62/
ASTM D 229/II:	Electrical insulating materials	sec; %	0	63/

55/ Films semicircularly clamped and ignited at one end.

56/ Films vertically clamped over a domed surface and ignited on surface area.

57/ Small specimens exposed to a temperature of 950°C and evaluated visually.

58/ Specimens brought into a combustion stack and ignited from below.

59/ Specimens stapled in a heating chamber and stored at 315°C; the loss in weight being determined.

60/ Specimens exposed to radiation heat.

61/ Behaviour of a specimen in a stream of hot air compared with the behaviour of red beech wood.

62/ Flame propagation on the surface of the specimen.

63/ Specimen wound round a mandrel; time to catch fire, burning time and loss in weight are determined.

(e) Inflammability (product tests)

DIN 51960:	Floorings	cm^2	0	64/
DIN 51961:	Floorings	visual	0	65/
ASTM D 350:	Hoses and tubes	cm/min	0	66/
ASTM D 876:	Hoses and tubes	cm/min	0	66/
ASTM D 470:	Electrical cables (rubber)	cm	0	
ASTM D 734:	Electrical cables (PVC)	sec	0	
ASTM D 626:	Textile fabrics	cm^2	0	67/
DIN 51906:	Textile fabrics	cm^2; sec	0	67/
DIN 51907:	Textile fabrics	cm^2; sec	0	67/

64/ Combustibility of flooring is determined.

65/ Resistance to glowing cigarettes is tested.

66/ The two methods differ insofar as the specimens are tested either in vertical (ASTM D 350) or in inclined positions (ASTM D 876).

67/ These standards refer to the testing of textile fabrics but are often used for the evaluation of plastic films and artificial leather.

7. ELECTRICAL PROPERTIES - DEFINITION OF TERMS

Arc resistance - Lichtbogenfestigkeit - Résistance a l'arc incandescant:

On the surface of the specimen between two electrodes an electric arc is produced by alternating current whose power and duration is increased in a specified manner. The time interval is measured after which surface destruction of the specimen can be observed.

Breakdown voltage - Durchschlagspannung - Tension disruptive:

The voltage necessary to produce a distruptive discharge between two conductors (electrodes) separated by the specimen. Besides the breakdown voltage produced by a gradual increase of voltage often the highest value of voltage is determined which can be applied during a specified time without causing breakdown.

Dielectric constant (Relative permitivity) - Dielektrizitätskonstante - Constante diélectrique (permittivité relative):

The ratio of capacitance of a capacitor in which the space between and around the electrodes is entirely and exclusively filled with the insulating material in question to the capacitance of the same configuration of electrodes in vacuum (Symbol: ε).

Dielectric dissipation factor (Loss factor) - Dielektrischer Verlustfaktor - Facteur de dissipation (Facteur de perte diélectrique):

The tangent of the loss angle by which the phase shift between current and voltage of a condenser filled by the respective material deviates from $\pi/2$ (Symbol: $\tan\delta$).

Dielectric strength - Durchschlagsfestigkeit - Rigidité diélectrique:

The property of a dielectric which opposes a disruptive discharge. It is measured by the intensity of the electric field which will break down the dielectric.

Tangent modulus - Tangentenmodul - Module tangeant:

The slope of the stress-strain curve at any specified stress or strain (see figure 1).

Tear resistance - Einreissfestigkeit - Résistance à la déchirure:

The ability of a material (film) to withstand tearing. It is a complex function of its ultimate resistance to rupture.

Tear propagation resistance - Weiterreissfestigkeit - Résistance à une déchirure amorcée:

The ability of a material to withstand a propagation of an existing single slit or nick until rupture of the specimen.

Tensile strength - Zugfestigkeit - Résistance à la traction:

The ability of a material to withstand tensile stress. In practice the tensile stress is gradually increased until rupture. Normally the tensile strenghth is calculated from the maximum load and the original cross section area of the specimen.

Time dependance of mechanical properties - Beeinflussung mechanischer Eigenschaften durch die Dauer der Krafteinwirkung - Dépendance des propriétés méchaniques de la durée de l'agissement d'une force extérieure:

If external forces are effective for a longer period of time the deformation increases with advancing time (cold flow or creep). At constant deformation the stress decreases gradually (stress relaxation). If the stress is kept constant the deformation increases gradually (creep test - zeitstandversuch - Essai de fluage). The stress can be a tensile, compressive or bending one.

Torsional modulus (Shear modulus or Modulus of rigidity) - Torsionsmodul (Schubmodul) - Module de torsion (Module de cisaillement ou Module de rigidité):

The quotient of the shear stress and the elastic torsional deformation resulting therefrom as long as the latter lies within the range of Hooke's law i.e. the torsional deformation is very small (Symbol: G).

Electrostatic charge - Elektrostatische Aufladung - Charge électrostatique:

Upon rubbing or merely touching a dielectric with another material (e.g. cat fur) electrostatic charges occur. Their values depend on the electrical properties of the rubbing partner and on the conductance of the material. Sometimes charges of several thousand volts can occur which then discharge producing sparks.

Glow discharge - Glimmentladung - Décharge luminescente:

Glow discharges are electrical discharges occurring in gaseous media between two electrodes separated by an insulating material.

Insulation resistance - Isolationswiderstand - Résistance d'isolement:

The insulation resistance between two electrodes that are in contact with or imbedded in a specimen is the ratio of the direct voltage applied to the electrodes to the total current between them at a given time after the application of that voltage. It is dependant upon both the volume and surface resistance of the specimen.

Insulation resistance between tapered pin electrodes - Widerstand im Inneren zwischen Stöpseln - Résistance d'isolement intérieur:

This is the insulation resistance between tapered pin shaped metallic electrodes which are imbedded in the insulating material in a standardised way.

