Solenis
Strong Bonds. Trusted Solutions.

Solenis supplies specialty chemicals for water-intensive industries, including the pulp and paper, oil and gas, chemical processing, mining, biorefining and power markets. Whether you want to increase production, develop new products, reduce costs or simply do more with less, we can help. With our innovative technologies, passionate people and unrivaled experience, Solenis is ready to deliver the solutions you need.

Together, we’ll create strong bonds that ensure trusted solutions.
Global Wet-strength Leader

Solenis invented the modern era of wet-strength paper manufacturing with the introduction of Kymene™ 557 wet-strength resin, the first polyamido-amine-epichlorohydrin (PAE) resin ever brought to the market.

The product was an instant commercial success, both for its ability to function in neutral/alkaline papermaking processes and for its novel wet-strength capabilities. Like all PAE resins, the polymer in Kymene 557H contains quaternary ammonium groups that adsorb onto negatively charged paper fibers and that continue to cross-link even as the paper dries and cures. That means the wet strength of paper treated with Kymene wet-strength resin continues to increase after it’s been put into storage. Over the years, our researchers have modified the basic chemistry to make stronger-performing resins with reduced by-products, 1,3-dichloropropanol (1,3-DCP) and 3-monochloropropan-1,2-diol (3-MCPD), as well as aminochlorohydrin (ACH) and polymer-bound CPD (PB-CPD). Solenis has led the industry in decreasing the organic chlorine content of its Kymene wet-strength resins without compromising their efficiency. Our scientists have developed manufacturing processes with greater control to maximize the efficiency of how epichlorohydrin is used to generate azetidinium chloride (AZE), the reactive portion of PAE resin, while minimizing the levels of 1,3-DCP and 3-MCPD. We’ve also introduced innovative technologies that can be applied after the manufacture of the basic PAE resin to reduce harmful by-products.

Kymene™ Wet-strength Resin Portfolio

Today, PAE resins account for 90 percent of the wet-strength market. Of this market, nearly half bear the Kymene brand name. One reason for the success of the product is a broad range of configurations that enable papermakers to customize their wet-strength programs to satisfy regional demands and regulatory requirements. Solenis has introduced market-leading technologies into each of the widely used industry descriptors of G1, G2, G2.5 and G3 PAE resins, making it possible to address a full range of customer compliance needs while balancing cost-in-use. Today, we offer the broadest portfolio in every region of the world and can provide solutions to satisfy even the most rigorous regulatory guidelines, including environmental labeling established by Nordic Ecolabel and recommendations issued by the German Federal Institute of Risk Assessment (Bundesinstitut für Risikobewertung, or BfR). Solenis’s wet-strength resins can be supplied in a wide range of solids content — from 13 percent total solids to 30 percent total solids — to help our customers balance freight costs, shelf life and product stability concerns.

Compliance Standards for Kymene Wet-strength Resins

We offer the broadest portfolio of wet-strength resins in the world, with different product configurations to accommodate any mill’s compliance standards, regardless of location.
A History of Chemical Innovation

In the late 1950s, Solenis researchers began a quest to find new wet-strength resins that could demonstrate good performance under neutral pH conditions. Their efforts led to polyamido-amine-epichlorohydrin (PAE) resin. Solenis filed its first patent application for PAE resin technology in 1957, and just two years later, it began to market Kynene™ 557 wet-strength resin effective at pH levels between 5 and 8.

But our researchers didn’t just invent the PAE resin: They have continued to refine the chemistry to reduce the by-products of the manufacturing process. In Kynene wet-strength resin synthesis, those by-products include 1,3-DCP and 3-MCPD, as well as ACH and PB-CPD. Both 3-MCPD and 1,3-DCP are considered hazardous substances and are possible human carcinogens. And all of the chlorine-containing by-products, taken together, increase adsorbable organic halogen (AOX) levels in the effluent of paper mills.

As a result, the use of PAE resins is highly regulated and allowable levels of by-products vary greatly from country to country. Government regulators also provide stringent requirements for the use of wet-strength resins in food-packaging applications.

The Synthesis of Kymene Wet-strength Resins

Although the basic reactions in the synthesis of wet-strength resins are well understood, we have introduced advanced process control and purification techniques to increase the efficiency of our products while lowering their environmental impact.

Next-generation Resins

To help papermakers meet compliance standards and government regulations, Solenis further developed and then incorporated “biodehalogenation” into its wet-strength resin manufacturing. This process relies on naturally occurring microorganisms to convert 1,3-DCP and 3-MCPD to glycerol, a simple sugar alcohol that the same microorganisms then use for food. Unlike other physiochemical methods used to reduce and remove epichlorohydrin residuals, biodehalogenation consumes very little energy, requires no additional chemicals and generates no additional waste stream. It does, however, limit the solids and level of functionality of the resins that can be purified this way, requiring papermakers to compromise on performance.

Membrane Separation Technology

A decade of research has led to revolutionary membrane separation technology, which can help paper mills decrease levels of both 1,3-DCP and 3-MCPD and overall AOX.
Solenis’ ongoing commitment to wet strength reflects an increasing demand among consumers for paper products that remain strong even when wet. Today, any grade of paper that needs to maintain its integrity after becoming wet relies on the application of a wet-strength agent. These grades include tissue (facial, kitchen towel, wipers, napkins and tableware), packaging (liquid packaging, aseptic container, carrier board, and other forms of food packaging), and specialty (tea bag, coffee filter, labels, currency, laminating grades, etc.).

Solenis’ PAE resin inventions established the modern wet-strength platform and helped to clarify the fundamental chemistry. Wet-strength resins are a class of chemicals that adhere to pulp fibers and form linkages between fibers through covalent bonding. These linkages supplement and reinforce the natural hydrogen bonding in the dry sheet and, because they’re covalent, cannot be broken by soaking in water and are resistant to cleaning chemicals. Papers treated with these resins, such as kitchen towels and wipers, typically have a wet breaking strength of 30 percent or greater of their dry breaking strength.

### Wet Strength: Satisfying Consumer Demand

Wet-strength papermaking is vitally important because of the prominence these grades have in day-to-day consumer activities and because governments carefully monitor any paper and board that comes into contact with food.

### Wet Strength by the Numbers

- **28%** Towel/Wipers
- **16%** Liquid Packaging Board
- **17%** Facial Tissues
- **8%** Carrier Board
- **6%** Cup and Plate
- **24%** Other Specialty Papers

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### Kymene™ Wet-strength Resin: Active Patents

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### The Future of Wet Strength

As consumer needs and regulatory requirements continue to evolve, wet-strength chemistry must evolve with it, which is why the Kymene story is far from being over. Solenis scientists continue to explore and refine the chemistry we invented at the same time that we research commercially viable alternatives, with the goal of introducing next-generation wet-strength products that:

- Increase solids so significantly that paper mills can cut their deliveries by half, thereby significantly improving sustainability.
- Improve functionality to significantly increase the wet-strength-to-dry-strength ratio papermakers can achieve.
- Remain far ahead of all regulatory compliance issues by further reducing 1,3-DCP, 3-MCPD and total AOX.

All of these innovations will lead to a better Kymene product line that helps our customers adapt to changing industry requirements, deliver products that are both functional and safe for consumers, increase sustainability and minimize associated environmental impacts.