POLYOX™
Versatile Water-Soluble Resins for Industrial Applications
POLYOX™ Water-Soluble Resins (WSR) are thermoplastic, nonionic polymers with high molecular weight. They are obtained through the heterogeneous polymerization of ethylene oxide \((\text{CH}_2\text{CH}_2\text{O})_n\), which in turn creates poly(ethylene oxide) or PEO.

POLYOX™ WSR can be supplied in a wide range of molecular weights to meet specific formulation and processing requirements.

**WHAT ARE POLYOX™ WATER-SOLUBLE RESINS (WSR)?**

POLYOX™ WSR exhibits many properties that are typical of other classes of water-soluble polymers:

- Lubricity
- Thickening and rheology modification
- Binding
- Film formation
- Water retention

They are also unique in that they are thermoplastic polymers that can be calendared, extruded, injection-molded or cast.
POLYOX™ WSR has been used for over 50 years for its unique properties. Unlike other polymers, POLYOX™ WSR combines water and solvent solubility. While thermo-elastic, POLYOX™ WSR polymers can also exhibit a thermoplastic behavior. This versatility has made POLYOX™ WSR a popular choice for many industrial applications.

**UNIQUE PERFORMANCE PROPERTIES THAT ADD VALUE TO YOUR PRODUCTS AND PROCESSES**

POLYOX™ WATER-SOLUBLE RESINS ARE VERSATILE AND PROVIDE BINDING, LUBRICITY, ADHESION AND MORE

- Resistant to oil and greases; Compatible with other resins and plasticizing agents
- Sticky wet adhesives; Non-tacky when dry
- Outstanding binder for inks, pigments, ceramics, metal powders, fillers and more; Burns off clean at low temperatures
- Can form highly water-retentive gels by irradiation without initiators or co-agents
- Adheres onto colloidal materials; Efficiently separates fines from aqueous systems
- Reduces splattering; Controls drift and misting when sprayed; Pituitous
- Readily extruded, calendared, injection-molded or cast; Heat-sealable and orientable
- Associates with polar compounds such as phenolic resins, mineral acids, ureas, etc.
- Thickens ketones, alcohols, esters and some hydrocarbons; Not generally soluble in glycols, diols and aliphatic ethers
- Low toxicity
- Large range of viscosities that can be customized; Compatible from pH 2 to 13; Nonionic and pseudoplastic
- Poorly absorbed and nonirritant
- Conserves energy by reducing turbulent friction for fluids
- Forms Novel Complexes
- Solubility in Organic Solvents
- Cross-linkable
- Flocculant
- Lubricity
- Thermoplasticity
- Viscoelasticity
- Drag Reduction
- Thickening
- High Binding Efficiency
- Wet Tack
- Film Former

Films of POLYOX™ WSR are flexible, tough and resistant to most oils and greases. With their very high molecular weight, POLYOX™ WSR polymers are viscoelastic, so their aqueous solutions can reduce spattering and misting. POLYOX™ WSR can also form association compounds with many other substances to achieve a wide variety of additional, useful formulation properties.
At DuPont Nutrition & Health, we support our customers in their efforts to develop new products, constantly solving new challenges as they arise. POLYOX™ WSR can be used in a wide range of applications and has seen increasing adoption in industrial applications. We often customize new POLYOX™ WSR grades or chemistries to meet specific customer requirements.

The applications mentioned above are typical of POLYOX™ WSR polymers. POLYOX™ WSR can also be used in many other applications, such as inks & coatings, release liners, automotive fluids, paper coating, textile sizing and many more.
POLYOX™ Water-Soluble Resins come in a wide range of molecular weights and viscosities to meet your specific needs.