Loss Index - Verlustzahl - Indice de perte:

The loss index of a dielectric material is equal to the product of its dielectric dissipation factor ($\tan \vartheta$) and its relative permitivity (ε).

Surface resistivity - Oberflächenwiderstand - Résistivité en surface:

The surface resistivity of a material is the electric potential gradient parallel to the direction of the current flow along its surface divided by the current per unit width of surface. It is numerically equal to the surface resistance between two electrodes forming opposite sides of a square. The size of the square is immaterial.

Volume resistivity - Spezifischer Durchgangswiderstand - Résistivité en volume:

The volume resistivity of a material is the electric potential gradient parallel to the direction of the current flow in the material divided by the current density. In the metric system volume resistivity of a material (in Ohm-cm) is numerically equal to the volume resistance between opposite faces of a centimetre cube of the material.

Tracking - Kriechstrombildung - Cheminement:

This is the formation of a carbonized conducting path across the surface of an insulating material between electrodes maintained at a given potential difference. It may be caused by the effect of a high-voltage low-current discharge, by impingement of a relatively low-voltage heavy-current arc on to the surface of the material or by the action of minute leakage currents initiated by the presence of excessive surface moisture or foreign matter.

7.1 ELECTRICAL TESTS

Arc resistance

ASTM D 495:	Electrical insulating materials	sec	0
DIN 53484:	Electrical insulating materials	sec	0

Dielectric constant

ASTM D 150:	Electrical insulating materials	(+)	68/
DIN 53483:	Electrical insulating materials	(+)	
BS 2782-205:	Electrical insulating materials	(+)	
BS 2782-206:	Electrical insulating materials	(+)	
BS 2782-207:	Electrical insulating materials	(+)	
ASTM D 669:	Laminates	0	
ASTM D 1673:	Cellular plastics	0	

68/ Values determined by different methods can only be compared if pretreatment of the specimen, frequency of the alternating current and experimental temperature are the same.

Dielectric dissipation factor

ASTM D 150:	Electrical insulation materials	tan ϑ	(+))	
BS 2782-205:	Electrical insulation materials	cos φ, tan ϑ	(+))	
BS 2782-206:	Electrical insulation materials	cos φ, tan ϑ	(+))	69/
BS 2782-207:	Electrical insulation materials	tan ϑ	(+))	
DIN 53483:	Electrical insulation materials	tan ϑ	(+))	
ASTM D 1673:	Cellular plastics	tan ϑ	0	
ASTM D 669:	Laminates	tan ϑ	0	

69/ A comparison of the results is only possible if the pretreatment of the specimen, frequency of the alternating current and experimental temperature are the same. The degree of frequency dependence varies considerably from material to material.

Dielectric strength

ASTM D 149:	Electrical insulation materials	V/mil	0
BS 2782-201 A-G:	Electrical insulation materials	V/mil; KV/mm	0
DIN 53481:	Electrical insulation materials	KV/cm	0

Electrostatic charge

DIN 53486:	Electrical insulating materials and rubber	V	0
DIN 51953:	Flooring	V	0

Glow discharge

DIN 53485:	Electrical insulating materials	V/sec	70/

70/ The behaviour at glow discharges is best represented by a series of curves which reflects the relationship between the voltage and the time necessary to produce the first glow discharge.

Insulation resistance between tapered pin electrodes

ASTM D 257:	Electrical insulating materials	ohm	+	}
DIN 53482:	Electrical insulating materials	ohm	+	}
BS 2782-202:	Electrical insulating materials	ohm	(+)	71/

71/ Results are only comparable with those of the other two standards if the pretreatment of the specimen and the voltage of the alternating current are the same.

Surface resistivity

ASTM D 257:	Electrical insulating materials	ohm	+	)
DIN 53482:	Electrical insulating materials	ohm	+	)
BS 2782-200 A:	Electrical insulating materials	ohm	(+)	72/

72/ A comparison of results obtained with those of the US and German standards is only possible if the same pretreatment and specimen and the same experimental temperature is observed.

Yield point - Streckgrenze - Seuil d'écoulement:

The lowest stress in a material and less than the maximum attainable stress, at which an increase in strain occurs without an increase in stress (see figure 1).

Volume resistivity

ASTM D 257:	Electrical insulating materials	ohm.cm	(+)	13/
DIN 53482:	Electrical insulating materials	ohm.cm	(+)	
BS 2782-202 A/B:	Electrical insulating material	ohm.cm	(+)	

13/ A comparison of the results is only possible if measurements are made at the same temperature.

Tracking resistance

ASTM D 2132:	Electrical insulating material	scale	0
DIN 53480:	Electrical insulating material	scale	0

8. AGEING PROPERTIES AND ENVIRONMENTAL INFLUENCES - DEFINITION OF TERMS

Abrasion strength - Abriebfestigkeit (Scheuerfestigkeit) - Resistance a l'abrasion (Usure):

The ability of a material to withstand grinding or chafing effects manifesting themselves at first by the loss of surface gloss and later by a loss in weight.

Ageing - Alterung - Vieillissement:

The change of properties of a material with time. Also the process of exposing a material to an environment for an interval of time.

Bleeding (of colourants) - Ausbluten (von Farbstoffen) - Migration (de colorants):

The transfer of colourants from coloured plastics to plastics or to other materials which are in close contact with them.

Chemical Resistance - Chemikalienbeständigkeit - Resistance chimique:

The ability of a material to resist chemical effects caused by oxygen, humidity, chemicals, gases and vapours.

Dimensional stability - Dimensionsstabilität (Masshaltigkeit) - Stabilité dimensionelle:

The ability of a material to maintain its shape with changes in the nature or condition of its environment and, more particularly with variation in atmospheric humidity.

