

Module E

Alternatives to lead in paint



Outline

- Paint basics
- Sources of lead in paint
- Alternatives for lead in paint
- Cost associated with lead in paint
- Summary
- References
- Point of Contact

Paint basics

See Module A1 for additional details



Paint ingredients

- Pigment and fillers
- Resin
- Solvent
- Driers
- Other additives



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Why is lead used in paint?

- Lead-containing paint ingredients are only intentionally added to solvent-based paint due to their chemical properties
- Primary source of intentionally added lead are pigments and drying agents
- Lead can also be unintentionally added through contaminated paint raw materials



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Alternatives to lead in paint



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Alternative drying agents

- Replacing lead-containing drying agents requires comparatively little reformulation research
- The most effective replacements of lead are based on strontium or zirconium
- Strontium is classified as non-toxic
- Less strontium is needed compared to lead to achieve the same effect (1 part of Strontium = 3 parts of Lead)
- Strontium provides a comparable performance to lead for most paint resins



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Reference E1.



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Alternative drying agents, con't

- Where strontium is unavailable, zirconium is the closest, direct replacement for lead
- Recommended levels of substitution are 3 parts zirconium metal to replace 4 parts of lead metal
- Exposure to zirconium can cause detrimental health effects, and occupational exposure limits are set in many countries
- Additional additives may be needed when zirconium is used as drier to achieve the same paint properties (e.g. drying time)



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Reference E1.



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Replacing lead pigments

- Coloring pigments provide shade, strength and brightness of color, opacity and can also give special optical effects
- Pigments are divided into organic and inorganic, depending upon the chemical structure
- In general, one of the most important factors to consider in reformulation is the volume concentration of pigment in the dry film, which determines color, hiding power, barrier properties, cost and a number of other properties
- The final formulation will be paint and brand specific, and needs to be determined by each manufacturer in collaboration with its suppliers



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Reference E2.



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Alternatives to white lead pigments

- White lead pigments are rarely used anymore
- The lead-free alternative most commonly used is titanium dioxide
- Titanium dioxide has excellent pigment properties and low toxicity
- As the opacity of titanium oxide is superior to that of white lead, lower levels of pigment will most likely give the desired result



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Reference E2.



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Alternatives to other lead pigments

- Replacement of lead chromates and lead molybdates demand a reformulation research process
- There is no 1:1 replacement for lead chromate pigments but there are a number of organic and inorganic pigments that can be blended together to produce the desired colors and performance
- The general approach is first to decide precisely which performance properties, in addition to color, are critical, and then reformulate the paint with the substitutes that meet the criteria.



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Reference E2.



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Considerations for reformulation

- One of the main differentiators is the desired level of weathering performance (interior or exterior performance)
- Paints for interior use do not need to have excellent weather resistance or light fastness
- Paints for exterior use require pigment blends with good color retention and weathering performance
- Inorganic pigments provide the opacity and potentially the weathering performance, whilst organic pigments are used in order to obtain the desired clean color shade.



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Reference E2.



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General properties of pigments

Organic and inorganic pigment properties			
Properties	Inorganic pigment	Organic pigment	
		Azo Type	HPP (High Performing Pigment)
Opacity	Excellent	Transparent	
Colouring strength	Low to average	Several time better than inorganic pigment	
Purity , Chroma	Dull	Bright	
Lightfastness	Good to Excellent	Low to average	Good to Excellent
Weather resistance	From mediocre to excellent	Mediocre	Good to Excellent
Heat resistance	normally > 500°C, not often <200°C	150 - 220 °C	200- 300°C
Bleed resistance	Excellent	Average to good	Good to Excellent
Chemical resistance	Mediocre to excellent depending upon the chemistry	Excellent expect for the salt	Excellent
Pigment cost	low to average	Average	High



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Some non-lead pigments are still health hazards

- Inorganic pigments producing bright colors can contain other metals that are considered health hazards
- Some examples
 - Yellow inorganic pigments can contain chromates or cadmium
 - Red and orange inorganic pigments can contain cadmium



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Cost associated with lead in paint



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Cost of replacing lead in paint

- Given the low levels of addition of driers and their relatively low contribution to overall cost structure, the cost of formulations containing lead-free driers can be comparable to those formulations containing lead driers.
- To replace lead pigments, more reformulation research is needed to yield a paint of equivalent color and performance
- The final production cost does not need to be higher



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Cost of pigment replacement, Example 1

- Replacement of lead pigment in RAL color 300: Flame Red

Lead-Based v. Lead Free Cost Comparison		
RAL 3000	Lead-Based	PR254
PY53	21.5	61.1
PR104	63.3	
PR254		27.3
PR122	8.0	
PR101	7.2	11.6
Metamerism	0.4	2.0
Lead-based = 3.24m ² € or 0.31€/m ²		
PR254 based = 4.99 m ² /€ or 0.20 €/m ²		

Replacement does not have to come with a higher production cost

Lead-based: 0.31 €/m²
Lead-free: 0.20 €/m²



Reference E3.

