ENEXIO

ENERGY.
ENGINEERING.
EXCELLENCE.

MARKET LEADER FOR FUNCTIONAL SURFACES
EFFICIENT SOLUTIONS FOR WATER AND AIR TREATMENT

Properties of Polymers PP and PVC

COOLING TOWER INSTALLATIONS MADE FROM PP OR PVC
A COMPARISON

We help you to choose

POLYMERS IN USE
POLYPROPYLENE EXPANDS THE CHOICES

In all the years we have been on the market as a manufacturer of cooling tower installations, we have noticed that many users only knew PVC (polyvinyl chloride) as a material for fills and drift eliminators. We found a good alternative as early as in the 1980s: PP (polypropylene).

This material is the second most commonly used plastic after polyethylene, and many of our customers have been using it successfully in cooling towers for decades. In order to give you an understanding of PP as an alternative to PVC, we will present the properties of the two polymers on the following pages.

In the following overview, you will see how the two materials are similar in terms of many properties. But they also differ, for example, in density and thus in mechanical stability, flammability and behavior at high temperatures. These properties can be influenced in part by the addition of additives.

PP and PVC for different requirements
We regard each cooling tower as a unique specimen for which an individual solution must be found. Aspects such as water quality, on-site conditions, serviceability, weather resistance and noise emissions are taken into account when selecting the design, weight class and material mix.

PP considerably expands the choices and helps us to meet every customer requirement. For decades, we have been processing PP as well as PVC and can support you superbly with the acquired know-how.

About us
As the market leader for functional surfaces, we supply efficient solutions for water and exhaust air treatment. For the construction and servicing of cooling towers, we supply fills, drift eliminators and other accessories and offer you support in engineering and planning.

ENEXIO Water Technologies
Areas of Activity

Biological water treatment

Sedimentation processes

Mass transfer (air treatment)

Cooling tower installations

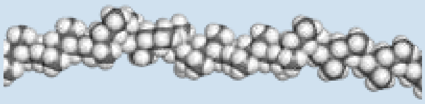
COMPARISON

Polypropylene (PP)

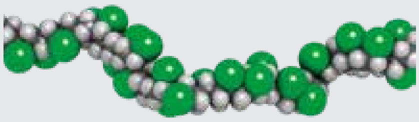
Polyvinyl Chloride (PVC)

CHEMISTRY

All polymers have as a main component carbon and hydrogen atoms. Thermoplastic polymers, which can be formed by means of extrusion and injection molding, are non-cross-linked polymer chains.



PP is completely made from carbon and hydrogen. The structure of the molecules is as such that they can partly organize in crystal; this type is called semi-crystal.



PVC has about 58% chloride weight content. The structure of the molecules is fully orderless, and this type is called amorphous.

PROPERTIES

The physical properties of polymers can vary in many ways and are within a range, since different polymerization and internal structure will influence the properties even within one polymer group.

DENSITY

The density is one of the influencing factors to determine the mean wall thickness of a product. The higher the density, the lower the wall thickness if all other parameters stay the same.

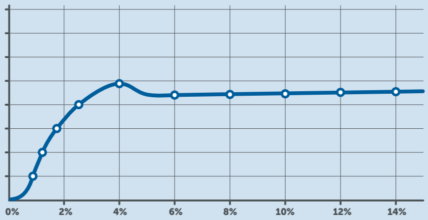
PP has a very low density.
1 kg (2.2 lb) of PP fills up a volume of 1.07 liter (0.28 US gal). PP swims in water.

PVC has a higher density.
1 kg (2.2 lb) PVC fills up a volume of about 0.75 liter (0.2 US gal).
PVC doesn't swim in water.

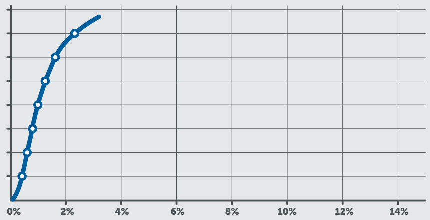
STIFFNESS & DUCTILITY

The important mechanical data to characterize the deformation behavior of polymers is the stiffness and the ductility.

PP has a **lower stiffness** and a **higher ductility**. In a tensile test, this results in E-Modulus of >1100 MPa (160 ksi) and strain at break >10%.



PVC has a **higher stiffness** and a **lower ductility**. In a tensile test, this results in E-Modulus of >2400 MPa (348 ksi) and strain at break <5%.



FAILURE MODES

Polymer fills will mainly fail by buckling of the foils.

If you compare PP and PVC fills (the same design and proper bonding) at the **same weight**, the PVC fill will fail first.

If you compare PP and PVC fills (the same design and proper bonding) with the **same thickness**, the PP fill will fail first.

	Polypropylene (PP)	Polyvinyl Chloride (PVC)

CHEMICAL RESISTANCE

Both PP and PVC have a high resistance to a wide range of chemicals. They will both withstand all common acids or bases. A case-by case review is highly recommended.

E.g. PP is more resistant than PVC to solvents like acetone or benzyl acetat.

E.g. PVC is more resistant than PP in contact with the disinfection agent sodium hypochlorite.

UV RESISTANCE

All polymers age when exposed to UV radiation. The result is embrittlement of the products. In theory, the aging processes and the ways to reduce these effects are very similar for PP and PVC.

In reality, it is very difficult to predict the aging of a specific product because the exact material composition, the wavelengths of the light as well as other environmental factors (e.g. temperature and humidity) will influence the results. Nevertheless, any polymeric material should contain UV-protection if exposed to the sun (even if it is only at storage conditions).