Fungus resistance - Beständigkeit gegen Mikroorganismen - Resistance aux moisissures:

The ability of a material to resist micro-organisms (bacteria and fungi) even under conditions which are particularly favourable for the growth of such micro-organisms.

Light resistance - Lichtechtheit - Resistance a la lumière:

The resistance of a material to change in colour under the influence of light. The property is evaluated by exposure of a sample of material to daylight or to an agreed source of artificial light. In order to control the influence of light, a reference sample of a known light resistance is exposed simultaneously with the test specimen to light of a specific radiation source.

Migration of plasticizers - Weichmacherabgabe (Weichmacherwanderung) - Migration des plastifiants:

The transfer, usually undesirable, of a material from a plastic body to other contacting solids.

Stress cracking - Spannungsrissbildung - Fissures de contraints:

External or internal cracks in a plastic caused by stresses less than that of its short-time mechanical strength. The development of such cracks is frequently accelerated by the environment to which the plastic is exposed. The stresses which cause cracking may be present internally or externally, or may be combinations of these stresses.

Water absorption - Wasseraufnahme - Absorption d'eau:

The property of a material to absorb water. Water absorption is defined by the weight of water absorbed by a specimen immersed in water for a specified time at a specified temperature. If at the same time parts of the material are dissolved in water their quantity has to be added to the observed weight increase.

Water vapour absorption - Feuchtigkeitsaufnahme aus der Dampfphase - absorption de vapeur d'eau:

The property of a material to absorb moisture when exposed for a specified time at a specified temperature to an atmosphere of specified relative humidity.

Water vapour transmission - Wasserdampfdurchlässigkeit - perméabilité à la vapeur d'eau:

The ability of water vapour to permeate a material. Water vapour transmission can be defined by three terms:

(a) The rate of water vapour transmission (WVT) of a body between two specified parallel surfaces is the time rate of water vapour flow normal to the surfaces, under steady conditions, through unit area, under the conditions of test.

(b) The water vapour permeance of a body between two specified parallel surfaces is the ratio of its WVT to the vapour pressure difference between the two surfaces.

(c) The water vapour permeability of a homogeneous material is the product of its permeance and thickness.

It should be mentioned that permeance and permeability are functions of relative humidity and temperature.

Weathering - Bewitterung - Exposition aux intempéries:

Exposure of a specimen either to outdoor weathering or to accelerated climatic conditions produced in the laboratory by combined or alternating effects of light, oxygen, humidity, heat and cold.

8.1 TESTS OF AGEING AND OF ENVIRONMENTAL INFLUENCES

Abrasion Resistance

ASTM D 1044:	Transparent plastics	%	0
ASTM D 1242:	Plastics	cm^3	0
ASTM D 673:	Plastics (with glossy surface)	g	0
DIN 53516:	Vulcanized rubber	cm^3	0
DIN 51954:	Floorings	mg; mm	0
BS 2782-310 B:	Printed films	cycles	0

Bleeding of colourants

ISO R 183:	Coloured plastics	visual	(+)	14/
BS 2782-506 A:	Coloured plastics	visual	(+)	
DIN 53415:	Coloured plastics	visual	(+)	
AFN T 51-028:	Coloured plastics	visual	(+)	
BS 2782-506 C:	Polyethylene	visual	(+)	
BS 2782-506 B:	Cellulosics	visual	(+)	

14/ The results are comparable insofar as the tests are carried out at equal temperatures and with the same contacting materials absorbing the bleeding colourant.

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5.1 MECHANICAL TESTS

Bearing Strength

ASTM D 953:	Rigid plastics	p.s.i.	0	
ASTM D 2582:	Films or sheets	kgf	(+)	2/
DIN 53506:	Films or sheets	kgf	(+)	2/

2/ Results are only approximately comparable owing to small differences in test conditions.

Bending (flexibility)

BS 2782-309 A:	Rigid plastics	mm	0
ASTM D 747:	Rigid plastics	p.s.i.	0
DIN 51950:	Flooring (hard)	kgf/cm^2	0
DIN 51949:	Flooring (flexible)	scale	0

A comparison of results is impossible because completely different experimental arrangements are used (DIN 51949 is a bending test over a mandrel; ASTM D 747 and DIN 51950 determine the bending of a specimen loaded on one end or at the centre of it; according to BS 2782-309 A only the drop of the free end of the specimen without referring to its cross section is measured).

Compressive Strength

ASTM D 695:	Rigid plastics	kgf/cm^2 (p.s.i.)	(+)	24/
ISO R 604:	Rigid plastics	kgf/cm^2	(+)	
BS 2782-303:	Rigid plastics	kgf/cm^2	(+)	
DIN 53454:	Rigid plastics	kgf/cm^2	(+)	
ASTM D 1621:	Cellular plastics (rigid)	kgf/cm^2	+	
ISO R 844:	Cellular plastics (rigid)	kgf/cm^2	+	
DIN 53421:	Cellular plastics (rigid)	kgf/cm^2	+	
AFN T 56-101:	Cellular plastics (rigid)	kgf/cm^2	+	
ASTM D 621:	Cellular plastics (non rigid)		(+)	25/
DIN 53577:	Cellular plastics (non rigid)		(+)	
AFN T 56-110:	Cellular plastics (non rigid)		(+)	

24/ If functional relationships between stress and compression are determined (e.g. by a force/movement diagram) the results are to some extent comparable.

25/ If the degree and the duration of compression as well as the number of load changes are equal the results are to some extent comparable. Decisive for the evaluation is the characteristic spring curve (i.e. the load/deformation curve and the recovery curve) which then gives the hysteresis effect.

