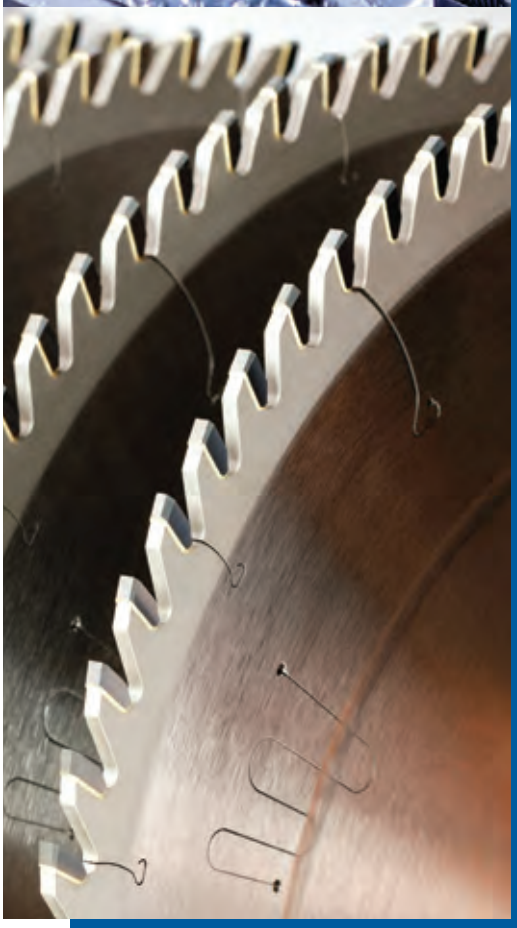
EASTMAN

Eastman solutions improve hot-melt strippable coatings.

Eastman Solus™
performance additive

Transportation, warehouse, and industrial facility and operations managers around the world are responsible for the conditions of an incredible range of metal machinery and components. This can include saw blades, drill bits, gears, rotors, stators, bearings, flanges, fasteners and more in environments ranging from marine to mining. These items are vulnerable to damage and corrosion that can be incredibly expensive to replace and repair. The global impact of corrosion alone costs businesses trillions of dollars each year. Fortunately, hot-melt strippable coatings containing Eastman Solus™ performance additives can help provide long-term protection and significantly reduce overall costs.



Application overview

Hot-melt strippable coatings provide flexible protective casings around a variety of metal assets, preventing damage through manufacturing, transport and storage. These coatings also reduce corrosion to parts and machinery in environments subject to dust, dirt, chemical contamination, temperature extremes and high humidity. They enable parts to be stored longer and reduce inspection and maintenance frequency, resulting in less downtime and improved safety and aesthetics.

Unlike traditional coatings, hot-melt strippable coatings can be peeled away easily when parts such as cover flanges, bolted assemblies, casings containing bearings and protective shields must be removed. Afterward, they can be reapplied and the parts put back in service.

During electroplating, hot-melt strippable coatings can mask components that don't require plating.

Hot-melt strippable formulations are applied at elevated temperatures and high film thickness, usually by dipping or spraying. Once the molten material is applied, the part can often be handled within a few minutes, increasing process productivity. In challenging environments, two coat applications may be required to achieve a thickness of 0.4–0.5 mm, fully cover parts and ensure the best protection.

Product-in-use details

The composition of a hot melt typically includes a cellulose ester polymer, plasticizer, oil, heat stabilizer and corrosion inhibitor. Once applied, it provides a durable, tough finish resistant to UV oxidation, salt and humidity. The oil embedded in the coating gradually exudes to the metal surface, providing continuous corrosion protection over many years. The polymer matrix of Solus™ helps retain and exude oil at a controlled rate, providing excellent long-term protection in challenging environments. Formulations can be designed with low, medium or high oil exudation. A formulation with a high level of oil exudation is ideal for highly corrosive environments. Figure 1 shows a section of coating with high exudation. The oil can be visually observed leaching from the material.

Figure 1. **A section of hot-melt strippable material that is leaching oil**

Eastman has supplied cellulose esters to the hot-melt strippable market for many years, and our cellulosic derivatives have a proven track record of metal protection. Since the formulation of a hot melt varies widely depending on performance requirements, various Solus™ grades may be used. Eastman technical service experts can recommend the best choice based on overall performance requirements, including excellent heat stability, toughness and, most importantly, the capability to retain a high percentage of synthetic or vegetable oil in the polymer matrix.

Solus™ cellulose esters are nontoxic and suitable for hand peeling from metal parts. Hot-melt strippable coatings used for protecting metal parts that contact food may require food-contact grades. Several Solus™ grades are offered in a food-contact grade that meets requirements for certain applications under regulations of the U.S. Food and Drug Administration (21 CFR), the European Commission (Regulation 10/2011), and the Switzerland Ordinance of the Federal Department of Home Affairs (FDHA) on materials and articles intended to come into contact with foodstuffs (817.023.21, Annex 10). They are manufactured, stored, handled and transported under conditions adhering to current Good Manufacturing Practices (cGMP) for food-contact applications. Contact your Eastman representative or authorized distributor for specific regulatory compliance documentation.

