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ACTIV-8® Drier Accelerator for Paints and Coatings

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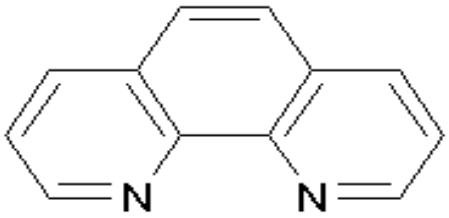
Coatings based on alkyd resins or drying oils such as linseed, soya, etc., dry by an oxidative polymerization process. During film formation, oxygen from the air crosslinks the resins or oils by the creation and decomposition of peroxides. The oxygen up-take process is catalyzed by certain transition metals: the use of drier metals such as cobalt, manganese, zirconium, zinc, calcium, rare earths, etc. is a well-established technology. Cobalt and manganese are the drier metals having the most activity. Cobalt is a surface or "top" drier, while manganese is a through drier. Zirconium, zinc, calcium and the rare earth metals are auxiliary driers, used in conjunction with cobalt or manganese. Zirconium used with cobalt improves through dry. The drying process occurs without the presence of metals, but at a much slower rate.

The activity of cobalt or manganese can also be enhanced by the addition of chelating agents, also known as drier accelerators. The chelating agents function by stabilizing the valence state of the metal so that the oxygen up-take rate is maximized. One such chelating agent is 1,10-phenanthroline, the chemical structure of which is given below:



1,10-phenanthroline is a very reactive molecule that chelates many metals, including cobalt and manganese. The chelating action takes place through free electrons on the two nitrogen atoms of the molecule. Iron and zinc do not usefully chelate with 1,10-phenanthroline when drying coatings. Iron reacts with 1,10-phenanthroline to form a dark reddish-pink colored compound which is undesirable for white or clear coatings. Zinc and 1,10-phenanthroline form an insoluble compound that does not contribute to drying.

Beware of pink and zinc.

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Vanderbilt Minerals, LLC offers a 38% solution of 1,10-phenanthroline under the trade name of ACTIV-8® Drier Accelerator. ACTIV-8 is offered in two forms with different solvents. The properties of the two forms are summarized below:

	ACTIV-8® Drier Accelerator	**ACTIV-8 HGL**
1,10-Phenanthroline	38 %	38 %
Solvent type	n-Butanol & 2-Ethylhexoic acid	Hexylene glycol
Density	0.95 g/l	1.03 g/l
VOC	492 g/l	640 g/l

It is very important to remember that ACTIV-8 and ACTIV-8 HGL are not driers, but drier accelerators. ACTIV-8 or ACTIV-8 HGL should therefore not be used alone. ACTIV-8 and ACTIV-8 HGL are most effectively used with cobalt and manganese; their activity can be greatly enhanced by the use of ACTIV-8 or ACTIV-8 HGL. Because the activity of the primary driers is increased when ACTIV-8 or ACTIV-8 HGL is used, the amount of cobalt or manganese can be reduced without sacrificing drying rates. The activity of the auxiliary metals is not enhanced by the use of ACTIV-8 or ACTIV-8 HGL.

Loss of dry on aging is a problem that can occur with pigmented waterborne paints containing cobalt drier. Over time, the cobalt is adsorbed by the pigment, so that it is no longer available to act as a drier. This is particularly problematic in coatings pigmented with carbon black. The addition of ACTIV-8 HGL to the waterborne coating will inhibit the loss of dry.

Determining the required amount of drier metals and ACTIV-8 or ACTIV-8 HGL is all-important to the achievement of good drying. The quantities vary depending upon the type of coating. The guidelines for the use of ACTIV-8 are:

For solvent-borne paints or coatings, use 10 parts (as received) of ACTIV-8 per 1 part of cobalt or manganese metal.

For waterborne paints or coatings, use 5 parts (as received) of ACTIV-8 HGL per 1 part of cobalt or manganese metal.