Delamination

DIN 53357:	Leather cloth	kgf	0
DIN 53463:	Rigid laminates	kgf	0

A comparison of results is impossible because DIN 53357 is based on a peeling tensile test, whereas DIN 53463 refers to a compressive clearing test.

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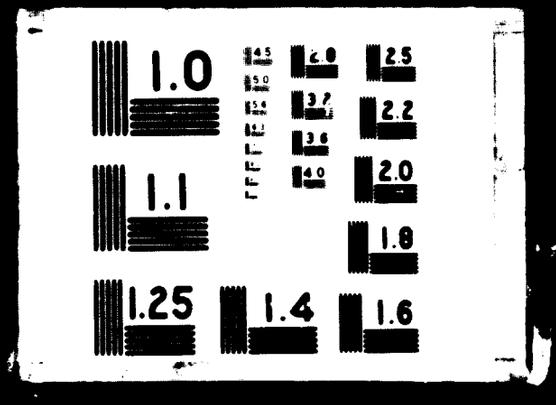


Chemical resistance

ASTM D 543:	Plastics	%, mm	(+)	75/
ISO R 175:	Plastics	%, mm	(+)	
DIN 53476:	Plastics	%, mm	(+)	
AFN T 51-029:	Plastics	%, mm	(+)	
AFN T 54-011:	Decorative laminates	mm	(+)	
ASTM D 543:	Plastics		(+)	76/
ISO R 462:	Plastics		(+)	
BS 2782-505 A:	PVC		(+)	
ASTM D 1239:	Films		(+)	
ASTM D 229:	Plastics	visual	0	
ASTM D 1712:	Plastics	visual	0	
ASTM D 2151:	PVC	visual	0	

75/ Besides visible changes those of weight and dimensions of the specimen serve as a criterion of the resistance to chemicals. Comparable values are obtained only if the same temperature and the same induction period is chosen and if the ratio between surface area and weight of the specimen is the same.

76/ The action of chemicals on certain properties (hardness, strength, deformation behaviour etc.) is examined. A comparison of results is only possible if the same experimental conditions are used (see footnote 75/).

Water vapour absorption

DIN 53473:	Plastics	mg	0
BS 2782-504:	Cellulosics	%	0

Water vapour transmission

ASTM E 96:	Plastic films	(+)	
ISO R 974:	Plastic films	(+)	91/
DIN 53122:	Plastic films	(+)	
BS 3177:	Plastic films	(+)	
BS 2782-513 A:	Plastic films	(+)	92/
BS 2782-513 C:	Plastic film bags	(+)	
BS 2782-513 B:	Plastic films	+	
BS 2782-513 D:	Plastic film bags	+	93/

91/ A comparison of the results is only meaningful if the tests are carried out on films of the same thickness as well as at the same temperature and humidity gradient.

92/ Tests are based on a temperature of 25°C and on a gradient of 75% against 0% relative humidity. A comparison of the results is possible if film thicknesses are the same.

93/ Test conditions are 38°C and gradient of 90% against 0% of relative humidity. Results are mutually comparable.

Gas transmission rate

ASTM D 1434:	Plastic films and sheeting	(+)	94/
BS 2782-514 A:	Plastic films and sheeting	(+)	

94/ Gas transmission rate is measured in cm^3 per m^2 per 24 hours per atmos, counted to standard conditions. It has to be noted that tests have always to be carried out with dry gases because humidity can have a considerable effect on the results.

Weathering

ASTM D 756:	Plastics	0	95/
ASTM E 42:	Plastics	0	95/
ASTM D 1435:	Plastics	0	96/
ASTM D 2565:	Plastics	0	97/
ASTM D 795:	Plastics	0	98/
ASTM D 1501:	Plastics	0	99/

95/ Repeated cycles of dry heat and humid heat are used.

96/ The evaluation of weather resistance is based on outdoor tests.

97/ An artificial weathering by Xenon light and water is used.

98/ An accelerated weathering with the help of a S-1 bulb and fog chamber is carried out.

99/ An artificial weathering with a fluorescent sun lamp and fog chamber is foreseen.

Remark: It should be mentioned that a complete imitation of all natural climatic conditions has not yet been successfully accomplished.

9. OPTICAL PROPERTIES - DEFINITION OF TERMS

Gloss - Glanz - Lustre (Brillance):

The degree to which a surface approaches perfect optical smoothness in its capacity to reflect light. Each specific method has its peculiar definition of gloss.

Haze - Trübung - Trouble:

Cloudy appearance within or on the surface of a plastic describable by the terms chalking, frosting or bloom. The haze number is the ratio between the intensity of light passing through the specimen within a certain cone of dispersion and the intensity of incident light.

Luminous transmittance - Lichtdurchlässigkeit - Transmission de lumière:

This is the ratio of transmitted light to incident light. The extinction coefficient is the reciprocal value of such a layer thickness (in cm) at which luminous transmittance equals 0.1.

Optical distortion - Optische Verzerrung - Deformation optique:

Any apparent alteration of the geometric pattern of an object when seen either through a plastic or as a reflection from a plastic surface.

Refractive index - Brechnungsindex (Brechungszahl) - Indice de réfraction:

It is the quotient $\sin \alpha / \sin \alpha'$ if α is the angle between the incident ray and the line perpendicular to the plane of the specimen facing the light ray and if α' is the angle between that perpendicular line and the emerging light ray. The refractive index depends on temperature as well as on the wavelength of the light. Usually the refractive index n is determined at 20°C and with monochromatic light of wavelength 5892 Å (D-line of sodium). The difference $(n_F - n_C)$ is called "optical dispersion". n_F and n_C are the refractive indices determined with light of the wavelength F (= 4861 Å) and C (= 6563 Å).

