

# **Alkyd Coatings in Refined GSI-191 Chemical Effects Testing**

CCNPP-CHLE-007, Appendix 1  
October 31, 2013

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## Introduction

This white paper documents the findings of the type of chemicals found in typical industrial grade alkyds that could be applied on various pieces of equipment, fire-protection system components, piping, and structures inside containment at Calvert Cliffs Nuclear Power Plant. Recommendations about appropriate alkyd coating brands and types to be used in representative testing of potential chemical effects also are provided.

An alkyd coating is considered an unqualified coating and therefore could fail during a LOCA. Once failed, it could be transported to the sump pool. Once in the sump pool, chemicals in the alkyd coating could contribute to chemical effects. To test these effects, the typical chemicals in alkyds must be known.

Typically inside containment there are many different pieces of equipment and systems in which a part will be coated to protect it from the environment (generally, to prevent or reduce corrosion). During the manufacture or installation of the part or system, there can be cases where the coating used on the given part or system may not be documented or known. Since they are unknown and there is a vast number of different manufacturers of parts, equipment, and alkyd coatings, a typical chemical composition of alkyd coating must be determined.

## Assumption

It will be assumed that the void percentage of ingredients by weight listed in various Material Safety Data Sheets (MSDS) is the alkyd resins or alkyd polymer used in the alkyd coating. This is a reasonable assumption as the alkyd resin is the ingredient that gives the coating its specific characteristics and is usually not listed in the MSDS. The combinations of resins are considered proprietary by the manufacturer and generally are not be listed in the MSDS.

## Discussion

A typical alkyd paint consists of the oil-modified polyester to form the coating film, a solvent such as hexane or mineral spirits to aid in application, metal naphthenates to catalyze the drying reaction, and pigment to provide color and hide the coated surface. Numerous industrial alkyd coatings from several manufacturers were examined. The top four chemicals of each coating were examined.

Major manufacturers of paints and coatings were researched to determine what types of industrial alkyd coatings they provided. Once the types of industrial alkyds produced were identified, each product's MSDS provided the chemicals used to manufacture each type of alkyd coating. See Table 1 for the results of this investigation. It is worth noting that only the top four chemicals are shown in Table 1 as they were the major ingredients to the alkyd coating. The "Total Represented" column refers to the total percentage of ingredients represented in the

MSDS and takes into account all ingredients listed in the MSDS. Frequently, the alkyd resin is listed as a proprietary ingredient and is not clearly listed in the MSDS.

The main chemicals found in the MSDS consistently in most types of industrial alkyds are mineral spirits and titanium dioxide. Xylene is an ingredient consistently found in some alkyd coatings at a lower level.

Solvents added to oil-based coatings are designed to evaporate evenly and totally as the coating dries; allowing the resin to produce a film and allow the coating to dry rapidly. Mineral spirits, xylene, and others are solvents that will evaporate during the drying process. Due to this, the study was adjusted to address only chemicals that would remain behind after the alkyd coating dries. According to each product's MSDS, the non-solvent ingredients are listed in Table 2 for each product. Again, the alkyd resin[s] are not generally listed.

Comparing the information contained in Tables 1 and 2, one can see that solvents and chemical ingredients only account for approximately 50-75% of the alkyd coating weight, the majority of the remaining amount is assumed to be alkyd resin[s]. Once the coating has dried, the solvent, approximately 25-45% of the total weight, will have evaporated. The remaining material for the most part will be the alkyd resin[s] and titanium dioxide.

Titanium dioxide is a white solid chemical that will give the coating its white color. A majority of alkyd coatings will come from the factory in white and then mixed with a pigment in order to get the desired color. The amount of pigment needed is negligible when compared to amount of titanium dioxide it requires to give the alkyd coating its white color. To prove this, a few alkyds offered in color by some companies were studied. Since fundamentally coating colors, for the most part, consist of three different amounts of red, yellow, and blue pigments; only these three colors were studied.

As shown in Table 3, the chemical composition of major ingredients does not change significantly based on color.

## **Conclusion**

In conclusion, after researching various industrial alkyd coatings of various colors and produced by major manufacturers, Alkyd resin is by far the most consistent and major chemical throughout all alkyd types with titanium dioxide being the second most major contributor when considering dried coatings.