When formulated correctly, formulations based on Solus™ can help formulators meet the requirements of the demanding conditions required to achieve Military Specification MIL-P-149D. Achieving this specification enables the protection of metal parts in corrosive environments and extreme weather conditions, from temperatures as low as –54°C to as high as 71°C.

Depending on the formulation, most hot-melt strippable coatings based on Solus™ are 100% nonvolatile materials and usually supplied in block or chunk form. They don't contain volatile solvents. Any used or unused material can be remelted and reused. The coatings can be formulated to be colorless or colored to suit company logos or promotional designs.

Many coating formulation variables need to be considered, so it's important to consult an Eastman expert and experiment to obtain the desired properties. A hot-melt strippable formulation generally consists of the ingredients listed in Table 1.

Table 1. Formulation components of a hot-melt strippable coating

Substance	Type of substance	Reason for use in the formulation
Polymer	Solus™	• Polymer matrix helps retain and exude oils at a controlled rate. • Formulations based on Solus™ could help formulators meet the requirements of Military Specification MIL-P-149D, enabling protection of metal parts at temperatures between 54°C and 71°C. • Rapid drying or setup time allows parts to be handled quickly.
Plasticizer	Diisononyl phthalate (DINP) Eastman DOP plasticizer Eastman benzoates Eastman 168™ non-phthalate plasticizer Eastman Effusion™ plasticizer	• Plasticizes the polymer to provide the required hardness and peelability; DINP is an ideal plasticizer. • A non-phthalate plasticizer such as Eastman 168 or Eastman Effusion can also be used. Changing the plasticizer type can dramatically affect the production and final properties of the strippable coating, so adjustments may be required.
Oil	Synthetic Mineral Vegetable (soybean, castor)	• This is required to leach out from the hot-melt coating and protect the metal part against corrosion. • This can also affect the hardness and peelability. • Oil leaching will be observed in high-content formulations. • Oil leaching will not be observed in low-content formulations. The formulations are called "dry-feel strippable coatings."
Heat stabilizer	Thermal stabilizer ESBO Hindered phenols Organophosphites	• This will reduce the thermal degradation of formulations on repeated heating. • Epoxidized soybean oil (ESBO) is a favored heat stabilizer often used at 5%. • Hindered phenols such as Irganox® 245 and organophosphates can also be used.
Corrosion inhibitor	Various	• Depending on the protection required, a corrosion inhibitor package may be required.

Formulation ingredients can affect the hardness, toughness and, ultimately, the degree of peelability. Shore hardness is a measure of resistance to indentation. A Shore A hardness of 80–90 is hard, tough and difficult to peel from a coated substrate, while a Shore A hardness of 30–40 is softer, less tough and easier to peel. A Shore A hardness of zero indicates that the material is very soft and tacky and contains too much plasticizer. Due to their molecular compositions, various Solus™ grades can provide different levels of coating hardness at the same level of plasticizer. Contact your Eastman technical representative to discuss which Solus™ grade is best for your application.

Formulation design

To assess several critical properties, two hot-melt strippable coating formulations were produced — one with high oil exudation and the other with a lower level.

Figure 2. End of a metal drill bit dipped in the hot melt, cooled and handled

Table 2. Evaluation of hot-melt strippable coatings based on two Solus™ grades

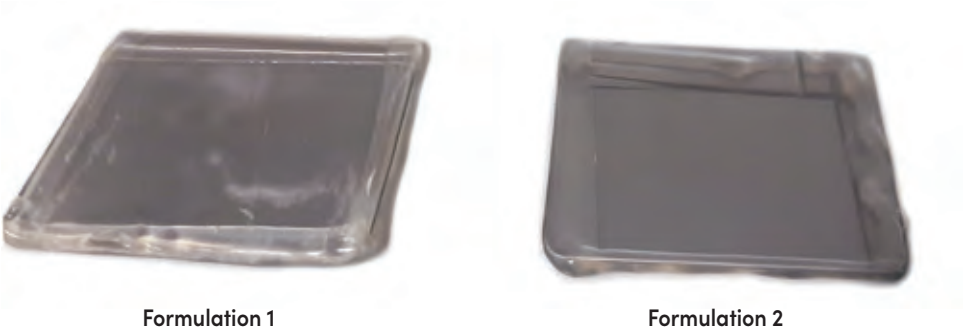
Physical property	Test method	Formulation 1	Formulation 2
Oil exudation	24 hr at 40°C (Military Specification MIL-P-149D) (% loss of liquid and volatile constituents calculated from the loss in weight)	–0.1 (low)	–0.5 (high)
Ability to peel	Cut edges with a sharp knife and peel by hand.	Peelable	Peelable
Hardness	Shore A	65–70	35
Clarity and color (based on added colorant)	Visual	Transparent blue	Transparent yellow
Nonvolatile content (%)	Calculated	100	100

The results show that a suitable Solus™ grade and the correct ingredient ratio can produce two hot-melt strippable coatings with varying degrees of oil exudation — one with high exudation and one with low exudation. The choice of formulation will depend on the application. Both are easy to apply and show excellent peelability.