9.1 OPTICAL TESTS

Gloss (Luminous Reflectance)

ASTM D 791:	Plastics	O
ASTM D 523:	Plastics	O
ASTM D 2457:	Plastics	O
BS 2782-515 B:	Plastics	O

Haze

ASTM D 1003:	Plastics	%	(+)	100/
BS 2782-515 A:	Plastics	%	(+)	
DIN 53490:	Plastics	%	(+)	

100/ The results are only comparable if the tests are based on cones of dispersion having the same aperture angle.

Luminous Transmittance

ASTM D 791:	Plastics	%	+
ASTM D 1003:	Plastics	%	+
ASTM D 1746:	Plastics	%	+
DIN 5032:	Plastics	%	+
ASTM D 1494:	Plastics (reinforced)	%	0

Optical Distortion

ASTM D 881:	Plastics	visual

Dimensional stability

ASTM D 1042:	General			
BS 1763/D:	PVC sheetings	cm/cm; %	(+)	1/
BS 2782-106 F:	PVC films	cm/cm; %	(+)	
ASTM D 1204:	Films and sheets	cm/cm; %	(+)	
AFN T 54-008:	Decorative laminates	cm/cm; %	(+)	
BS 4370:	Cellular plastics (rigid)	%	0	

1/ A comparison of results is possible if the shape and size of the specimens as well as the temperature and duration of the thermal after-treatment which releases internal stresses are the same.

Refractive Index

ASTM D 542:	Plastics	+ } 101/
ISO R 489:	Plastics	+
DIN 53491:	Plastics	+

101/ The results are only exactly comparable if the measurements are carried out at the same temperature and wavelength of light.

10. QUALITY SPECIFICATIONS OF POLYMERS, MOULDING COMPOUNDS AND SEMI-FINISHED PRODUCTS

In general the foregoing standards have to be used for quality control but often they include also specific tests adapted to the material or to the products made of them. Since those specific test methods often differ considerably, no comparisons can be made. For the sake of completeness, however, the standards are listed in alphabetic order.

ABS-Polymers

ASTM D 1788	:	Rigid ABS-plastics

Acetal-Resins and Compounds thereof

ASTM D 2133	:	Plastic materials for injection moulding and for extrusion

Acrylics

ASTM D 702	:	Casting materials
ASTM D 788	:	Plastic materials for injection moulding and for extrusion
DIN 7745	:	Plastic materials for injection moulding and for extrusion
DIN 16945	:	Casting materials
ASTM D 1547	:	Extruded sheets

Allyl Resins and Compounds thereof

ASTM D 1636	:	Moulding compounds

Aminoplastics

DIN 7708	:	Moulding materials
ASTM D 704	:	Melamine moulding materials
BS 1322	:	Melamine moulding materials
ASTM D 705	:	Urea moulding materials
BS 2906	:	Mouldings
DIN 7735	:	Laminated sheets

Cellular Plastics

DIN 7726	:	General terms and properties
AFN T 56-001	:	General terms and properties
AFN T 56-200	:	Rigid cellular plastics
DIN 18164	:	Rigid cellular plastics in construction
ASTM D 1940	:	Porosity of cellular plastics
ASTM D 1638	:	Raw materials for polyurethane-cellular plastics
ASTM D 1786	:	Raw materials for polyurethane-cellular plastics
ASTM D 1717	:	Foaming agents for cellular plastics
ASTM D 1564	:	Flexible polyurethane-foams
ASTM D 2125	:	Polystyrene cellular plastics
AFN T 56-201	:	Polystyrene cellular plastics
AFN T 56-202	:	PVC cellular plastics
ASTM D 1565	:	Flexible PVC cellular plastics
DIN 7790	:	Rubber latex foams.

Celluloses

ASTM D 701	:	Cellulose nitrate plastics (sheets, rods, tubes)
ASTM D 706	:	Cellulose acetate moulding compounds
DIN 7742	:	Cellulose acetate moulding compounds
BS 1524	:	Cellulose acetate moulding compounds
ASTM D 786	:	Cellulose acetate (sheets)
ASTM D 1202	:	Cellulose acetate (sheets) for electrical insulation
ASTM D 1562	:	Cellulose propionate moulding materials
ASTM D 707	:	Cellulose acetate-butyrate moulding materials
DIN 7743	:	Cellulose acetate-butyrate moulding materials
ASTM D 1503	:	Cellulose acetate-butyrate pipes.

Laminated Decorative Sheets

BS 3794	:	Specification
DIN 16926	:	Specification
AFN T 54-010	:	Specification
DIN 53799	:	Methods of testing
AFN T 54-006	:	Abrasion resistance testing
AFN T 54-005	:	Scratch resistance testing
AFN T 54-010	:	Surface heat resistance testing.

Dimensional Tolerances

DIN 7710 Bl.1	:	Compression mouldings
DIN 7710 Bl.2	:	Injection mouldings.

Epoxy Resins and Plastics

ASTM D 1763	:	Resins
BS 3534	:	Resins
DIN 16945	:	Resins
DIN 16946	:	Thermoset castings
DIN 16912	:	Moulding materials.