## **Recommendations**

In order to cover any additional manufacturers or colors; additional contributing chemicals also need to be studied. It is recommended that the alkyd resins, titanium dioxide, talc, calcium carbonate, kaolin, limestone, and quartz be studied in testing.

A combination of Glidden Professional Alkyd and KRYLON Industrial Enamel 100 series is recommended to be used for testing. This is reasonable as these two industrial alkyd coatings combined have almost all the major typical chemicals found through all the major manufacturers of industrial alkyd coatings.

KRYLON Industrial Enamel 100 series has the fourth highest percentage of alkyd resin seen in the study and various typical chemical ingredients in alkyd coatings. While Glidden Professional alkyd may not have a larger percentage of alkyd resin it does have a type of kaolin, which contains aluminum, and could contribute to chemical effects.

**Table 1. Top Compounds in Alkyd Coatings**

Coating Name	Chemical #1	Chemical #2	Chemical #3	Chemical #4	Total Ingredients Represented in MSDS	Percent Alkyd Resin
<b>Valspar P6</b>	Mineral Spirits - 35%	Titanium Oxide - 15%	Kaolin - 10%	Xylene - 1%	61%	39%
<b>Valspar P14</b>	Mineral Spirits - 35%	Kaolin - 20%	Xylene - 1%	N/A	56%	44%
<b>Glidden Professional Alkyd</b>	Limestone - 30-40%	Alkyd Resin (polymers with glycerol, pentaerythritol and phthalic anhydride)- 10-20%	Alkyd Resin (polymers with ethylenediamine, pentaerythritol, phthalic anhydride and tall oil fatty acids) – 10-20%	Mineral Spirits – 10-20%	100%	20-40%
<b>KRYLON Industrial Enamel 53 Series</b>	Mineral Spirits - 37%	Titanium dioxide - 21%	Calcium Carbonate - 5%	Ethylbenzene - 0.1%	63.1%	36.9%
<b>KRYLON Industrial Enamel 100 Series</b>	Titanium dioxide - 32%	Butyl Acetate - 11%	Calcium Carbonate - 6%	Mineral Spirits - 3%	56.2%	43.8%
<b>Pratt Industrial Alkyd</b>	Mineral Spirits - 24%	Titanium dioxide - 16%	Quartz - 8%	Butoxyethanol - 2%	50.2%	49.8%
<b>Rust-Oleum V7400</b>	Stoddard Solvents - 25%	Titanium Dioxide - 20%	Mineral Spirits – 15%	Limestone - 10%	82%	18%
<b>Sherwin Williams Industrial Enamel VOC</b>	Mineral Spirits - 21%	Mineral Spirits 140 - 14%	Titanium Dioxide - 11%	Xylene - 2%	48.3%	51.7%
<b>Sherwin Williams Industrial Enamel</b>	Mineral Spirits - 40%	Titanium Dioxide - 14%	Talc - 6%	Ethylbenzene - 0.2%	60.1%	39.9%
<b>Sherwin Williams HS Industrial Enamel</b>	Mineral Spirits – 24%	Titanium dioxide - 16%	Quartz – 8%	Butoxyethanol - 2%	50.2%	49.8%
<b>Martin Senour Tough Coat</b>	Mineral Spirits 140 - 42%	Titanium Dioxide - 19%	Xylene - 1%	Ethylbenzene - 0.2%	62.3%	37.7%
<b>Corotile High Solids Enamel</b>	Stoddard Solvent - 40%	Distillates - 10%	Kaolin - 10%	Xylene - 2%	66%	34%
<b>Devguard 4306 Industrial Alkyd</b>	Titanium dioxide - 10-20%	Limestone - 10-20%	Solvent Naphtha - 10-20%	Alkyd Resin - 10-20%	95%	11-25%

