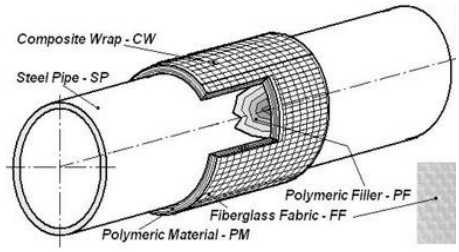

H.B. Composites

Vinyl Ester Composite Coatings and Linings

Engineering Excellence in Corrosion Protection.

Date: September 2025 H.B. Composites (Arian Sadeh Co.) Tehran, Iran

Contact: info@hbcomposites.com | +98-21-22221767

Company Overview

- H.B. Composites (Arian Sadeh Co.) specializes in advanced composite solutions for industrial corrosion prevention and repair. With a focus on fiberglass-reinforced polymer (FRP) technologies, we deliver durable, high-performance coatings and linings tailored to demanding environments. Our Vinyl Ester Composite Coatings represent our flagship offering: a seamless integration of premium vinyl ester resin and woven fiberglass reinforcement, designed for superior chemical resistance, mechanical integrity, and longevity in aggressive service conditions.
- As pioneers in the Iranian composites sector, H.B. Composites adheres to global best practices, ensuring every application meets rigorous engineering standards. This catalog provides precise technical data for engineers, procurement specialists, and maintenance professionals seeking reliable solutions for tanks, pipes, and process equipment.

Fundamentals of Vinyl Ester FRP Systems

- Fiber-Reinforced Polymer (FRP) composites, such as those based on vinyl ester resin, operate on the principle of synergistic material integration. The vinyl ester resin serves as the matrix—a thermosetting polymer derived from the reaction of epoxy resins with unsaturated monocarboxylic acids (e.g., methacrylic acid). This matrix provides chemical resistance by forming a cross-linked network upon curing, which resists penetration by corrosive agents through low permeability and high bond strength.
  - The reinforcement, typically E-glass fiberglass in woven or mat form, imparts mechanical strength by distributing loads across the composite

structure. The fiber-matrix interface, enhanced by silane coupling agents, ensures efficient stress transfer, preventing delamination under thermal, chemical, or mechanical stress. Vinyl ester resins exhibit superior toughness compared to polyesters (due to fewer ester linkages vulnerable to hydrolysis) and better processability than epoxies, making them ideal for corrosion barriers in industrial settings.

- Key scientific principles include:
  - **Curing Mechanism**: Initiated by organic peroxides (e.g., MEKP), leading to free radical polymerization and a rigid, infusible structure.
  - **Corrosion Resistance**: Achieved via molecular barriers that minimize diffusion of ions and molecules, quantified by low water absorption (<0.5% per ASTM D570).
  - **Mechanical Enhancement**: Fibers increase tensile strength by 5-10 times over unreinforced resin, following the rule of mixtures for composite properties.

Product Overview

- H.B. Composites Vinyl Ester Composite Coatings and Linings are engineered for internal and external protection of industrial equipment against corrosion, erosion, and leakage. These systems utilize a thermosetting vinyl ester resin matrix reinforced with woven E-glass fiberglass fabric (typically 450-800 g/m²), forming a robust laminate that bonds tenaciously to substrates such as carbon steel, stainless steel, concrete, and fiberglass.
- To clarify terminology: **Coatings** generally refer to thinner protective layers (often 0.5-2 mm) applied to external surfaces for environmental protection, abrasion resistance, or aesthetic purposes. **Linings**, in contrast, are thicker barriers (typically 2-10 mm) installed internally to withstand immersion in aggressive media, providing a seamless, impermeable shield against contained chemicals and preventing leakage or substrate degradation. Our systems encompass both, offering versatile solutions for comprehensive asset protection.
- Key benefits include:

- **Exceptional Chemical Resistance**: Withstands acids, alkalis, solvents, and oxidizers without degradation.
- **High Mechanical Strength**: Provides structural reinforcement, extending asset life by 20-30 years in typical applications.
- **Thermal Stability**: Continuous service up to 93°C (200°F), with peaks to 120°C (248°F).
- **Versatile Application**: Suitable for hand lay-up, spray-up, or filament winding, with thicknesses from 2.5 mm (corrosion barrier) to 10 mm (structural lining).
- **Low Permeability**: Vapor transmission rates <0.1 perm (ASTM E96), minimizing substrate attack.

