Plastic Protective Coatings

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Plastic coatings are being tried by Union Sugar Division, Consolidated Foods Corporation in place of the usual oil paints as a means of providing a more complete, durable coating that will fully resist corrosion. During the year 1955, coatings have been applied successfully to the continuous diffuser, Oliver filters, other internal equipment, and to a lesser extent on the buildings and other minor pieces of equipment. With the rising costs of labor and materials necessary to make yearly replacements in equipment due to corrosion and numerous paint failures, plastic coatings were tried as a means of controlling these losses. (1, 2)[2].

A careful survey of the available types of plastic materials was made and coatings were selected for trial primarily on the basis of their ability to withstand the corrosive effects of temperature and moisture. The next consideration was whether to determine if the material would stand both acid and alkaline corrosive agents. This latter requirement was first tested in the laboratory prior to application and subsequently in the field. In the laboratory tests, the materials were subjected to pure mineral reagents and in the field, the results of natural organic reagents present in the juices were observed.

In the application of plastic coatings to beet sugar equipment, it has been found that strict attention must be given to the conditions existing at the point of application. Generally speaking, when excessive moisture and heat conditions are present, in addition to the constantly changing acid and alkaline corrosive agents, extreme toughness and durability on the part of the plastic is required. Certain fundamental requirements had to be adhered to if satisfactory performance was to be obtained. These were: 1. Preparation of surface. 2. Adequate film thickness. 3. Selection of type of plastic material.

Preparation of Surface

The success or failure of any plastic coating starts with surface preparation (3). In instances where the coating is subjected to total immersion, the surface must be sandblasted to white metal. In no case has our company been able to hold a coating under these conditions without resorting to this procedure. Where the surface is exposed only occasionally to wetting or fumes, a thorough wiping and wire brushing of the corroded surface was sufficient. Other methods such as solvent cleaning,

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[2] Numbers in parentheses refer to references.

pickling, or flame cleaning are not advised. These have produced coating failures when tried.

Blast cleaning to white metal removes all mill scale, rust, spatter, flux, and other detrimental materials. A grit which polishes the surface must be avoided. In the trials here reported, steel slag for blasting has worked out very well and lends itself to repeated use after screening out the dirt and fine material. After blasting the surface is best cleaned with a vacuum cleaner, thus avoiding dusting and recontamination of the surface.

The initial or prime coat should be applied as soon as possible after the surface is prepared. In terms of practical application, this means within eight hours after the surface is sandblasted. Successive coats should be applied as quickly as the preceding coat is dry.

Adequate Film Thickness

If a surface is properly prepared, the protective value of the coating will largely depend on the thickness of the coating (4, 5). To a certain degree, surface coatings are not completely impermeable to moisture and gases and as the film thickness decreases, permeability increases disproportionately.

The surface tension of the liquid causes the coating to pull thin over the high points of sharp edges, welds, or seams and further causes the plastic to pile up excessively in the corners and crevices, usually entrapping air bubbles. Hence, the minimum thickness of the coating should be enough, that when measured on a plane surface, will give adequate protection at some lesser thickness over irregularities. It is generally recommended that a minimum thickness of 0.005 inch be applied. In most cases the average thickness obtained per coat is about 0.001 inch.

For severe conditions where the coating is subjected to total immersion, our company has adopted a uniform standard of not less than eight coats. Our experience has shown that with an application of less than six coats the surface fails rapidly and the additional two coats have been well worth applying.

Decisions governing the optimum coating thickness are influenced by the anticipated permanence of the equipment and the degree of importance of permanent 100 percent protection. In order to avoid difficulties arising from uneven application of repeated coats, different colors may be used. This method shows up weak spots as the coatings are applied or after the final application. It also shows defects due to cracking, peeling, or trapped air bubbles after the final coating is dry.

Table 1.—Coating Applications.