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Cost of pigment replacement, Example 1 continued

- Replacement of lead pigment in RAL color 300: Flame Red (% by weight)

	Lead free		Lead containing	
	High performance	Economic		
Pigment calculated on solid binder	11.50%	11.20%		23.90%
Pigment in wet paint	5.40%	5.00%		11.00%

Organic pigments have a higher color strength
 less alternative pigment may be needed



Cost of pigment replacement, example 2

- Replacement of lead pigment RAL1021: Greenish yellow

Lead-Based v. Lead Free Cost Comparison		
RAL 1021	Lead-Based	PR254
PY151		81.5
PY34	85.8	
PBr24	11.0	17.7
PY139	0.8	0.8
Metamerism	0.4	2.0
Lead-based = 2.89m ² € or 0.35€/m ²		
PY151 based = 1.41 m ² /€ or 0.71 €/m ²		

However, some performance demands may increase production cost

Lead-based: 0.35 €/m²
Lead-free: 0.71 €/m²



Reference E3.

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Lead content and retail price

- In 2013, retail price and lead content of paints in six Asian countries were recorded
- Only paint cans of similar size were included



Average price of cans of white paint

Country	Low lead content (<90 ppm)	High lead content (>90 ppm)	Price difference between paints with low and high lead content, local currency (EUR/USD)	Price difference (% of price of low lead paints compared to high lead paints)
Bangladesh	372 BDT	385 BDT	-13 (-0.12/-0.16)	97%
India	324 INR	354 INR	-30 (-0.35/-0.48)	92%
Indonesia	44423 IDR	49822 IDR	-5399 (-0.34/-0.46)	89%
Philippines	238 PHP	313 PHP	-75 (-1.23/-1.68)	76%
Sri Lanka	1018 LKR	981 LKR	37 (0.21/0.28)	104%
Thailand	170 THB	145 THB	24 (0.55/0.75)	117%

Reference E5.

Average price of white paint

- Although the average price of white paints with low lead levels were in some cases higher, the actual increase in average price amounted to only a maximum of 0.55 Euro per liter.
- Detailed comparison of price for cans of white paint
 - In four countries, the average retail price was lower for paints with lead content below 90 ppm compared to paints with lead content above 90 ppm (76% - 97% of the average retail price compared to cans with lead content above 90 ppm)
 - In two countries, the average retail price was higher for paints with lead content below 90 ppm compared to paints with lead content above 90 ppm (104% - 117% of the average retail price compared to cans with lead content above 90 ppm)



Average price of colored paint

	Low lead content (<90 ppm)	High lead content (>90 ppm)	Price difference between paints with low and high lead content, local currency (EUR/USD)	Price difference (% of price of low lead paints compared to high lead paints)
Bangladesh	304 BDT	434 BDT	-130 (-1.22/-1.66)	70%
India	332 INR	306 INR	26 (0.31/0.42)	109%
Indonesia	58330 IDR	43884 IDR	14446 (0.91/1.24)	133%
Philippines	277 PHP	276 PHP	0.2 (0.00)	100%
Sri Lanka	829 LKR	915 LKR	-86 (-0.48/-0.66)	91%
Thailand	224 THB	161 THB	63 (1.41/1.93)	139%

Reference E5.

Average price of colored paint

- Although the average price of paints with low lead levels were in some cases higher, the actual increase in average price amounted to only a maximum of 1.41 Euro per liter.
- Detailed comparison of price for cans of colored paint
 - In two countries, the average retail price was lower for paints with lead content below 90 ppm compared to paints with lead content above 90 ppm (70% - 91% of the average retail price compared to cans with lead content above 90 ppm)
 - In one country, the average retail price was the same for paint with lead content below and above 90 ppm
 - In three countries, the average retail price was higher for paints with lead content below 90 ppm compared to paints with lead content above 90 ppm (109% - 139% of the average retail price compared to cans with lead content above 90 ppm)



Summary

- Lead is intentionally added to paint as lead driers or lead pigment
- Lead contaminated raw materials can contribute to lead in paint
- Cost-effective reformulation alternatives are available for all lead-containing paint ingredients
- A high retail price is not necessarily a guarantee for low lead content of the paint



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References

E1. Contract Report for IPEN (2015). Lead drier replacement in solvent based alkyd decorative paints. Safinah Coatings Consultants.

E2. Contract Report for IPEN (2015). Replacement of lead pigments in solvent based decorative paints
Safinah Coatings Consultants.

E3. BASF Third party submission of information on alternatives for Applications for Authorisation (2015)
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References

E4. Clariant Pigments, Personal communication with Mr Wai Siang, Yuen, Technical Manager ASEAN Pacific Clariant BU Pigments - Coatings

E5. IPEN (2014) Asia Regional Paint Report . March.
<http://ipen.org/sites/default/files/documents/Asia%20Regional%20Paint%20Report%20final.pdf>



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