- These coatings are ideal for rehabilitation of aging infrastructure or new construction, preventing downtime and reducing lifecycle costs by up to 50% compared to metallic alternatives.

Technical Specifications

Material Composition

Component	Description	Typical Specification
Resin	Brominated or non-brominated vinyl ester (bisphenol A-fumarate)	Viscosity: 200-400 cps; Gel time: 15-30 min at 25°C; MEKP catalyst (1-2% by wt.)
Reinforcement	Woven E-glass fabric	Areal weight: 450-800 g/m²; Binder: Silane-treated for resin compatibility
Surface Veil	Synthetic (C-veil or Nexus®)	Thickness: 0.02-0.05 mm; For resin-rich outer layer
Fillers/Additives	Thixotropic agents, promoters (CoNap 6-12%)	Minimal; No pigments in corrosion barrier
Laminate Structure	Corrosion barrier (2-3 mm) + Structural plies	Glass content: 25-35% by weight; Void content <2% (ASTM D2734)

Mechanical Properties

- Tested per ASTM standards on hand lay-up laminates (60% resin content, post-cured at 80°C for 2 hours). Values are typical minimums for 3 mm thick samples, compliant with ISO 24817 and ASME PCC-2.

Property	Test Method	Value (Imperial)	Value (Metric)	Notes
Tensile Strength	ASTM D638	30,000 psi	207 MPa	Longitudinal direction
Tensile Modulus	ASTM D638	1.8 × 10⁶ psi	12.4 GPa	-

Flexural Strength	ASTM D790	40,000 psi	276 MPa	-
Flexural Modulus	ASTM D790	2.0 × 10^6 psi	13.8 GPa	-
Interlaminar Shear Strength	ASTM D2344	3,000 psi	20.7 MPa	-
Impact Strength	ASTM D256	10 ft-lb/in	534 J/m	Notched Izod
Hardness	ASTM D2583	40-50 Barcol	-	Post-cure, per ISO 24817
Density	ASTM D792	110-120 lb/ft^3	1.76-1.92 g/cm^3	-

- Data derived from representative vinyl ester FRP systems; actual values may vary with fabrication.

Chemical Resistance

- The chemical resistance of H.B. Composites Vinyl Ester Composite Coatings and Linings is evaluated per ASTM C581 (Standard Practice for Determining Chemical Resistance of Thermosetting Resins in FRP Structures), as required by ISO 24817 and ASME PCC-2. Exposure: 7 days at 25°C, immersion; rating based on <5% weight change and no blistering/delamination. The listed temperatures represent the highest known values for good service life in industrial or laboratory testing, but they are not necessarily the maximum service limits.
- Ratings are categorized as follows:
  - **Excellent**: Robust performance at high temperatures (>80°C/176°F) for continuous exposure.
  - **Good**: Reliable performance at moderate temperatures (50–80°C/122–176°F) for extended exposure.
  - **Fair**: Acceptable performance at lower temperatures (<50°C/122°F) for short-term exposure.
  - **Limited**: Conditional use for brief exposure (3 days to 1 year at ≤40°C/104°F), requiring cleaning and inspection.
- For additional chemicals or specific guidance, please contact H.B. Composites for further information or data requests.