It is recommended that the following three steps be used to determine the required quantity of ACTIV-8 or ACTIV-8 HGL:

1) *Determine the amount of resin solids in the coating as follows*:

195 kg of a 90% nonvolatile solids alkyd resin solution contains:

195 kg x 0.90 = 175 kg of resin solids

2) *Determine the amount of metal drier to use as follows*:

Drier metals are sold as solutions of metallic salts of long chain organic acids in various solvents. The concentrations are expressed as % metal. Typical recommended levels of primary drier metals, based on resin solids, are:

Cobalt	0.02-0.05%
Manganese	0.01-0.06%

For the 175 kg of resin solids in Step 1, determine the amount of 6% cobalt drier equivalent to 0.025%:

175 kg of resin solids x 0.00025 = 0.044 kg of cobalt metal

0.044/ 0.06 = 0.73 kg of 6 % cobalt drier

3) The required amount of ACTIV-8® Drier Accelerator is determined as follows:

0.044 kg of cobalt metal x 10 = 0.44 kg of ACTIV-8

When using ACTIV-8 or ACTIV-8 HGL, it is recommended that a preblend be made with the drier metals in an appropriate solvent. This allows the 1,10-phenanthroline and cobalt or manganese to react without the presence of interfering substances. This is especially important if zinc oxide is present in the coating. Improved drying rates are achieved with preblending .

The following examples demonstrate the use and effectiveness of ACTIV-8 or ACTIV-8 HGL. All dry times were measured using Gardiner Circular Dry-Time Recorders.

1) A high gloss black solvent-borne alkyd coating had slow through dry and very poor hard dry. The drier package was 0.05% Co/0.33% Zr/0.17% MEKO. The addition of ACTIV-8 at a ratio of 10:1 to the cobalt yielded an improved formula with much faster dry times. The drying rates were as follows:

	Original Formula	**Improved Formula**
Set to Touch	3 hours	2 hours
Surface Dry	17 hours	4 hours
Through Dry	27 hours	11 hours
Hard Dry	>48 hours	22 hours

2) A high gloss black waterborne alkyd coating had a problem with loss of dry on aging. The only drier was cobalt at 0.05%. The addition of ACTIV-8® Drier Accelerator HGL at a ratio of 5:1 to the cobalt not only improved the dry times, it also eliminated the loss of dry problem. The drying rates were as follows:

	Original Formula		**Improved Formula**	
	1 day	60 days	1 day	60 days
Set to Touch	1 hour	1 hour	1 hours	2 hours
Tack Free	10 hours	14 hours	3 hours	4 hours
Hard Dry	18 hours	> 24 hours	5 hours	7 hours

3) A manufacturer of solvent-borne alkyd paints of various colors was using lead drier along with cobalt and calcium (1.5% Pb/0.05% Co/0.05% Ca). The dry times were acceptable, but the manufacturer needed to remove the lead for health and environmental reasons. Three colors were made: black, maroon and orange. It was found that the dry times could be improved by removing the lead and using ACTIV-8. The improved formulas were as follows:

Black: 0.05% Mn/0.5% ACTIV-8
Maroon: 0.05% Co/0.05% Zr/0.5% ACTIV-8
Orange: 0.05% Mn/0.05%Co/0.5% ACTIV-8

The dry time results are summarized below:

	Original Formula			**Improved Formula**		
	Black	Maroon	Orange	Black	Maroon	Orange
Set to Touch	½ hour	½ hour	¾ hour	½ hour	½ hour	½ hour
Surface Dry	7 hours	8 hours	4 hours	4 ½ hours	3 ½ hours	3 hours
Through Dry	8 ½ hours	9 ½ hours	5 hours	12 ¾ hours	4 ½ hours	3 ½ hours
Hard Dry	19 ½ hours	14 ½ hours	16 hours	15 hours	7 ½ hours	10 hours

The above examples show the effectiveness of using ACTIV-8 or ACTIV-8 HGL as drier accelerators. Each coating formulation is unique; laboratory evaluations are recommended before using ACTIV-8 or ACTIV-8 HGL in any coating.

Additional information on ACTIV-8 or ACTIV-8 HGL can be obtained by visiting the Paint & Paper section of R. T. Vanderbilt Company's website at www.rtvanderbilt.com. Included are the "How-To Guide for the Use of ACTIV-8" and two "classic" technical articles describing in detail the drier catalyst activity of 1,10-phenanthroline in organic coatings. Technical assistance in formulating with ACTIV-8 or ACTIV-8 HGL can be obtained from the Paint & Paper Department of R.T. Vanderbilt Company, Inc.