

# Water Absorption 24 hours

## Absorption Properties of Polymers

Some polymers have a natural tendency to absorb water. Indeed, superabsorbent polymers are gaining traction in advanced application in medical, construction etc., however at the same time, absorption capacity of thermoplastics lead to several **changes w.r.t processing and properties.**

**Moisture/water absorption** is the capacity of a plastic or a polymer to absorb moisture from its environment. Absorbed moisture has been shown to act as a plasticizer, reducing the **glass transition temperature** and strength of plastic – which is a reversible effect. However, absorbed water also can lead to irreversible degradation of the polymer structure.

Some of the known effects include:

- Dimensional & mass changes (e.g. swelling) caused by water absorption
- Extraction of water-soluble components
- Changes in mechanical (elasticity, tensile strength, impact strength) and electrical performance

Water absorption is expressed as **increase in weight percent** or **% weight gain of a plastic specimen** under following testing procedures:

- **Water Absorption 24 hrs at 23°C** - Immersion of a plastic specimen in distilled water during 24 hours at 23°C
- **Water Absorption 24 hrs at 100°C** - Immersion of a plastic specimen in distilled boiling water during 24 hours
- **Water Absorption at saturation** - Immersion of a plastic specimen in distilled water at 23°C. Measurement occurs when the polymer does not absorb water anymore
- **Water Absorption at Equilibrium** - Plastic specimen is exposed to a humid environment -- generally at 50% relative humidity -- at a specified temperature -- 23°C or 73.4°F -- for 24 hours

$$\text{Increase in weight, \%} = \frac{\text{wet weight} - \text{conditioned weight}}{\text{conditioned weight}} \times 100$$

Exposure to humidity, immersion and exposure to boiling water can result in distinctly different material responses. The equilibrium moisture content can be used to compare the amount of water absorbed by different types of plastics when they are exposed to moisture.

**View All Polymer Grades with Low to None Water Absorbing Capability  
Available in Omnexus Plastics Database**

*Check out more on Moisture/water absorption:*

- » **Water Absorption Values of Several Plastics**
- » **Significance of Water Absorption During Polymer Processing**
- » **How to Measure Water Absorption of Plastics?**
- » **Factors Affecting Water Absorption**

Importance of Water Absorption – Plastics Processing & Properties

The water absorption data is important to understand the **performance of the polymeric materials** during processing e.g. injection molding as well as in water or humid environments to avoid **premature moisture-related failures**.

Absorption phenomenon is particularly detrimental to the plastic products. The wet material is also more permeable to gases. For example, for moist PA6 CO<sub>2</sub> permeability is three times greater than for PA6 dried.

- The presence of moisture in the material structure is also influence **thermal insulation** and **dielectric properties**
- The absorption and the presence of moisture in the polymer structure is one of the factors causing aging of the material
- Polyolefins such as **PE**, **PP**, and polybutylene contain no chemical bonds that are easily hydrolyzable. Hence, they absorb little water and essentially unaffected by aging in water
- The presence of excessive moisture reduces the viscosity of the plastic, which is the cause of many processing problems
- Moisture in the material also affects the appearance of the part

For example, if the injection molding process uses wet granulation, the plasticization stage, the reaction occurs in water. Hydrolysis leads to structural

changes in the material (degradation) and the result of the deterioration of the mechanical properties, particularly toughness and resistance.

- The use of moist **PMMA granules** for injection causes the matured parts with poor surface quality and the **POM** injection also leads to a raid in shape.
- In the case of **PET and PBT materials** can lead to shorter-chain molecules present in the hydrolytic decomposition. This results in a significant deterioration in the mechanical properties of the material.
- Presence of moisture impairs impact strength and mechanical strength in **polyamides**.

**Water absorption in composites** is more complex than in polymers alone. In the case of **thermoplastic composites**, the extent of the water absorption into the polymeric matrix depends on the chemistry and morphology of the polymer as well as the volume fraction and configuration of the fibers present and whether any wicking at the interface occurs.

### **How to Measure Water Absorption of Plastics?**

Most widely used standards to measure Water Absorption in plastics are **ASTM D570 and ISO 62** (*ofcourse there exist several other methods as well, but they are not discussed here*)

#### **ASTM D570 - Standard Test Method for Water Absorption of Plastics**

This test method for rate of water absorption has two chief functions:

- First, as a guide to the proportion of water absorbed by a material and consequently, in those cases where the relationships between moisture and electrical or mechanical properties, dimensions, or appearance have been determined, as a guide to the effects of exposure to water or humid conditions on such properties; and
- Second, as a control test on the uniformity of a product. It is particularly applicable to sheet, rod, and tube arms when the test is made on the finished product.

Test Procedure: For the water absorption test, the specimens are dried in an oven for a specified time and temperature and then placed in a desiccator to cool. Immediately upon cooling the specimens are weighed. The material is then emerged in water at agreed upon conditions, often 23°C for 24 hours or until equilibrium. Specimens are removed, patted dry with a lint free cloth, and weighed.

