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# POLYVINYL ALCOHOL (PVA)

Polyvinyl Alcohol (PVA) is a water soluble and biodegradable synthetic polymer. It is a dry solid, and is available

In granule and powdered forms. Grades include both fully hydrolyzed and partially hydrolyzed. PVA is an excellent adhesive with superior bonding strength, film forming and emulsifying properties.The film of PVA exhibits outstanding resistance to oil, grease and solvents. In addition to its film forming property, it has excellent adhesion to both hydrophilic and hydrophobic materials. PVA has been extensively used in textile industry for warp sizing and resin finishing; in paper industry for surface sizing and pigment coating; in the production of PVAc emulsion as protective colloid; in the suspension polymerization of PVC as a dispersion agent; as binder for ceramics, magnet, foundry cores and pigments.

PVA is manufactured by polymerization of vinyl acetate monomer, followed by hydrolysis of the polyvinyl acetate. PVA is produced in a wide range of hydrolysis and polymerization. In the partially hydrolyzed grades, 86-89 mole% of acetate group is replaced by alcohol group. Likewise, in the fully hydrolyzed grade,

| | | | | |
|---|---|---|---|---|
| 04-98 | 98.0-99.0 | 5 | 5--7 | 4.0-5.0 |
| 05-98 | 98.0-99.0 | 5 | 5--7 | 5-6 |
| 06-98 | 98.0-99.0 | 5 | 5--7 | 6-7 |
| 08-98 | 98.5-99.5 | 5 | 5--7 | 8-12 |
| 10-98 | 98.0-99.0 | 5 | 5--7 | 9-11 |
| 10-99 | 98.0-100.0 | 5 | 5--7 | 9-14 |
| 14-98 | 98.0-99.0 | 5 | 5--7 | 13-17 |
| 14-99F | 99.0-99.8 | 5 | 5--7 | 12.5-17.5 |
| 15-98 | 98.0-99.0 | 5 | 5--7 | 18.5-21.5 |
| 17-98 | 97.0-99.0 | 5 | 5--7 | 20-26 |
| 17-99 | 98.0-100.0 | 5 | 5--7 | 20-26 |
| 18-98 | 98.0-99.0 | 5 | 5--7 | 28-32 |
| 19-99 | 98.0-100.0 | 5 | 5--7 | 26-32 |
| 20-99 | 98.0-100.0 | 5 | 5--7 | 32-40 |
| 22-99 | 98.0-100.0 | 5 | 5--7 | 40-48 |
| 24-98 | 98.0-99.0 | 5 | 5--7 | 54-66 |
| 24-99 | 98.0-100.0 | 5 | 5--7 | 48-60 |
| 26-99 | 98.0-100.0 | 5 | 5--7 | 60-75 |
| 27-99 | 99.8-100.0 | 5 | 5--7 | 75-80 |
| 28-99 | 99.8-100.0 | 5 | 5--7 | 80-90 |
| 30-98 | 98.0-99.0 | 5 | 5--7 | 90-100 |
| 30-99 | 99.8-100.0 | 5 | 5--7 | 90-100 |

**Mediaum Hydrolysised Grades of PVA resin**

| PVA Type10/15/20/25Mesh min | HydrolysisDegree % (mol/mol) | Volatile %MAX | PH Value | Viscosity(cps.) |
|---|---|---|---|---|
| 17-80 | 78.0-82.0 | 5 | 5--7 | 18-24 |
| 18-80 | 78.0-82.0 | 5 | 5--7 | 21-31 |
| 10-92 | 90.0-94.0 | 5 | 5--7 | 8-13 |
| 14-92 | 90.0-94.0 | 5 | 5--7 | 13-18 |
| 17-92 | 90.0-94.0 | 5 | 5--7 | 20-30 |

in general-purpose adhesives such as textile, leather, wood, and porous ceramic surfaces.

The partially hydrolyzed grades of PVA are often selected for remoistening adhesives.

As an emulsifier, PVA are widely used as a protective colloid in the emulsion process. They are often used during the polymerization of vinyl acetate and vinyl acetate copolymer systems (vinyl acetate/ethylene, vinyl acetate/acrylic ester, etc.) to form high-solids emulsions with stability and adhesive properties.

PVA products are also used in emulsions for non-vinyl acetate system (styrene/butadiene, styrene/acrylic ester, acrylic ester, etc.) lattices and bead or suspension polymerization of vinyl monomers like vinyl acetate, styrene, and vinyl chloride. PVA are also used during post-emulsification of hydrophobic substances like wax and asphalt.