Film, Sheet and Coated Fabrics

BS 1133	:	Film and sheets, general properties
AFN T 54-004	:	Film and sheets, general properties
ASTM D 2103	:	Polyethylene
DIN 16935	:	Polyisobutylene for construction purposes
ASTM D 1927	:	Rigid PVC sheets
DIN 16927	:	Rigid PVC sheets
ASTM D 1593	:	Flexible PVC sheets and films
BS 1763	:	Flexible PVC sheets and films
BS 3878	:	Flexible PVC sheets and films for hospital uses
DIN 16924	:	Calendered flexible PVC sheets and films
DIN 16950	:	PVC flooring
ASTM D 2123	:	Sheets of Vinyl-copolymers
ASTM D 1463	:	Styrene film (biaxially orientated)
ASTM D 1547	:	Extruded acrylic sheets
ASTM D 786	:	Films and sheets of cellulose acetate
ASTM D 1202	:	Films and sheets of cellulose acetate for primary electrical insulation
ASTM D 701	:	Sheets of cellulose nitrate compounds
DIN 40622	:	Laquered paper for electrical insulation
DIN 40623	:	Laquered fabric for electrical insulation
DIN 40632	:	Laquered glass-fabric for electrical insulation
DIN 16922	:	PVC leather-cloth
DIN 16923	:	Coated fabric.

Fluoroplastics

ASTM D 1457	:	Moulding material (Polytetrafluor-ethylene)
ASTM D 1430	:	Moulding material (Poly-chlorotrifluorethylene)
ASTM D 2116	:	Moulding material (Ethylene-propylene-fluorocarbon polymer)
ASTM D 1710	:	Rods of polytetrafluorethylene.

Laminated Sheets, Rods and Tubes

ASTM D 709	:	Laminated thermosetting products
DIN 7735	:	Laminated sheets
BS 2572	:	Laminated sheets
DIN 40605	:	Laminated sheets, paperbase
BS 1137	:	Laminated sheets, paperbase
BS 2076	:	Laminated sheets, paperbase
DIN 40606	:	Laminated sheets, fabricbase
BS 2966	:	Laminated sheets, fabricbase
ASTM D 229	:	Sheets and plates for electrical purposes
DIN 40802	:	Laminated sheets, copper-clad
DIN 7707	:	Laminated wood
BS 3953	:	Sheets of reinforced plastics
ASTM D 1919	:	Corrugated sheets of reinforced plastics
ASTM D 1502	:	Corrugated sheets of reinforced plastics, methods of testing
BS 3794	:	Decorative laminated sheets
DIN 16926	:	Decorative laminated sheets
AFM T 54-010	:	Decorative laminated sheets
BS 1885	:	Laminated tubes, rolled
BS 1951	:	Laminated tubes, rolled
DIN 40607	:	Laminated tubes, rolled
DIN 40615	:	Laminated tubes, rolled + moulded 
DIN 40616	:	Laminated tubes, rolled + moulded 
DIN 40617	:	Laminated tubes, rolled + moulded 
DIN 40618	:	Laminated tubes, rolled + moulded 
DIN 40624	:	Laminated rods, rolled + moulded 
DIN 40625	:	Laminated rods, rolled + moulded 
DIN 40626	:	Laminated rods, rolled + moulded 
DIN 40627	:	Laminated rods, rolled + moulded

Pipes and Tubes

ISO R 161	:	Pipes (dimensions in mm)
ISO R 330	:	Pipes (dimensions in inches)
ASTM D 1503	:	Pipes of cellulose-aceto-butyrate
ASTM D 1527	:	Pipes of ABS-Polymers
ASTM D 2282	:	Pipes of ABS-Polymers
ASTM D 1939	:	Pipes of ABS-Polymers (testing)
ASTM D 2104	:	Polyethylene pipes
ASTM D 2239	:	Polyethylene pipes
DIN 8072/73	:	Pipes of PE low density
DIN 8074/75	:	Pipes of PE high density
BS 1967	:	PE pipes for water
BS 3284	:	PE pipes for water
BS 1972/73	:	PE pipes for general purposes
BS 3796	:	PE pipes for general purposes
ASTM D 1785	:	Rigid PVC pipes
ASTM D 2241	:	Rigid PVC pipes
ASTM D 2152	:	Rigid PVC pipes (quality test)
BS 3505	:	Rigid PVC pipes
BS 3506	:	Rigid PVC pipes
DIN 8061/62	:	Rigid PVC pipes
DIN 19531	:	Rigid PVC pipes (for drainage purposes)
AFN T 54-002	:	Rigid PVC pipes
AFN T 54-003	:	Rigid PVC pipes
ASTM D 2310	:	Pipes of reinforced thermosets
ASTM D 2143	:	Pipes of reinforced thermosets (testing)
ASTM D 1964	:	Pipes of reinforced thermosets (thread).

Special methods for pipe-testing

ASTM D 1598	:	Time to failure under long-term hydrostatic pressure
ASTM D 1599	:	Short-time rupture strength
ASTM D 2143	:	Cyclic pressure strength of reinforced, thermosetting plastic pipes.

Polycarbonate

DIN 7744	:	Moulding and extrusion materials

Unsaturated Polyester

BS 3532	:	Resin
DIN 16945	:	Resin
DIN 16946	:	Castings (methods of test)
DIN 16913	:	Impregnated glass-mats (preprogs)
ASTM D 1201	:	Moulding materials
DIN 16911	:	Moulding materials

Polyolefines

ASTM D 1248	:	PE-compounds for moulding and extrusion
DIN 7740	:	PE-compounds for moulding and extrusion
ASTM D 1928	:	Moulding of specimens by compression
DIN 16934	:	Polyethylene-chemical resistance
ASTM D 2103	:	Films and sheets of polyethylene
DIN 16925	:	Sheets of polyethylene
ASTM D 2146	:	Polypropylene-compounds for moulding and extrusion.

Reinforced Plastics

ASTM D 1529	:	Raw materials (mats)
BS 3496	:	Raw materials (mats)
ASTM D 2150	:	Raw materials (glass-fabrics)
DIN 16913	:	Preprogs
ASTM D 709	:	Laminated thermosetting material
BS 3953	:	Reinforced plastic sheets
DIN 7735	:	Reinforced plastic sheets
ASTM D 1919	:	Corrugated sheets
BS 4154	:	Corrugated sheets
ASTM D 1502	:	Corrugated sheets (methods of testing).