*Note – Percentages are given in percent by weight*

**Table 2. Non-Solvent Compounds in Alkyd Coatings**

<b>Coating Name</b>	<b>Chemical #1</b>	<b>Chemical #2</b>	<b>Chemical #3</b>	<b>Chemical #4</b>	<b>Chemical #5</b>	<b>Chemical #6</b>
<b>Valspar P6</b>	Titanium Oxide - 15%	Kaolin - 10%	N/A	N/A	N/A	N/A
<b>Valspar P14</b>	Kaolin - 20%	N/A	N/A	N/A	N/A	N/A
<b>Glidden Professional Alkyd</b>	Limestone - 30-40%	Alkyd Resin (polymers with glycerol, pentaerythritol and phthalic anhydride)-10-20%	Alkyd Resin (polymers with ethylenediamine, pentaerythritol, phthalic anhydride and tall oil fatty acids)-10-20%	Calcined Kaolin Clay – 5-10%	Titanium Dioxide – 1-5%	Magnesium Carbonate – 1-5%
<b>KRYLON Industrial Enamel 53 Series</b>	Titanium dioxide - 21%	Calcium Carbonate - 5%	N/A	N/A	N/A	N/A
<b>KRYLON Industrial Enamel 100 Series</b>	Titanium dioxide - 32%	Calcium Carbonate - 6%	Quartz – 2%	Talc – 2%	N/A	N/A
<b>Pratt Industrial Alkyd</b>	Titanium dioxide - 16%	Quartz - 8%	N/A	N/A	N/A	N/A
<b>Rust-Oleum V7400</b>	Titanium Dioxide – 20%	Limestone – 10%	Talc – 10%	N/A	N/A	N/A
<b>Sherwin Williams Industrial Enamel VOC</b>	Titanium Dioxide - 11%	N/A	N/A	N/A	N/A	N/A
<b>Sherwin Williams Industrial Enamel</b>	Titanium Dioxide - 14%	Talc - 6%	N/A	N/A	N/A	N/A
<b>Sherwin Williams HS Industrial Enamel</b>	Titanium dioxide - 16%	Quartz – 8%	N/A	N/A	N/A	N/A
<b>Martin Senour Tough Coat</b>	Titanium Dioxide - 19%	N/A	N/A	N/A	N/A	N/A
<b>Corotile High Solids Enamel</b>	Kaolin – 10%	N/A	N/A	N/A	N/A	N/A
<b>Devguard 4306 Industrial Alkyd</b>	Titanium dioxide - 10-20%	Limestone - 10-20%	Alkyd Resin (polymers with ethylenediamine, pentaerythritol, phthalic anhydride and tall oil fatty acids) – 10-20%	Clay – 1-5%	Alkyd Resin (polymers with glycerol, pentaerythritol and phthalic anhydride)- 1-5%	Quartz – 0.1-1%

*Note – Percentages are given in percent by weight*

<b>Table 3. Compounds in Alkyd Coatings of Various Colors</b>				
<b>Red</b>				
Sherwin Williams Industrial Enamel	Mineral Spirits - 25%	Talc - 10%	Titanium Dioxide - 2%	Xylene - 1%
Sherwin Williams Pro Industrial Enamel	Mineral Spirits - 25%	Talc - 10%	Titanium Dioxide - 2%	Xylene - 1%
Martin Senour Tough Coat	Mineral Spirits - 47%	Xylene - 1%	Titanium Dioxide - 0.2%	Ethylbenzene - 0.2%
KRYLON Industrial Enamel 53 Series	Mineral Spirits - 26%	Calcium Carbonate - 24%	Titanium Dioxide - 1%	Ethylbenzene - 0.2%
<b>Yellow</b>				
Sherwin Williams Industrial Enamel	Mineral Spirits - 25%	Titanium Dioxide - 12%	Talc - 4%	Xylene - 2%
Sherwin Williams Pro Industrial Enamel	Mineral Spirits - 25%	Titanium Dioxide - 12%	Talc - 4%	Xylene - 1%
Martin Senour Tough Coat	Mineral Spirits - 42%	Titanium Dioxide - 8%	Xylene - 1%	Ethylbenzene - 0.2%
KRYLON Industrial Enamel 53 Series	Mineral Spirits - 16%	Calcium Carbonate - 16%	Titanium Dioxide - 11%	Xylene - 5%
<b>Blue</b>				
Martin Senour Tough Coat	Mineral Spirits - 44%	Titanium Dioxide - 9%	Xylene - 1%	Ethylbenzene - 0.2%
KRYLON Industrial Enamel 53 Series	Mineral Spirits 140 - 44%	Titanium Dioxide - 9%	Xylene - 1%	Ethylbenzene - 0.2%

*Note – Percentages are given in percent by weight*