**PVA - Ceramic Application**



PVA is outstandingly suitable as a temporary binder and plasticizer for ceramic compounds. It breaks down almost entirely into water and carbon dioxide when a ceramic moulding is fired. The possible applications depend essentially on the nature of the ceramic compound and the moulding process. The quantities used vary considerably, depending on the technology applied. PVA is particularly effective as a temporary binder in special ceramics (technical ceramics).

In the case of low-viscosity fully hydrolysis compounds it should be noted that foaming may occur to prevent this, additions of defoamer relative to PVA (solid) are recommended.

Low ash and fully hydrolysed grades PVA have proved useful in the ceramics sector. These products are applied either alone or with an addition of plasticizer such as glycerine, glycol, trimethylol propane, neopentyl glycol or polyglycol

**PVA - Other Application**

Over the short term, increasing usage in the construction industry materials, including caulks and sealants, joint compounds like joint cement and drywall mud

In the food packaging industry, PVA is majorly used as a binding and coating agent. As a film coating agent, it is used in applications, where moisture barrier or protection properties are required.

PVA (Special grade) protects the active food ingredients from moisture, oxygen, and other environmental components, while simultaneously masking their taste and odor. It allows for easy handling of finished products and facilitates ingestion and swallowing.

| | | | | |
|---|---|---|---|---|
| 18-92 | 90.0-94.0 | 5 | 5--7 | 28-32 |
| 26-94 | 90.0-95.0 | 5 | 5--7 | 60-70 |
| 17-95 | 94.0-96.0 | 5 | 5--7 | 20-30 |
| 24-95 | 94.0-96.0 | 5 | 5--7 | 50-60 |
| 17-96 | 94.0-98.0 | 5 | 5--7 | 20-30 |
| 08-97 | 96.0-98.0 | 5 | 5--7 | 8-9 |
| 17-97 | 96.0-98.0 | 5 | 5--7 | 21-31 |

**Partial Hydrolysised Grades of PVA resin**

| PVA Type10/15/20/25Mesh min | HydrolysisDegree % (mol/mol) | Volatile %MAX | PH Value | Viscosity(cps.) |
|---|---|---|---|---|
| 03-88 | 86.0-90.0 | 5 | 5--7 | 3.0-3.5 |
| 04-88 | 86.0-90.0 | 5 | 5--7 | 3.5-4.5 |
| 05-88 | 86.0-90.0 | 5 | 5--7 | 5-6 |
| 14-88 | 86.0-90.0 | 5 | 5--7 | 11-14 |
| 16-88 | 86.0-90.0 | 5 | 5--7 | 16.5-19.5 |
| 17-88 | 86.0-90.0 | 5 | 5--7 | 20-28 |
| 20-88 | 86.0-90.0 | 5 | 5--7 | 28-40 |
| 24-88 | 86.0-90.0 | 5 | 5--7 | 40-50 |
| 26-88 | 86.0-90.0 | 5 | 5--7 | 50-58 |
| 28-88 | 86.0-90.0 | 5 | 5--7 | 65-75 |

**PVA for textile**

Polyvinyl alcohol (PVOH) are the superior products for textile warp sizing in spun and filament yarn. Providing a protective coating for spun and filament yarn, PVA allow yarn to be desized in hot water and are more effective than starch. The excellent film-forming capabilities provide protective coatings for spun and filament yarn, yet are still tough enough in abrasion resistance.

In order to reduce warp breakages and weft-stops, PVA are used to improve toughness and smoothness and elasticity of yarns, binding fluffs for good shedding, particularly on spun polyester blended yarns. PVA are superior to other materials, like starch, because they are stronger and provide the required protection. The excellent weave performance of PVA allows for advantageous and difficult-to-weave constructions. When PVA are used instead of starch, shedding on the slasher decreases due to the efficiency of polyvinyl alcohol. This minimizes waste in the weave loom.

The film-forming characteristics of PVA make them ideal for yarn sizing. Their adhesion, toughness, and film strength are reflected in improved physical properties of the sized yarn. Along with superior characteristics, less PVA are needed when compared to starch. The improved toughness and smoothness of yarn, when sized with PVA , is indicative of good abrasion resistance against reed motion, shedding motion, and high tension on the weave loom.

Advantage:

Abrasion resistance
Excellent adhesion especially to synthetic fibers
Flexible and excellent elongation
Ease of desizing in hot water
Excellent viscosity stability
Good anti-foaming performance
Economically recoverable and reusable
Biodegradable

Other Application in Textile

Textile finishing agent
Raw material of vinylon
Hand builders for fabric finishing
Adhesives for screen printing

**PVA for Paper Application**

Polyvinyl alcohol (PVOH) is the strongest binder in the paper industry. As a surface-applied additive, polyvinyl alcohol can provide both sheet physical strength and surface strength to a paper or paperboard containing secondary fiber. Finally, PVOH is in tune with the environment due to its complete biodegradability.