Special methods of testing

ASTM D 2290	:	Testing of reinforcements
ASTM D 2291	:	Testing of reinforcements
ASTM D 2343	:	Testing of reinforcements

Styrene-Polymers and Copolymers

ASTM D 703	:	Polystyrene-compounds for moulding and extrusion
BS 1493	:	Polystyrene-compounds for moulding and extrusion
DIN 7741	:	Polystyrene-compounds for moulding and extrusion
ASTM D 1892	:	Styrene-butadiene-copolymers for moulding and extrusion
ASTM D 1431	:	Styrene-acrylonitrile-copolymers for moulding and extrusion
ASTM D 1788	:	Rigid ABS-polymers
ASTM D 1463	:	Polystyrene films biaxially oriented.

Vinyls

(a) Homopolymers

ASTM D 1755	:	PVC resins
ISO R 1060	:	PVC resins
DIN 7746	:	PVC resins
AFN T 53-001	:	PVC resins
ASTM D 1784	:	Rigid PVC compounds for moulding and extrusion
DIN 7748	:	Rigid PVC compounds for moulding and extrusion
ASTM D 1927	:	Rigid sheets of PVC
DIN 16927	:	Rigid sheets of PVC
DIN 16929	:	Rigid sheets of PVC (chemical resistance)
DIN 16926	:	Rigid sheets of PVC for construction purposes
ASTM D 2287	:	Non rigid compounds for moulding and extrusion
DIN 7749	:	Non rigid compounds for moulding and extrusion
ASTM D 1047	:	PVC jacket compound for electrical cables
ASTM D 1593	:	Non rigid sheets of PVC
BS 1763	:	Non rigid sheets of PVC
BS 2793	:	Non rigid sheets of PVC
DIN 16924	:	Calendered sheets of PVC
DIN 16937	:	Non rigid films for construction purposes
DIN 16941	:	Non rigid extruded profiles of PVC.

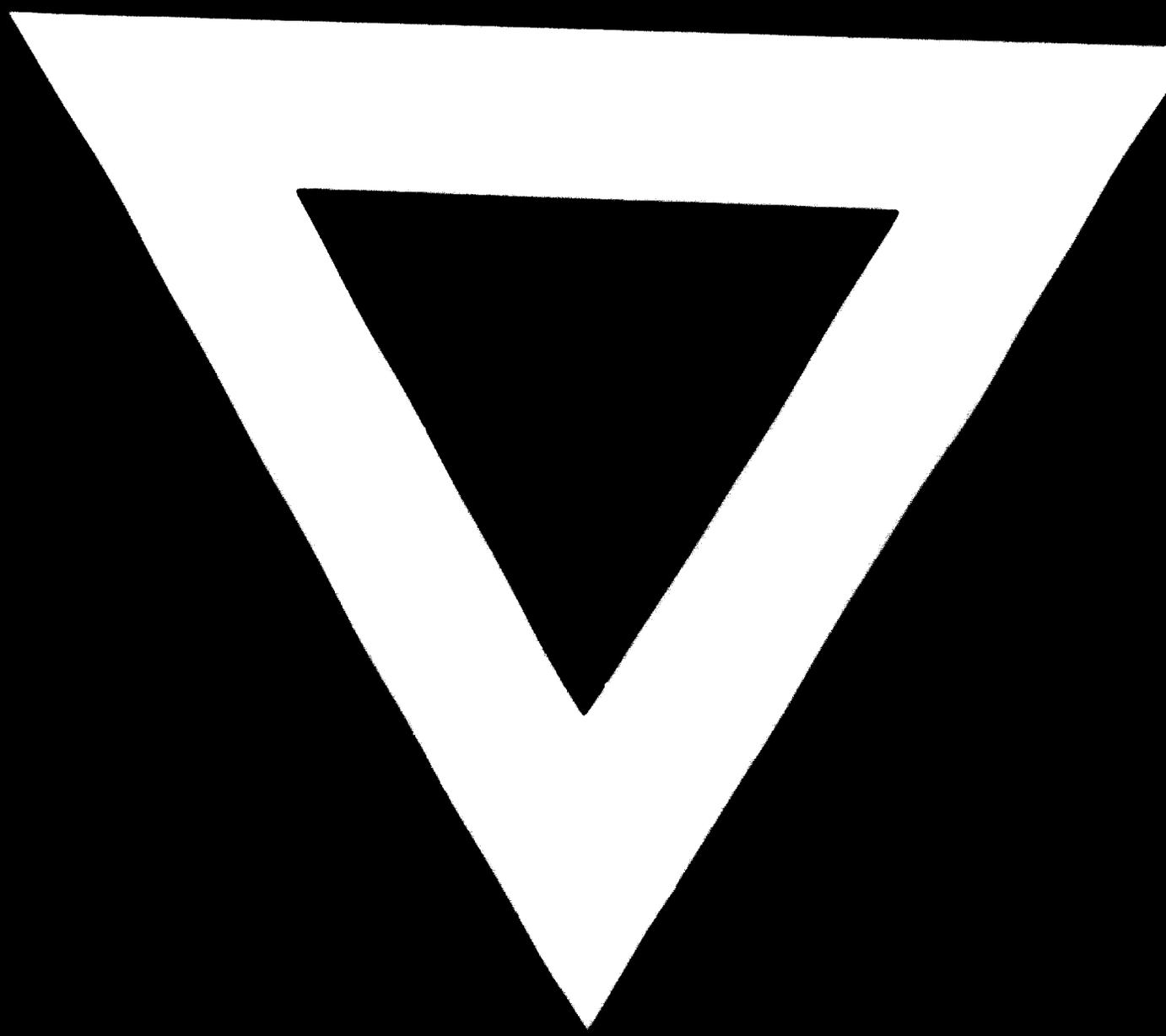
(b) Copolymers

DIN 7747	:	Copolymer resins
ASTM D 2114	:	Copolymer compound for moulding and extrusion
ASTM D 2123	:	Rigid sheets of copolymers of vinyl chloride and vinyl acetate.