## ISO 62 Plastics - Determination of Water Absorption

It describes a procedure for determining the moisture absorption properties in the “through-the-thickness” direction of flat or curved-form solid plastics. It also describes procedures for determining the amount of water absorbed by plastic specimens of defined dimensions, when immersed in water or when subjected to humid air under controlled conditions.

### Factors Affecting Water Absorption

- Type of plastic
- Morphology (crystalline, amorphous...)
- Type and proportion of additives, fillers and reinforcements used
- Fiber fraction and orientation (in composites)
- Relative humidity and temperature
- Length of exposure

### Water Absorption Values of Several Plastics

Polymer Name	Min Value (% weight)	Max Value (% weight)
ABS - Acrylonitrile Butadiene Styrene	0.05	1.80
ABS Flame Retardant	0.10	0.80
ABS High Heat	0.10	0.80
ABS High Impact	0.10	0.80
ABS/PC Blend - Acrylonitrile Butadiene Styrene/Polycarbonate Blend	0.20	0.30
ABS/PC Blend 20% Glass Fiber	0.20	0.30
ABS/PC Flame Retardant	0.20	0.20
Amorphous TPI Blend, Ultra-high heat, Chemical Resistant (Standard Flow)	0.39	0.39
ASA - Acrylonitrile Styrene Acrylate	0.20	0.30
ASA/PC Blend - Acrylonitrile Styrene Acrylate/Polycarbonate Blend	0.30	0.40

ASA/PVC Blend - Acrylonitrile Styrene Acrylate/Polyvinyl Chloride Blend	0.10	0.20
CA - Cellulose Acetate	1.90	1.90
CAB - Cellulose Acetate Butyrate	1.90	2.20
Cellulose Diacetate-Colored Films	2.15	2.15
COC - Cyclic Olefin Copolymer	0.01	0.01
CP - Cellulose Propionate	1.20	3.00
CPVC - Chlorinated Polyvinyl Chloride	0.02	0.15
ECTFE - Ethylene Chlorotrifluoroethylene	0.10	0.10
ETFE - Ethylene Tetrafluoroethylene	0.03	0.03
EVA - Ethylene Vinyl Acetate	0.005	0.13
EVOH - Ethylene Vinyl Alcohol	6.00	10.0
FEP - Fluorinated Ethylene Propylene	0.01	0.01
HDPE - High Density Polyethylene	0.005	0.01
HIPS - High Impact Polystyrene	0.05	0.15
HIPS Flame Retardant V0	0.05	0.10
Ionomer (Ethylene-Methyl Acrylate Copolymer)	0.01	0.01
LCP - Liquid Crystal Polymer	0.03	0.03
LCP Carbon Fiber-reinforced	0.03	0.03
LCP Glass Fiber-reinforced	0.02	0.02
LCP Mineral-filled	0.02	0.05
LDPE - Low Density Polyethylene	0.005	0.015
LLDPE - Linear Low Density Polyethylene	0.005	0.01
MABS - Transparent Acrylonitrile Butadiene Styrene	0.34	0.36

PA 11 - (Polyamide 11) 30% Glass fiber reinforced	0.10	0.20
PA 11, Conductive	0.90	1.90
PA 11, Flexible	0.80	1.60
PA 11, Rigid	1.60	1.90
PA 12 (Polyamide 12), Conductive	1.00	1.20
PA 12, Fiber-reinforced	0.50	1.40
PA 12, Flexible	0.90	1.90
PA 12, Glass Filled	0.30	0.40
PA 12, Rigid	0.70	1.60
PA 46 - Polyamide 46	1.30	3.70
PA 46, 30% Glass Fiber	9.50	9.50
PA 6 - Polyamide 6	1.60	1.90
PA 6-10 - Polyamide 6-10	0.40	0.60
PA 66 - Polyamide 6-6	1.00	3.00
PA 66, 30% Glass Fiber	0.80	1.10
PA 66, 30% Mineral filled	1.10	1.20
PA 66, Impact Modified, 15-30% Glass Fiber	0.60	1.00
PA 66, Impact Modified	1.00	3.00
Polyamide semi-aromatic	2.30	3.20
PAI - Polyamide-Imide	0.10	0.30
PAI, 30% Glass Fiber	0.10	0.30
PAI, Low Friction	0.10	0.40
PAN - Polyacrylonitrile	0.30	0.30
PAR - Polyarylate	0.27	0.30