FIRE RESISTANCE

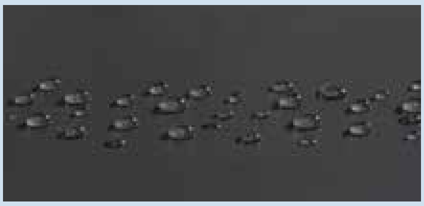
All polymers are combustible, so they will possibly burn when exposed to fire. They also will continue burning after the external fire source is not there any longer if the initial heat was high enough.

There are additives available to increase the flame retardancy, as standard PP can catch fire easily. Different additives and different content can achieve different levels of flame retardancy. To ensure a certain level effectively, only virgin material grades should be used.

Due to the chloride, the flame retardancy of standard PVC is higher than standard PP, and a lot of smaller tests are passed with this material even without further additives. Nevertheless, more severe testing showed that standard PVC can fail as well. Then it will release chloric acid.

SURFACE ENERGY

The surface energy is a measure of how far the water will spread evenly over the material surface. This will significantly influence the performance of fills and drift eliminators. Polymers in contact with process water will change their surface energy over a period of 4 to 8 weeks (seasoning).



New PP is a very hydrophobic material. After seasoning, the surface energy of PP is the same as of PVC.

New PVC is hydrophobic as well but less than PP. After seasoning, the surface energy of PVC is the same as of PP.

	Polypropylene (PP)	Polyvinyl Chloride (PVC)

BEHAVIOR AT HIGH TEMPERATURES

High temperatures have two effects on polymers: The material becomes increasingly softer and the aging of the material will be accelerated.

Polypropylene (PP)

PP becomes gradually softer but will remain strong enough to be used up to 110°C (230°F). If needed, thicker material must be used to ensure the mechanical integrity of the product.

Above 70°C (158°F) permanently, the material must be enhanced by increased anti-oxidizers to counteract the aging aspect (high temperature [HT] version).

Polyvinyl Chloride (PVC)

The softening of PVC is low at temperatures below 55°C (131°F) but becomes extreme above 60°C (140°F).

This effect is so significant that there will be a high level of deformation even without great forces being involved. This effect therefore prevails over the problem of aging.

BEHAVIOR AT LOW TEMPERATURES

Low temperatures don't directly harm the material. Without any mechanical impact, they withstand any low temperature. But any handling or other collision can cause brittle cracks and thus serious damage to the products.

Polypropylene (PP)

PP will grow into a brittle state below 5°C (41°F). This limit can be reduced to about 0°C (32°F) by altering the composition, although this would result in softer material at higher temperatures. In general PP offers a longer installation period on site compared to PVC, even in countries with cold climates.

Polyvinyl Chloride (PVC)

PVC will grow into an increased brittle state below 10°C (50°F). With PVC, this is a gradual process of embrittlement, since PVC is already brittle at room temperature. So this material should always be treated with care during installation, especially if the foil thickness is low.

	Polypropylene (PP)	Polyvinyl Chloride (PVC)

FOIL BONDING

There are different assembly and bonding methods available. Especially gluing and welding differ due to the different material properties. Both PP and PVC can be mechanically assembled as well.

GLUING

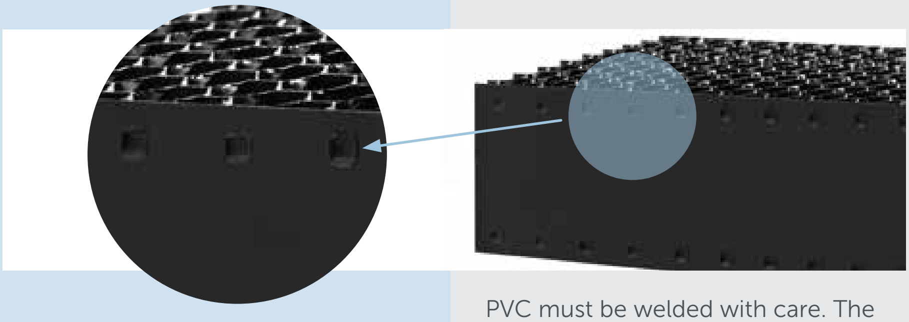
For gluing, additional material (glue) is added to the foil without heating in order to bond the foils.

Polypropylene (PP): The low surface energy of new PP makes gluing of this material complicated. Therefore in fill application this material is normally not glued.

Polyvinyl Chloride (PVC): With PVC, there are several gluing methods; the most commonly used is solvent gluing. With this glue, you have to watch environmental and safety regulations very carefully.

WELDING

For welding the material is heated up into a plasticized state and then the foils are locally bonded.



Polypropylene (PP): For PP, welding is the most common bonding technology.

Polyvinyl Chloride (PVC): PVC must be welded with care. The processing window is small and may release chloric acid if the material is heated too much.

ENVIRONMENT

Recycling

The use of recycling material and recycling of the ENEXIO production waste both make an important contribution to lowering the environmental impact of the polymeric products. Both PP and PVC can be recycled.

Polypropylene (PP): 100% of internal PP wastes are recycled within ENEXIO Water Technologies.

Polyvinyl Chloride (PVC): Recycling of PVC is technically more challenging due to foreign material contamination (e.g. glue) and cracking.

Energy management

Resource and energy management is an important issue. Therefore ENEXIO Water Technologies is certified according to ISO 50001. With the unique ENEXIO inline forming technology, it is possible to reduce the energy consumption up to 35% compared to a two-step process (foil extrusion and thermoforming). This technology can be applied to both materials.

www.enexio.com

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