<table>
<thead>
<tr>
<th>GRADES</th>
<th>Approximate Molecular Weight</th>
<th>Viscosity of aqueous solution at 25 °C and given concentration, Brookfield RVF</th>
</tr>
</thead>
<tbody>
<tr>
<td>POLYOX™ WSR N-10</td>
<td>100,000</td>
<td>5 wt% 12 – 50</td>
</tr>
<tr>
<td>POLYOX™ WSR N-80</td>
<td>200,000</td>
<td>5 wt% 65 – 115</td>
</tr>
<tr>
<td>POLYOX™ WSR N-750</td>
<td>300,000</td>
<td>5 wt% 600 - 1,000</td>
</tr>
<tr>
<td>POLYOX™ WSR N-3000</td>
<td>400,000</td>
<td>5 wt% 2,250 - 4,500</td>
</tr>
<tr>
<td>POLYOX™ WSR 205</td>
<td>600,000</td>
<td>5 wt% 4,500 - 8,800</td>
</tr>
<tr>
<td>POLYOX™ WSR 1105</td>
<td>900,000</td>
<td>5 wt% 8,800 - 17,600</td>
</tr>
<tr>
<td>POLYOX™ WSR N-12K</td>
<td>1,000,000</td>
<td>2 wt% 400 - 800</td>
</tr>
<tr>
<td>POLYOX™ WSR N-60K</td>
<td>2,000,000</td>
<td>2 wt% 2,000 - 4,000</td>
</tr>
<tr>
<td>POLYOX™ WSR 301</td>
<td>4,000,000</td>
<td>1 wt% 1,650 - 5,500</td>
</tr>
<tr>
<td>POLYOX™ WSR Coagulant</td>
<td>5,000,000</td>
<td>1 wt% 5,500 - 7,500</td>
</tr>
<tr>
<td>POLYOX™ WSR 303</td>
<td>7,000,000</td>
<td>1 wt% 7,500 - 10,000</td>
</tr>
<tr>
<td>POLYOX™ WSR 308</td>
<td>8,000,000</td>
<td>1 wt% 10,000 - 15,000</td>
</tr>
<tr>
<td>UCARFLOC™ Polymer 304 CP²</td>
<td>7,500,000</td>
<td>1 wt% 7,500 - 13,000</td>
</tr>
<tr>
<td>UCARFLOC™ Polymer 309 CP²</td>
<td>8,500,000</td>
<td>1 wt% &gt; 13,000</td>
</tr>
</tbody>
</table>

¹Based on rheological measurements. Molecular weights obtained by other methods, including light scattering and gel permeation chromatography, may not be directly comparable.
²Coarse Particle (CP) grade specified as less than 15% through a 200 mesh screen (74 µm)

**POLYOX™ (WSR) VISCOSITY AS A FUNCTION OF MOLECULAR WEIGHT**

POLYOX™(WSR) provides you with a one-of-a-kind toolbox, enabling you to customize viscosity according to your requirements.
Although POLYOX™ Water-Soluble Resins are completely water soluble in typically 0.5 to 3 hours, dispersing the powder with minimal shear is important to facilitate complete dissolution. If the resins are added too quickly, they will form gel-coated agglomerates that prevent complete hydration. Detailed procedures and equipment recommendations for laboratory- and commercial-scale dissolving methods are available upon request.

There are three major techniques that ensure sufficient dispersion of POLYOX™ WSR resin particles, but the choice depends on the final viscosity target and required volume.

**DIRECT ADDITION TO WATER**
Recommended for laboratory-scale and less-than-drum quantities.
This is best accomplished by introducing POLYOX™ WSR at an adequate rate of addition. If you add it too slowly, the viscosity will build too rapidly, and you will not be able to add the remaining resin. However, if the resin is added too quickly, it will form gel-coated agglomerates.

**PRE-DISPERSION IN WATER-MISCIBLE NON-SOLVENTS**
Recommended for laboratory-scale and less-than-drum quantities.
POLYOX™ WSR is first dispersed in a water-miscible non-solvent, such as isopropyl alcohol, to separate the individual particles from each other. Each individual particle has a chance to swell, hydrate and dissolve. This technique avoids the typical clumping that occurs when dissolved in water alone. The use of alcohols or glycols has the added benefit of stabilizing the solution viscosity over time.

**USE OF MECHANICAL DEVICES THAT ACHIEVE DISPERSION WITH MINIMAL SHEAR**
For large volume or continuous operations.
The relative ease of dissolving POLYOX™ WSR directly in water depends on three factors:
- Rate of viscosity buildup, which is a function of solution concentration and molecular weight
- Particle size
- Type of agitation; the underlying factor, once again, is to obtain good resin dispersion before the solution viscosity builds to a point where it is no longer possible to disperse additional resin

Additional information and detailed procedures, laboratory equipment recommendations and commercial scale methods for dissolving POLYOX™ Water-Soluble Resins are described in a separate brochure. Our sales and technical team can assist you with process-related questions.
WHAT WE DO

POLYOX™ Water-Soluble Resins for industrial applications are available only from DuPont Global Specialty Solutions and its distributors. Global Specialty Solutions, a business of DuPont Nutrition & Health (N&H), manufactures cellulosic polymers alongside other N&H portfolio products. Our dedicated Global Specialty Solutions team commercializes DuPont products into various global markets.

OUR CORE VALUES

More than just goals, our core values reflect the way we work every day with our customers and partners in communities around the globe:

- Safety & Health
- Environmental Stewardship
- Respect for People
- Highest Ethical Behavior

WHO WE ARE

We are innovative problem solvers, drawing on deep application understanding and market insight to help our customers turn challenges into high-value business opportunities. Learn more at dupontspecialtiesolutions.com

GLOBAL SPECIALTY SOLUTIONS MANUFACTURING & RESEARCH SITES

5 production sites, 3 R&D/Technical Support and Development (TS&D) centers

- Michigan Midland
- Louisiana Plaquemine
- West Virginia Institute
- Germany Stade, Bomlitz
- China Shanghai

- Bomlitz, Germany
- Midland, MI, U.S.A.
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