PARA (Polyarylamide), 30-60% glass fiber	0.13	0.20
PBT - Polybutylene Terephthalate	0.10	0.20
PBT, 30% Glass Fiber	0.05	0.10
PC (Polycarbonate) 20-40% Glass Fiber	0.10	0.20
PC (Polycarbonate) 20-40% Glass Fiber Flame Retardant	0.10	0.40
PC - Polycarbonate, high heat	0.10	0.20
PC/PBT Blend - Polycarbonate/Polybutylene Terephthalate Blend	0.03	0.50
PC/PBT blend, Glass Filled	0.06	0.30
PCL - Polycaprolactone	0.35	0.35
PCTFE - Polymonochlorotrifluoroethylene	0.01	0.05
PE - Polyethylene 30% Glass Fiber	0.02	0.06
PEEK - Polyetheretherketone	0.10	0.50
PEEK 30% Carbon Fiber-reinforced	0.06	0.06
PEEK 30% Glass Fiber-reinforced	0.06	0.12
PEI - Polyetherimide	0.20	0.30
PEI, 30% Glass Fiber-reinforced	0.10	0.20
PEI, Mineral Filled	0.20	0.30
PEKK (Polyetherketoneketone), Low Crystallinity Grade	0.10	0.20
PESU - Polyethersulfone	0.10	1.70
PESU 10-30% glass fiber	0.20	0.90
PET - Polyethylene Terephthalate	0.10	0.20
PET, 30% Glass Fiber-reinforced	0.05	0.10
PET, 30/35% Glass Fiber-reinforced,	0.10	0.30

Impact Modified		
PETG - Polyethylene Terephthalate Glycol	0.10	0.10
PE-UHMW - Polyethylene -Ultra High Molecular Weight	0.005	0.10
PFA - Perfluoroalkoxy	0.01	0.03
PI - Polyimide	1.34	1.43
PMMA - Polymethylmethacrylate/Acrylic	0.10	0.40
PMMA (Acrylic) High Heat	0.20	0.40
PMMA (Acrylic) Impact Modified	0.20	0.80
PMP - Polymethylpentene	0.01	0.01
PMP 30% Glass Fiber-reinforced	0.01	0.01
PMP Mineral Filled	0.11	0.11
POM - Polyoxymethylene (Acetal)	0.11	0.50
POM (Acetal) Impact Modified	0.30	0.30
POM (Acetal) Low Friction	0.20	0.27
POM (Acetal) Mineral Filled	0.20	0.50
PP - Polypropylene 10-20% Glass Fiber	0.01	0.02
PP, 10-40% Mineral Filled	0.01	0.03
PP, 10-40% Talc Filled	0.01	0.03
PP, 30-40% Glass Fiber-reinforced	0.01	0.02
PP (Polypropylene) Copolymer	0.01	0.10
PP (Polypropylene) Homopolymer	0.01	0.10
PP, Impact Modified	0.01	0.10
PPA - Polyphthalamide	0.36	0.75
PPA - 30% Mineral	0.11	0.13

PPA, 33% Glass Fiber-reinforced	0.20	0.22
PPA, 33% Glass Fiber-reinforced – High Flow	0.25	0.27
PPA, 45% Glass Fiber-reinforced	0.11	0.13
PPE - Polyphenylene Ether	0.06	0.12
PPE, 30% Glass Fiber-reinforced	0.06	0.10
PPE, Flame Retardant	0.08	0.12
PPE, Impact Modified	0.06	0.12
PPE, Mineral Filled	0.06	0.12
PPS - Polyphenylene Sulfide	0.01	0.07
PPS, 20-30% Glass Fiber-reinforced	0.02	0.05
PPS, 40% Glass Fiber-reinforced	0.04	0.05
PPS, Conductive	0.03	0.07
PPS, Glass fiber & Mineral-filled	0.02	0.08
PPSU - Polyphenylene Sulfone	0.35	0.37
PS (Polystyrene) 30% glass fiber	0.05	0.30
PS (Polystyrene) Crystal	0.01	0.04
PS, High Heat	0.01	0.07
PSU - Polysulfone	0.20	0.80
PSU, 30% Glass fiber-reinforced	0.30	0.40
PSU Mineral Filled	0.30	0.30
PTFE - Polytetrafluoroethylene	0.005	0.010
PTFE, 25% Glass Fiber-reinforced	0.01	0.02
PVC (Polyvinyl Chloride), 20% Glass Fiber-reinforced	0.01	0.20
PVC, Plasticized	0.20	1.00

PVC, Plasticized Filled	0.15	0.75
PVC Rigid	0.04	0.40
PVDC - Polyvinylidene Chloride	0.10	0.10
PVDF - Polyvinylidene Fluoride	0.03	0.05
SAN - Styrene Acrylonitrile	0.15	0.30
SAN, 20% Glass Fiber-reinforced	0.10	0.20
SMA - Styrene Maleic Anhydride	0.10	0.30
SMA, 20% Glass Fiber-reinforced	0.10	0.30
SMA, Flame Retardant V0	0.10	0.30
SMMA - Styrene Methyl Methacrylate	0.10	0.10
SRP - Self-reinforced Polyphenylene	0.14	0.20
XLPE - Crosslinked Polyethylene	0.005	0.010