Resin Technology for Engine and Industrial Filtration

Introduction

Hollingsworth & Vose has developed a range of modern resin technologies that satisfy the highest performance requirements of the marketplace, and offer a range of technical solutions for both curing and non-curing element assembly lines.

Resins are critical to the performance of modern filter media. They bind a matrix of fibers to create a strong, flexible material that meets the market's highest performance demands. Major benefits resins can bring to filter media include:

- Strength—enabling operation under increased flow of air or other fluids through the filter
- Minimal resistance to fluid flows—ensuring maximum filtration effectiveness and minimizing pressure drop across the element
- Stiffness—allowing pleats to remain stable without deformation during pleating and application
- Thermal stability—for increased high-temperature operations
- Chemical stability—to resist degradation in service due to use of fuel and lubrication additives (such as detergents and biofuels)

Resin Technology

Today's filtration market is both environmentally conscious and cost-sensitive. Higher-speed pleating, lower energy costs, and reduced environmental emissions are all critical for the element manufacturer. Increasingly, traditional standard-cure phenolic resins can't meet the demands of today's automated, high-speed pleating lines.

Today's resins must deliver elevated levels of performance including:

- High thermal stability over a longer service lifetime
- Rapid cure speed, requiring lower energy input
- Reduced emissions
- Fast pleating speed
- Lower cost of ownership
- High product consistency with low levels of waste

Curable Phenolic Resin Technology

VH60: H&V's standard-cure phenolic resin is ideal for the highest thermal or chemical resistance applications. It's well-suited for specialty applications where performance is critical. VH60 also offers lower emissions than the industry norm—without compromising performance.

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VH188 and VH198: These flexible phenolic resin systems are excellent for air, lube, and fuel applications.

Water-based phenolic resins: H&V boasts a unique range of water-based resole chemistry products for use in lube and fuel applications.

A250: H&V's highest-performing, flexible phenolic technology product features fast curing with improved physical performance compared to traditional phenolic-based resins. A250 delivers longer service life and lower manufacturing costs for a wide range of applications, while retaining a lower environmental impact than those conventional resins. A250 benefits include the following:

- High strength
- Increased flexibility
- Excellent lifetime burst performance
- Reduced processing costs
  - — Higher pleating throughput with lower waste
  - — Faster curing than traditional resin technologies, for lower energy expenses

VH255: This resin provides the same high level of performance as A250 with a slower, more controlled cure speed, suitable for more traditional pleating lines.

F260: This unique, environmentally acceptable (fully GADSL-compliant), flame-retardant phenolic resin meets the market's highest requirements in terms of physical performance and flame retardancy to DIN53438 F1. Water- and heat-durable, F260 retains flame retardancy after extended water soak, plus high levels of strength following extended heat exposure.

Advanced Cure Resin (ACR) Technology

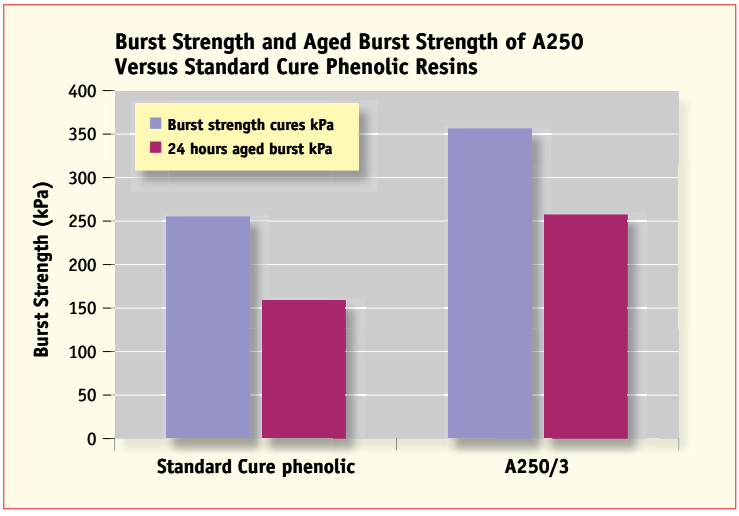
H&V's ACR products exemplify an innovative technology that combines the traditional thermal stability of phenolic resins with the cost benefits of non-cure or low-cure resin offerings.

ACR advantages include:

- Lower running costs with reduced or no oven use
- Higher throughput and productivity
- Lower emissions and reduced environmental impact

ACR products are not a technical compromise. They show significantly increased physical strength (see Figure 1) and performance over traditional phenolic resins, with considerably higher cure speeds as well (see Figure 2) as reducing the energy demand and increasing the throughput for the customer.