Chemical	Concentration	Temperature (°C/°F)	Rating
Acetic Acid	25%	50/122	Good
Acetic Acid	50%	70/158	Good
Acetic Acid	75%	60/140	Good
Acetone	10%	40/104	Fair
Alcohol (Ethanol)	20%	50/122	Good
Alcohol (Ethanol)	50%	40/104	Fair

Alum	All	100/212	Excellent
Aluminium Chloride	All	100/212	Excellent
Aluminium Sulfate	All	100/212	Excellent
Ammonia Water[1]	5%	80/176	Excellent
Ammonia Water[1]	10%	65/149	Good
Ammonium Chloride	All	100/212	Excellent
Ammonium Hydroxide[1]	5%	80/176	Excellent
Ammonium Hydroxide[1]	20%	65/149	Good
Ammonium Nitrate	All	100/212	Excellent
Ammonium Sulfate	Sat'd	100/212	Excellent
Barium Chloride	All	100/212	Excellent
Barium Sulfate	All	100/212	Excellent
Benzoic Acid	All	100/212	Excellent
Benzoline/Naphtha	100%	80/176	Excellent
Borax	All	100/212	Excellent
Boric Acid	All	100/212	Excellent
Brine	All	100/212	Excellent
Bromine Water	5%	60/140	Good
Butanol	All	50/122	Good
Calcium Chloride	All	100/212	Excellent
Calcium Hydroxide[1]	All	80/176	Excellent
Calcium Hypochlorite[1,2,3]	All	80/176	Excellent
Calcium Nitrate	All	100/212	Excellent
Calcium Sulphate	All	100/212	Excellent
Chlorine Dry Vapor[4,2]	100%	100/212	Excellent
Chlorine Water	All	90/194	Excellent
Chlorine Wet Vapor[4,3]	100%	100/212	Excellent
Chloroacetic Acid	25%	50/122	Good
Chromic Acid	10%	85/185	Excellent
Chromic Acid	20%	60/140	Good
Citric Acid	All	100/212	Excellent
Copper Chloride	All	100/212	Excellent
Copper Sulfate	All	100/212	Excellent
Crude Oil	100%	100/212	Excellent
Diesel Fuel	All	80/176	Excellent
Ferric Chloride	All	100/212	Excellent
Ferric Sulfate	All	100/212	Excellent
Ferrous Chloride	All	100/212	Excellent
Ferrous Sulfate	All	100/212	Excellent
Formaldehyde	All	65/149	Good
Formic Acid	10%	80/176	Excellent
Formic Acid	30%	65/149	Good

Fuel Oil	100%	80/176	Excellent
Hydrochloric Acid[5,6]	20%	90/194	Excellent
Hydrochloric Acid[5,6]	25%	80/176	Excellent
Hydrochloric Acid[5,6]	30%	65/149	Good
Hydrochloric Acid[5,6]	37%	50/122	Good
Hydrofluoric Acid[1,3]	10%	65/149	Good
Hydrogen Peroxide[2,3]	20%	65/149	Good
Lactic Acid	All	100/212	Excellent
Magnesium Chloride	All	100/212	Excellent
Magnesium Hydroxide[1]	All	100/212	Excellent
Magnesium Sulfate	All	100/212	Excellent
Mineral Oil	100%	100/212	Excellent
Motor Oil	100%	100/212	Excellent
Nitric Acid[3]	5%	65/149	Good
Nitric Acid[3]	20%	50/122	Good
Oleic Acid	All	100/212	Excellent
Phosphoric Acid	All	100/212	Excellent
Potassium Chloride	All	100/212	Excellent
Potassium Hydroxide[1,3]	All	65/149	Good
Potassium Nitrate	All	100/212	Excellent
Potassium Sulfate	All	100/212	Excellent
Seawater	All	100/212	Excellent
Sodium Bicarbonate	All	80/176	Excellent
Sodium Bisulfate	All	100/212	Excellent
Sodium Chloride	All	100/212	Excellent
Sodium Hydroxide[1,3]	5%	75/167	Good
Sodium Hydroxide[1,3]	10%	75/167	Good
Sodium Hydroxide[1,3]	25%	75/167	Good
Sodium Hydroxide[1,3]	50%	80/176	Excellent
Sodium Hypochlorite[1,2,3]	6%	80/176	Excellent
Sodium Hypochlorite[1,2,3]	15%	60/140	Good
Sodium Nitrate	All	100/212	Excellent
Sodium Sulfate	All	100/212	Excellent
Sulfuric Acid	70%	70/158	Good
Sulfuric Acid	80%	100/212	Excellent
Water	-	100/212	Excellent
Water (tap water)[3]	100%	100/212	Excellent
Zinc Chloride	All	100/212	Excellent
Zinc Sulfate	All	100/212	Excellent

Footnotes

General Note: Information indicated in footnotes is essential to ensure a good

service life of FRP equipment. It is strongly recommended that these are followed.