Fungus Resistance

ASTM D 1924:	Plastics	visual	(+)	
ISO R 846:	Plastics	visual	(+)	78/

78/ Results are comparable if micro-organisms of the same kind are used. Evaluation of resistance to fungi is based on visual inspection and on changes in the mechanical strength and deformation.



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Thermal ageing

ASTM D 794:	Plastics		(+)	79/
BS 2782-101 A:	Plastics		(+)	
DIN 53446:	Plastics		(+)	
DIN 53497:	Thermoplastics		(+)	
DIN 53498:	Thermosets		(+)	
BS 2782-108:	Polyethylene	$\tan \vartheta$	0	
BS 2782-104 D:	PVC (non rigid)	$^{\circ}C$	0	
BS 2782-110 A:	PVC (non rigid)		0	

79/ Changes of property values are measured which occur after a definite storage at a specifiel temperature or at specified temperature cycles (ASTM D 794) or after a specified heat treatment. Results can only be compared if all experimental conditions are the same.

Light resistance

ISO R 877:	Plastics	scale	+		
DIN 53388:	Plastics	scale	+		80/
BS 2782-507 A:	Plastics	scale	0		80/
ASTM D 620:	Plastics	visual	0		81/
ISO R 879:	Plastics	scale	+		
DIN 53389:	Plastics	scale	+		82/
AFN T 54-012:	Decorative sheets	scale	+		
ISO R 878:	Plastics	scale	0		83/

80/ Specimens are exposed to day light. The evaluation of light resistance according to these three standards is based on a colour fastness scale (8 different types), however, in case of BS 2782-507 A the reference material is to a certain degree pre-exposed.

81/ A General Electric sunlamp (Modul BM 12) is used.

82/ A Xenon radiation source is used; the light resistance of the specimen is evaluated on the basis of discolouration of samples of the 8 different types of the colour fastness scale, which are exposed simultaneously with the specimen.

83/ A standard oscillating arc is used; evaluation of the light resistance is made by comparison with the discolouration of the 8 different samples of the colour fastness scale.

Remark: Generally speaking it should be noted, that the results obtained with radiation sources having a particularly high portion of UV-radiation do not agree with the results of light resistance measurements in practice.

Migration of plasticizers

ASTM D 1203:	Plasticized plastics	%	(+)	84/
ISO R 176:	Plasticized plastics	%	(+)	
ISO R 177:	Plasticized plastics	%	(+)	85/
DIN 53405:	Plasticized plastics	%	(+)	
AFN T 51-025:	Plasticized plastics	mg	(+)	
BS 2782-511 A:	Plasticized plastics	tan ϑ	0	
ASTM D 2134:	Plasticized plastics		0	86/

84/ Activated carbon serves as an acceptor of plasticisers. A comparison of results is possible if temperature and induction time are the same.

85/ Unplasticised films of polyethylene, polyvinyl chloride or cellulose acetate are used as acceptors of plasticisers. A comparison of results is only possible if acceptor, temperature and induction time are the same.

86/ The softening of organic coatings caused by the transfer of plasticisers from plastics is measured.

Stress cracking

ASTM D 1693:	Polyethylene	hours	0
DIN 53449:	Plastics	%	0

Water absorption at room temperature

ASTM D 570:	Plastics	%	0	87/
ISO R 62:	Plastics	mg	(+)	
BS 2782-502 F:	Plastics	mg	(+)	88/
BS 2782-502 G:	Plastics	mg	(+)	
DIN 53475:	Plastics	mg	(+)	
AFN T 51-002:	Plastics	mg	(+)	
BS 2782-502 A:	Moulded phenolics	mg	0	
BS 2782-502 B:	Moulded aminoplastics	mg	0	
BS 2782-502 C:	Moulded PVC compounds	mg	0	
BS 2782-502 D:	Laminated sheets	mg	0	
DIN 53472:	Laminated sheets	mg	0	
BS 2782-502 E:	Laminated rods and tubes	mg	0	
ASTM D 2127:	Cellular plastics (rigid)	g/1000 cm^3	0	

87/ The amount of water absorbed as well as the amount of material dissolved in water are measured after arbitrarily chosen time periods and reported in weight percentages.

88/ The duration of the immersion in water is 24 hours; the amount of water absorbed as well as of material dissolved in water are determined. A comparison of results is only possible if the specimens have the same surface area to weight ratio.

Water absorption at elevated temperatures

ASTM D 570:	Plastics	%	+	89/
DIN 53471:	Plastics	mg	+	
ISO R 117:	Plastics	mg	+	
BS 2782-503 B:	Plastics	mg	+	
AFN T 51-011	Plastics	mg	+	
ASTM D 570:	Plastics	%	+	90/
DIN 53471:	Plastics	mg	+	
ISO R 117:	Plastics	mg	+	
BS 2782-503 C:	Plastics	mg	+	
BS 2782-503 A:	Moulded aminoplastics	mg	0	
AFN T 54-008:	Decorative laminates	mg	0	

89/ Specimens are immersed in boiling water for 30 minutes and the weight increase is determined. Insofar as the surface area to weight ratio is the same, results can mutually be compared.

90/ Specimens are immersed in boiling water for 30 minutes and both the amount of absorbed water as well as that of dissolved material in water are determined. A mutual comparison of results is possible if the surface area to weight ratio is the same.