Figure 1: Burst strength and aged burst strength of A250 versus traditional standard-cure phenolic resins



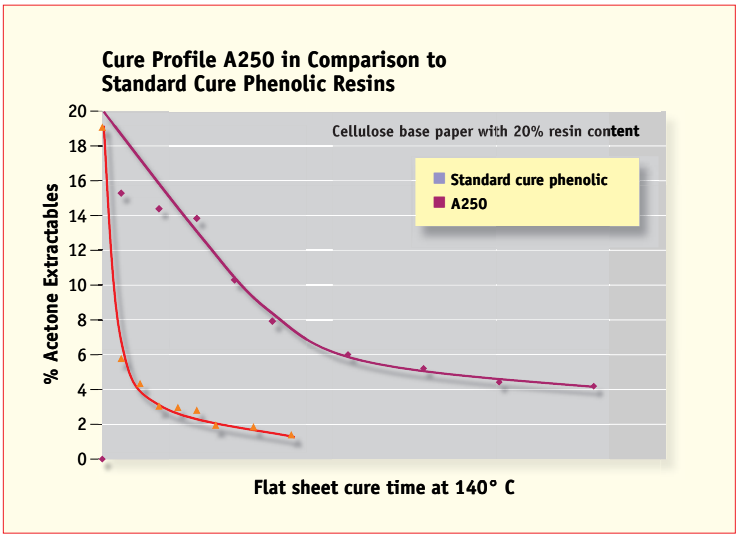


Figure 2: A250 cure in comparison to standard-cure phenolic resins

ACR media are available based on the A250 resin system in different levels of pre-cure, and are suitable for all standard phenolic filter media applications. (See Figure 2.)

A250/3: This partially cured, flexible phenolic technology offers several advantages including:

- Higher pleating speeds over traditional phenolic resins
- Significantly reduced cure time with 50% or lower curing temperatures, for reduced emissions — and thus reduced running costs

A250/7: Cured to a minimum of 70% of its optimal wet burst strength, A250/7 has enough strength for the final application without further cure. It's suitable for processing on lines without curing ovens; post-heating of the pleated pack can be applied to reduce springiness. A250/7 offers the following benefits:

- Phenolic levels of physical performance plus heat and chemical resistance
- Flexibility to facilitate pleating at elevated levels of resin cure
- No need of curing for end-use applications
- Lower capital investment in curing ovens, plus reduced production line footprint
- Extremely low emissions

A250/7 is highly springy when pleated. It's ideal for modern automated production lines with hot-melt edge sealing capabilities. (Other resin technologies are better suited for conventional manual lines.)

Non-Cure (NC) Resin Technology

NC resins combine the ultimate benefits of resin flexibility for pleating with low manufacturing costs. These products are ideal for air filtration applications, where their reduced costs make production simple. (Other resin technologies are more appropriate for elevated fluid temperatures.)

H&V offers a range of NC technologies, including acrylic-based and epoxy resins.

VH134 and VH243: These thermoplastic non-cure resins are ideal for applications where resistance to high temperatures (greater than 80° C for extended periods) or chemicals is not essential, but price and performance are critical. These resins are phenol-free, with no curing required. VH243 offers a higher level of wet performance.

VH243FR: This GADSL-compliant, non-durable FR system meets the requirements of DIN53438 Part 3 F1.

Other thermoplastic resin technologies: With high corrugation depth and good water resistance, H&V's wide range of in-line saturated thermoplastic media for heavy duty air and industrial air filtration meets users' highest performance standards.

VH206: This flexible, high-performance epoxy resin delivers the highest level of performance in a non-cure resin system. VH206 offers no-compromise levels of physical strength in combination with high production speeds.

Applications Performance

Hollingsworth & Vose provides the broadest range of resin technology in the industry. Selection of the correct resin for any particular application is critical. Factors affecting selection include:

- Manufacturing process used by the customer
- Application requirements

The nature of the resin used affects the physical performance of the filter element and the lifetime of the filter.

Process factors include:

- Preheating
- Line speed
- Pleating type: plain or embossment
- Element curing
  — Time and temperature
- Element collating and assembly
  — Springiness

Application factors include:

- Operating temperature
  — Stiffness of the pleats
- Chemical environment
  — Lube oil is highly aggressive at elevated temperatures
  — Fuel is an aggressive solvent
- Water resistance requirements
  — Wet pressure drop recovery
  — Wet stiffness and strength
- Retention of physical performance with flame-retardant technology
- Retention of flame-retardant properties if element becomes damp or wet in service

Environmental Performance

Filter media have been based traditionally on phenolic resins, which deliver a high level of performance at comparatively low cost. But environmentally conscious customers no longer accept these materials' toxic by-products, such as methanol, phenol, and formaldehyde.

Hollingsworth & Vose has worked actively to reduce emissions levels by implementing strict controls on free phenol and formaldehyde in raw materials, and installing the latest manufacturing processes to control emissions within our plants.