Corrosion resistance testing

Metal test panels (cold-rolled steel, 0.81-mm thickness, Q-panel S-46) were degreased with isopropanol and hot dipped into either formulation 1 or formulation 2. After drying under ambient conditions for one minute, the panels were touch dried. The dry film thickness (DFT) was measured in the center of the test panel after a single dip, and the value was 800–1,000 microns. When examining the panels, it was noted that the edges of the metal panels had a much thinner coating compared to the middle of the panel. Thinner coatings are more likely to have defects such as pinholes. Entrapped air bubbles, dust particles or debris can also allow the salt solution to penetrate the coating and creep underneath it. This may corrode the metal, so it's important to check for defects. The edges of the panels were dipped with a second coat of material to counteract this effect for a total edge DFT of approximately 2,000 microns. A dry coating thickness of 2,000 microns (by double dipping) is recommended for metal edges, with the remaining metal surface having a dry coating thickness of 800–1,000 microns. Dipping the whole metal panel twice is another option to reduce defects that lead to corrosion. Producing defect-free coatings unlocks the true potential of hot-melt strippable coatings using Solus™ for corrosion protection under extremely corrosive environments.

Figure 3. Dipped metal test panels prior to salt spray corrosion testing



Formulation 1 Formulation 2

After 24 hours of drying under ambient conditions, the coated panels were placed into a salt spray machine for corrosion testing for 1,500 hours according to ASTM B117. The panels were placed in the middle of the salt spray chamber, which was fed with 5% salt water and converted into a mist of salt fog. The panels were checked regularly for signs of corrosion and coating damage.

Table 3. Salt spray results

Time (hr)	Formulation 1	Formulation 2
48	No rust	No rust
168	No rust	No rust
744	No rust	No rust
1,500	No rust	No rust

After 1,500 hours of harsh salt spray testing, the metal underneath the coating looked corrosion free. To further inspect the metal for any signs of corrosion, the coating from formulation 2 was easily removed (stripped) from the panel by cutting the edges. This removal technique is often performed on hot-melt strippable coatings to inspect valves, connections and other metal parts exposed to marine conditions. After stripping, the metal panel showed no signs of damage or corrosion from testing. The noncorroded metal panel contained a film of oil. This is normal and shows the coating system was functioning properly by exuding oil onto the metal surface and protecting the surface from corrosion. The stripped coating can be collected, remelted and reused if desired.

Figure 4. The edges of the coatings (formulation 2) are cut, allowing the coating to be peeled off.

Figure 5. Peeled-off hot-melt strippable coating (formulation 2) shows no damage to the metal. An oil film is visible.

ASTM B117 is an accepted test method to evaluate the long-term performance of protective coatings under extremely corrosive environments. The results show that the hot-melt strippable coating formulations can easily withstand over 1,500 hours of harsh salt spray conditions, which simulate the most aggressive marine environments and correlate to 15 years of "real life" exposure.

Conclusion

In addition to the high financial cost to companies to replace damaged components and machinery, corrosion can impact safety and affect the metal's appearance. By enveloping and encapsulating it with durable, tough coatings, the need for replacement parts is significantly reduced.

Hot-melt strippable coatings are unique because they protect against damage and corrosion and can easily be peeled away, an advantage when metal parts — such as flanges and fasteners used on exterior piping systems in challenging offshore and onshore environments — must be removed for servicing or alteration. During use, their retained oil leaches out at a controlled rate to protect metal parts from corrosion. When a part is dipped or sprayed with molten material and then removed from that material, it can often be handled within a few minutes.

Most hot-melt strippable coatings based on Solus™ are 100% solid materials and don't contain harmful volatile organic solvents. Any stripped or unused material can be remelted and reused, leading to cost and material savings.

The materials referenced in this brochure are a good starting point for creating hot-melt strippable coatings that provide excellent long-term corrosion protection for numerous metal components. When formulated correctly, formulations based on Solus™ can meet very demanding requirements, including military specifications that require protection of metal parts in extremely corrosive environments and weather conditions with temperatures as low as –54°C and as high as 71°C. (Customers should perform their own in-house testing before submitting a final compound for compliance with Military Specification MIL-P-149D.)

Contact your Eastman technical representative or your authorized Eastman distributor to help determine the best Solus™ for your specific hot-melt strippable coating need.

Globally, the impact of corrosion costs businesses trillions of dollars each year. Hot-melt strippable coatings containing Solus™ can help provide long-term protection against that damage.

For nearly a century, Eastman has been the world leader in manufacturing specialty cellulose esters and has developed deep application expertise. Eastman Solus™ can help formulators achieve high performance, enduring beauty, sustainability and regulatory compliance. Because of the breadth of possibilities, this naturally derived cellulosic is ideal for many applications. It offers the consistency and quality that formulators require and brand owners rely on. Eastman Solus™ — the natural choice.

EASTMAN

Eastman Corporate Headquarters
P.O. Box 431
Kingsport, TN 37662-5280 U.S.A.

U.S.A. and Canada, 800-EASTMAN (800-327-8626)
Other locations, +(1) 423-229-2000

eastman.com/locations

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