[1] Two layers of organic fiber surfacing veils are required in the corrosion barrier.

[2] BPO/DMA curing system is recommended.

[3] Post-cure recommended for increasing service life.

[4] Corrosion barrier requires two layers of chemical-resistant fiberglass surfacing veil and 2.5–5 mm thickness.

[5] Corrosion barrier requires two layers of chemical-resistant fiberglass surfacing veil.

[6] Corrosion barrier requires acid-resistant glass fiber or C-glass fiber.

Thermal and Environmental Performance

- **Continuous Service Temperature:** 93°C (200°F) in non-oxidizing media, validated per ISO 24817 and ASME PCC-2.
- **Thermal Conductivity:** 0.2-0.3 W/m·K (ASTM C518).
- **Flammability:** Class 1 (ASTM E84); Optional fire-retardant grades available.
- **UV Resistance:** Good with topcoat; Pigmented gel coat extends outdoor life >10 years.

Applications

- H.B. Composites Vinyl Ester Systems are deployed across industries requiring robust corrosion barriers:

Industry	Equipment	Typical Use Case
Oil & Gas	Storage tanks, pipelines	Internal lining for crude oil/sour gas; External coating for leak repair
Chemical Processing	Reactors, sumps, ducts	Immersion service in acids/alkalis; Containment basins
Water/Wastewater	Clarifiers, lift stations	Abrasion-resistant linings; Odor control in sewers
Power Generation	Cooling towers, scrubbers	Flue gas desulfurization; Boiler feedwater tanks
Pulp & Paper	Digesters, bleach towers	Hypochlorite resistance; Structural reinforcement

Case Studies: Successful Projects

- H.B. Composites has completed +28 successful projects since 1996, demonstrating proven expertise in GRV (Glass-Reinforced Vinyl Ester) linings for towers, tanks, and pipelines. Below is a selection of key installations:

Project Description	Service Conditions	Client	Year
GRV Lining on 100,000 L Tanks TK-508 A&B	Acidic brine at 100°C	Shiraz Petrochemical	1995
GRV Lining on 100,000 L Tank D-503	Sodium Hypochlorite	Shiraz Petrochemical	1995

GRV Lining on 300,000 L Tanks TK-902 A&B	33% Hydrochloric Acid	Shiraz Petrochemical	1997
GRV Lining on 400,000 L Tanks TK-803 A&B	Sodium Hypochlorite	Shiraz Petrochemical	1997
GRV Lining on Tower C-703	Hydrochloric Acid at 140°C	Bandar Imam Petrochemical	2002
GRV Lining on Absorption Tower C-701	Hydrochloric Acid at 140°C	Bandar Imam Petrochemical	2002
GRV Lining on Tower C-101	VC & EDC	Bandar Imam Petrochemical	2002
GRV Lining on Hydrochloric Acid Storage Tank	30% Hydrochloric Acid	Arak Petrochemical	2005
GRV Lining on Sodium Hypochlorite Storage Tank	Sodium Hypochlorite	Kimia Bon	2008
Kimia-Coat Lining on GRV Tank M-801	Inert Gas 64% - Ethylene Gas 20%	Bandar Imam Petrochemical	2008
GRV Lining on Tank and Channel	Seawater	Lavan Refinery	2008
GRV Coating on Gasoline Transfer Pipelines	Saline Soil	Shahroud Pipelines	2008
GRV Lining on Tank 30-V-3004	37% Hydrochloric Acid at 40°C	Arak Petrochemical	2005
GRV Coating on 26" Oil Transfer Pipe	Oil and Products Transfer	Arak Pipelines	2005
GRV Coating on 20" Oil Transfer Pipe	Oil and Products Transfer	Isfahan Pipelines	2005
GRV Coating on 12" Oil Transfer Pipe	Oil and Products Transfer	Rey Pipelines	2005
GRV Coating on 18" Pipe	Crude Oil Transfer	Isfahan Pipelines	2011
GRV Coating on 16" and 14" Oil Transfer Pipelines	Products and Crude Oil Transfer	Khuzestan Pipelines	2005
GRV Coating on 14" Oil Transfer Pipeline	Products and Crude Oil Transfer	Tehran Pipelines	2005
GRV Lining on Tank TK-2012	Chemical Waste	Arak Petrochemical	2005
GRV Lining on Distillation Unit Heat Exchangers	Seawater Transfer	Lavan Refinery	2005
GRV Lining on Hydrochloric Acid Storage Tank	32% Hydrochloric Acid	Kimia Bon	2005
GRV Lining on Sodium Hypochlorite Storage Tank	Sodium Hypochlorite	Kimia Bon	2007
GRV Coating on 16" Oil Transfer Pipeline	Products and Crude Oil Transfer	Lorestan Pipelines	2014
GRV Lining on Caustic and Hydrochloric Acid Storage Tank	HCL 32% at 65°C; NaOH 15% at 65°C	Kermanshah Petrochemical	2016
GRV Lining on Hydrochloric Acid Storage Tank	HCL 32% at 65°C	Kermanshah Petrochemical	2024