Type of Coatings	Application	Corrosive Agent	Operating Temperature	Condition of Coating (After 1 Yr.)
Straight Phenolic Resin	Diffuser Cell Walls	Raw Juice	160-190°F	Failure
Modified Phenolic-Epoxy Resin Coatings	Silver Diffuser Cell Walls	Raw Juice	160-170°F	Good
	Oliver Filters	Hydrochloric Acid	180°F	Good
	Evaporators	Thin Juice, Hydrochloric Acid, Sod. Hydroxide	200°F	Good
	Thick Juice Storage Tanks	Hot Thick Juice	195°F	Good
	Liquid Sugar Tanks	Hot Sugar Syrup	190°F	Good
	White Mixer	White Fillmass	200°F	Failure
Vinyl Resin Coatings	White Mixer	White Fillmass	200°F	Fair
	Wet Sugar Bin	Wet Sugar Moisture	180°F	Good
	Centrifugal Discharge Chutes	Wet Sugar and Steam	180°F	Good
	Silver Diffuser Cells	Raw Juice	160-170°F	Failure
	Liquid Sugar Filters	Hot Sugar Syrup	190°F	Good
Alkyd Resin Coating	Bldgs. and Outside of Equipment	Sugar Vapors, Acid and Alkaline Fumes	70-120°F	Good
Chlorinated Rubber Base Paints	Bldgs and Structural Steel	Sugar Vapors, Acid and Alkaline Fumes	70-120°F	Failure
Coal Tar Plastic Coatings	Cold Water Lines	Condensed Moisture	60-80°F	Good
Polyvinyl Acetate Coatings	Cover for Petroleum Base Coatings and Insulation Materials	Condensed Moisture	60-80°F	Good
Petroleum Resins Coatings	Temporary Protection of Process Equipment (Beet Washer, Elevator, Syrup Tanks, Catchalls, etc.)	Condensed Moisture	60-190°F	Good

[1] Condition due to insufficient coating thickness.

Selection of Plastic for Coating

The chief considerations advanced in selecting a plastic coating for a given application as previously referred to are: 1. Maximum temperature resistance required. 2. Type of corrosive agent present

Table I shows the various types of plastic coatings used (6). A list of coatings applied successfully is as follows: Plastic No. 7155, Tygon TP61, Line Tite 700 coating, No Drip Plastic Coating, Nalcrete Polyvinyl Acetate Coating, and Sovakote No. 602.

For temperature ranges near or above the boiling point of water, Vinyl and epoxy-phenolic resin type coatings were chosen. For temperature conditions below 140° F., alkyd resin paints were used. Petroleum (7) and coal tar resin coatings were used at temperatures near or below the ambient temperature. Polyvinyl acetate water mixed resins were used to cover these latter coatings as they did not allow the under protecting material to bleed through and at the same time presented a good, clear, light-reflecting surface. The combination of the two types of resin coatings used in this manner avoids the usual objection to the use of petroleum plastics due to their black color and poor light reflectance. Vinyl coatings possess good resistance to the corrosive conditions encountered, but are extremely difficult to apply. The surface must be sandblasted or a special primer used to obtain the necessary adherence of the coating. Our company has adopted the procedure of taking both the precaution of sand blasting and using a single special primer coat. Coatings applied in this manner have given good service. Before this procedure was adopted a number of unexplained failures were encountered.

Phenolic resins have better adhesion but must be modified with other resins such as epoxy or furfural resins to provide the necessary acid resistance. Ordinary phenolic coatings, not compounded with other materials, failed where tried.

Petroleum resins were introduced primarily for temporary protection of equipment during intercampaign. One of these coatings exceeded all expectations and provided good protection in open syrup tanks at temperatures of approximately 200° F. Several types of these materials are available at a low initial cost and can be used effectively where temporary or semipermanent protection is desired without resorting to any special surface preparation.

Epoxy phenolic resin plastics (8) are not too difficult to apply and have given good service under extremely difficult conditions. These coatings have been exposed to organic acids in the battery and standard liquor tank, to mineral acids and alkalies

on the Oliver filters and evaporators for the past year without deteriorating to any extent.

The coated evaporator bodies were cleaned as frequently as once a week with dilute sodium hydroxide and hydrochloric acid solutions near the boiling point of water. The service rendered was of inestimable value especially when consideration is given to the fact that the bodies are more than fifty-five years old and the original cast iron has degraded to the point where it would no longer stand up under the necessary boilout procedures.

These plastics have also been used to coat the inside of the liquid sugar melter and storage tanks and have given good service in this instance. Some difficulty has been experienced with the welds that were not ground smooth before coating necessitating patchwork at these points. In general the coatings have proven very satisfactory.

Chlorinated rubber base coatings have given disappointing results where tried. This type of coatings has been replaced on structural steel and factory equipment by Alkyd resin coatings which are much cheaper and have resisted corrosive action comparatively longer.

Summarizing the results and experiences with plastic coatings, our company is well satisfied that plastic-type materials have an important place in the sugar industry and that their use will continue to grow and develop as new materials are provided. Success with the epoxy-phenolic type resin coatings has been satisfying and plans are to use this type of plastic extensively to control corrosion in the continuous diffuser, the evaporators, throughout the beet end, the sugar end, and wherever corrosion or rust endanger the final product and necessitate costly yearly replacement.

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