With A250/3 ACR media, H&V has significantly reduced the level of phenol and formaldehyde, and eliminated the supply of methanol delivered to customers with traditional phenolic filter media. With our NC and A250/7 resin systems, we offer customers the opportunity to avoid the need for resin curing, as well as the elimination of nearly all emissions.

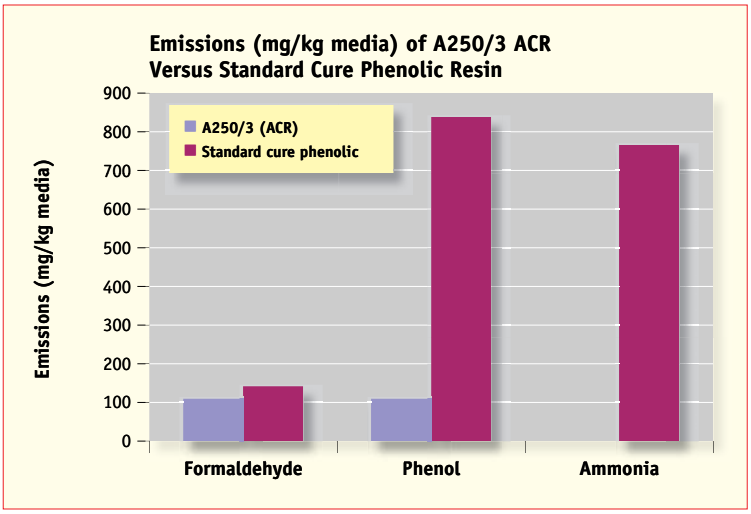


Figure 3: Phenol and formaldehyde emissions of A250 versus standard cure phenolic resins

Selecting a suitable resin could not be simpler. The following tables show the suitability of H&V technology for each application, and indicates typical process settings that should be used for optimal performance.

Applications and Process Settings

H&V Resin code	Description	Panel Air	Heavy Duty Air Gas Turbine	Lube	Fuel CR Diesel Gasoline	EDM
Non-Cure Resin Systems						
VH 134	no-cure acrylic	**	**	not suitable	*	not suitable
VH 243	water-resistant acrylic	**	**	not suitable	*	not suitable
VH 243 FR	flame-retardant, water-resistant acrylic	**	***	not suitable	not suitable	not suitable
VH 206	epoxy resin	****	**	*	**	*
Standard-Cure Resin Systems						
VH 60	resol phenolic	*	*	**	**	***
VH 188	flexible phenolic	**	*	**	**	**
VH 198	flexible phenolic	**	**	**	***	**
VH 255	high-performance, flexible phenolic	***	***	***	***	**
A 250	high-performance, flexible phenolic	***	***	***	***	**
F 260	high-performance, flame-retardant phenolic	***	***	not suitable	not suitable	not suitable
Advanced Cure Phenolic Resins						
A 250/3	high-performance, flexible phenolic	****	***	***	***	**
A 250/7	high-performance, flexible phenolic	***	**	***	***	**
Water-Based Resin Technology						
	water-resistant acrylic	**	****	not suitable	*	*
	water-based phenolic (non-European production only)	not suitable	not suitable	**	**	**

Applications and Process Settings (continued)

H&V Resin code	Description	Pleatability		Preheat Surface Temperatures	Element Manufacture Post-Curing	Environmental Emissions	
		Curable Resin	Non-Curable Resin			Phenol	Formaldehyde to VDA 275
Non-Cure Resin Systems							
VH 134	no-cure acrylic		**	low preheat recommended	no cure required however, some post-pleating heat may be desirable to assist in setting pleats and reducing element springiness		**
VH 243	water-resistant acrylic		***	70-80°C			*
VH 243 FR	flame-retardant, water-resistant acrylic		***	70-80°C			*
VH 206	epoxy resin		***	75-85°C	no cure required		****
Standard-Cure Resin Systems							
VH 60	resol phenolic	**		70-85°C	10 min 160°C	**	**
VH 188	flexible phenolic	**		70-85°C	12 min 160°C	**	**
VH 198	flexible phenolic	**		70-85°C	10 min 160°C	**	**
VH 255	high-performance, flexible phenolic	***		70-85°C	5 min 160°C	**	**
A 250	high-performance, flexible phenolic	****		70-85°C	5 min 160°C	***	***
F 260	high-performance, flame-retardant phenolic	****		70-85°C	5 min 165°C	***	***
Advanced Cure Phenolic Resins							
A 250/3	high-performance, flexible phenolic	****		75-90°C	3 min 160°C	***	***
A 250/7	high-performance, flexible phenolic		****	75-90°C	no cure required	****	****
Water-Based Resin Technology							
	water-resistant acrylic		***	70-85°C	no cure required		*
	water-based phenolic (non-European production only)	***		70-85°C	10 min 160°C	**	*

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