- These projects demonstrate our ability to deliver reliable linings in harsh chemical and thermal environments, with performance verified through client feedback and inspections.

Coating of Various Components

- In addition to tank, tower, and pipeline projects, H.B. Composites has successfully completed 12 component coating projects since 1995, applying GRV linings and coatings to various equipment components exposed to aggressive process fluids or environmental conditions. Below is a selection of key installations:

Project Description	Service Conditions	Client	Year
GRV Lining on THICKENER Agitators	Wastewater	Zolal Iran Co.	1995
GRV Lining on Ferric Chloride Mixer Impeller	Ferric Chloride	Zolal Iran Co.	1995
GRV Lining on Brine Pump	Brine (Chlorine Unit)	Abadan Petrochemical	1995

GRV Lining on SCRUBBER Interior	SO3 Gas	Toli Pers Co.	1995
GRV Lining on Brine Filter	Brine	Tehran Water & Wastewater	1997
GRV Lining on Ferric Chloride Filter	Ferric Chloride	Tehran Water & Wastewater	1997
GRV Lining on Inlet & Outlet Components	Chlorine Unit Fluids	Shiraz Petrochemical	1997
GRE Coating on Metallic Risers (Filament Winding)	Seawater (Offshore)	TOTAL/ELF	2005
GRV Lining on Fan 902 Body	Chlorine Gas	Shiraz Petrochemical	2005
FRP Lining on Inlet & Outlet Components	Chlorine Unit Fluids	Abadan Petrochemical	2005
GRV Lining on Diaphragm Valve	Various Chemical Units	Azarnab Co.	2005
GRV Lining on Chlorine Unit Cells	Chlorine Fluids	Abadan Petrochemical	2008

Surface Preparation and Application Guidelines

Adherence to these procedures ensures optimal bond strength (>200 psi, ASTM D4541) and performance. All work is performed by certified applicators.

Surface Preparation

1. **Inspection**: Assess substrate for contamination, pitting, or defects (NACE SP0178).
2. **Cleaning**: Remove oils/grease via solvent wipe (SSPC-SP1); Abrasive blast to Sa 2½ (ISO 8501-1) for steel; Acid etch (10% HCl) for concrete, followed by neutralization.
3. **Profile**: Achieve 3-5 mil anchor pattern (CSP 3-5 for concrete).
4. **Environmental Controls**: Substrate temperature >5°C above dew point; RH <85%; No application in direct rain.