PVA can give paper,coated paper and paperboard many improvement in the surface properties (rub and picking strength, abrasion resistancy ,resisitance to oil,grease and organic solvents, rsstance to water,smoothness, gloss, print-ability) and the inherent properties (bursting and tensile strength,folding endurance).

Paper surface sizing used to facilitate the water-resistant protection of a paper's surface. These substances are typically used to prevent ink from seeping into the paper and to prevent ink from blurring due to contact with water

Surface sizing chemical (mostly oxidized or enzymatically modified starch) flows into the pores of cellulose network and also remains on the surface affecting the surface and intrinsic properties of paper. Polyvinyl alcohol (PVA) can be used for surface sizing because it is a water soluble polymer and has high film forming ability.

Surface sizing with blends of oxidized starch solution and PVA solution increased the time of air leak in comparison to base paper.

PVA are effective binders in coating formulations at the size press. Because of their excellent binding performance, they can replace starch on a one-to-five basis. With the incorporation of PVA into binding solutions, the optical and surface properties are improved compared to a clear, uncoated sheet. In other sectors, PVA are used as powerful binders to produce matte, glossy, or high-speed industrial inkjet papers. Additionally, both are used in thermal dyestuff dispersant, a thermal top coat agent under a combination with a crosslinking agent for thermal paper/label application.

## PVA for Adhesive Application

The unique combination of properties in PVA grades has allowed for its widespread use in industrial adhesives and unique grades for the adhesives market.

PVA is used for polyvinyl acetate emulsions, specifically in wood and paper adhesives. PVA are used for water-resistant wood adhesives. PVA can also be used

98.5~99.2 mole % of acetate group is replaced by alcohol group.

Individual PVA grade varies in molecular weight (degree of polymerization) and degree of hydrolysis. In order to

1798 : Fully hydrolyzed PVA with degree of polymerization about 1700.
2088: Partially hydrolyzed PVA with degree of polymerization about 2000.

The two-digit number indicates the degree of polymerization by one-hundredth; the higher the number, the higher degree of polymerization, so is the viscosity.

The most important properties which the majority of applications depend are degree of polymerization and degree of hydrolysis. The degree of polymerization is an expression of the size of polymer. The higher the degree of polymerization of polymer is, the bigger the size and the longer the length of polymer is. Similarly, the degree of hydrolysis is an expression of the ratio of hydrophilic alcohol group and hydrophobic acetate group.



**The properties of PVA are summarized as follows:-**

Based on

1 degree of polymerization

The higher the polymerization of the polymer, the higher the viscosity of the solution and the adhesive strength of the film.

Polymer has high degree of polymerization, low water solubility and high solvent resistance.

The higher the polymerization level of the polymer, the higher the tensile strength of the PVA film.

The higher the polymerization level of the polymer, the lower the penetration and softness of the film.

The higher the polymerization level of the polymer, the better the protection capacity.

2 Based on degree of hydrolysis- Dissolving properties

Fully hydrolyzed grade PVA can be easily dissolved in over 90°C water, but it only swells in room temperature water.

Partially hydrolyzed grade PVA can be slowly dissolved in room temperature water. But in normal uses, raising temperature to 90°C is necessary for saving dissolving time.

Super low hydrolyzed grade PVA can be dissolved in 25°C to 50°C water, according to their grades.

3 Characteristic of Fully hydrolyzed type PVA

Good affinity to hydrophilic fiber such as cotton, rayon and paper.
Better water resistance film property than partially hydrolyzed type PVA film.
Viscosity is less stable in the condition of low temperature and high concentration than Partially hydrolyzed type PVA. Dissolving rate is slower than partially hydrolyzed type PVA.

4 Characteristic of Partially hydrolyzed type PVA

Good affinity and cohesion power to hydrophobic fiber such as polyester, nylon, polyester /cotton blended and polyester/ rayon blended fiber.
Good compatibility with oiling agent.
Good solution viscosity stability.
Better protective colloid property than Fully hydrolyzed type PVA.

**Grades and Specifications**

| PVA Type10/15/ 20/25Mesh min | Hydrolysis Degree % (mol/mol) | Volatile % MAX | PHValue | Viscosity(cps.) |
|---|---|---|---|---|
| 03-98 | 98.0-99.0 | 5 | 5--7 | 3.0-4.0 |