Application Procedure

1. **Priming**: Apply vinyl ester primer (0.1-0.2 mm DFT) for adhesion promotion.
2. **Corrosion Barrier**: Lay 2-3 plies of surface veil + chopped strand mat (CSM, 450 g/m²) in resin, achieving 2.5 mm min. thickness. Roll out air voids to ensure <2% void content (ASTM D2734).
3. **Structural Layers**: Alternate woven roving (WR, 600 g/m²) and CSM plies, wet-out with resin (1:1 fiber:resin ratio). Total build: 3-10 mm.
4. **Topcoat**: Resin-rich gel coat (0.5 mm) with UV in hibitors for external exposures.
5. **Curing**: Formulated for ambient cure, with post-curing at 60–80°C for 4–8 hours recommended to achieve optimal hardness (>90% Barcol per ASTM D2583).

6.

7. **Inspection and Testing**:
    - **Adhesion Test**: Pull-off test per ASTM D4541, ensuring >200 psi bond strength, per ISO 24817 and ASME PCC-2.
    - **Holiday Testing**: Non-destructive testing per ASTM D5162 to detect pinholes or defects, per ISO 24817 and ASME PCC-2.
    - **Thickness Verification**: Measured per ISO 2808 to confirm uniform thickness of 2.5-10 mm, per ISO 24817 and ASME PCC-2.
    - **Hardness Test**: Barcol hardness per ASTM D2583 to verify cure quality (>90% hardness), per ISO 24817.
    - **Chemical Resistance Test**: Immersion testing per ASTM C581 for specific media (e.g., 32% HCl, 15% NaOH) to ensure performance in service conditions, per ISO 24817 and ASME PCC-2.

Tools: Rollers, brushes, or spray equipment; Cure with MEKP (1.5-2% by wt.). Minimum overlap: 50 mm at seams.

Standards Compliance and Quality Assurance

- H.B. Composites systems conform to the following international standards, ensuring traceability and reliability:

Standard	Description	Compliance Level
ASTM C581	Chemical Resistance of Thermosetting Resins in FRP	Full (Immersion Testing)
ASTM C582	Contact-Molded RTP Laminates for Corrosion Equipment	Type I, Grade 1
ASTM D3299	Filament-Wound FRP Tanks	Filament-Wound Variant
ASTM D4097	Contact-Molded FRP Tanks	Contact-Molded Variant
ASTM D6041	Contact-Molded FRP Pipe/Fittings	Full
ASTM D638/D790	Tensile/Flexural Properties	Tested & Certified
ISO 8501-1	Surface Preparation	Sa 2½ Minimum
NACE SP0178	Fabrication of FRP Equipment	Design/Inspection
ANSI/RTM-1	Reinforced Thermoset Plastic Equipment	Equivalent
ASME PCC-2	Repair of Pressure Equipment and Piping (Part 4: Nonmetallic and Bonded Repairs)	Full for Composite Wraps and Linings
ISO 24817	Composite Repairs for Pipework – Qualification, Design, Installation, Testing, and Inspection	Full for Qualification and Application

- Quality is maintained via ISO 9001:2015 certification, batch testing, and third-party verification. All materials are free of halogens in food-grade applications (FDA 21 CFR 177.2420 compliant where applicable).

Why Choose H.B. Composites?

- **Proven Durability**: 28 successful projects since 1996 across petrochemical, refinery, and pipeline sectors, verified per ISO 24817 and ASME PCC-2.
- **Custom Engineering**: Tailored formulations for specific media/temperatures.
- **Sustainability**: Low-VOC resins; Recyclable waste streams.
- **Support**: On-site training, 24/7 technical assistance, and 10-year warranty on qualified applications.

Important Notices

- For quotes, samples, or consultations, contact our engineering team. Together, we safeguard your assets for the future.
- **H.B. Composites – Integrity in Every Layer**
- *This document is for informational purposes. Specifications subject to change without notice. Consult H.B. Composites for project-specific recommendations.*

Contact Information

- Address: Suite 14, No. 1, 2nd Alley, North Razan, Mirdamad Blvrd, Tehran, Iran
- Phone: +98-21-22221767
- Fax: +98-21-22252921
- Email: info@hbcomposites.com
- Website: www.hbcomposites.com