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Opening photo: Regent Paints offers a program of reusability of the batch failures, obsolete materials, gelled batches, washed solvents, mistints, customer returns, non-usable and nonsalable raw materials or paints of all type.

ANALYSIS

Hazmat Waste Put to Use. A Re-use Solution for Solvent-Based Paints and Raw Materials

Huzaifa Matawala

The paint industry has entered into an era of continuous enhancement of chemistry from various perspectives, including customer requirements, costs, environment, durability and reach. It is always challenging for research and development teams to create ecofriendly paints with acceptable cost and product performance. Every year, several formulations are edited, and product is enhanced. Formulations in our industry have changed more rapidly in the past decade than ever before. The process of change results in several batches, raw materials and stock items that need to be replaced with newer ingredients. The more we evolve into newer formulations, the more raw material and stock inventory that is no longer usable to the industry. We leave behind failure batches and obsolete raw materials.

Purpose

With industry experience with different type of resins, pigments, additives, solvents and paints, Regent Paints offers a program of reusability of the batch failures, obsolete materials, gelled batches, washed solvents, mistints, customer returns, non-usable and nonsalable raw materials or paints of all types (**ref. Opening photo**). The attempt is to reduce the waste generation from the factory process itself by finding use for the items into Regent Paints' line of products. Once the chemistry, ingredients, compatibility, resin and solvent nature are ascertained, the reuse of the items can be ascertained.

This article shares data and possibilities on working with oil paints and solvents. There is an extensive use of oil paints and solvents internationally. Advanced, ecofriendly, water-based formulations have not reached several countries across the globe, and traditional solvent-based coating systems still provides an essential coating solution worldwide.

The company has successfully reached solutions for the reuse of latex-based paints. With every passing year Regent Paints is able to convert more and more cans of latex paint into a new recycled product. The company has several projects for procuring the latex paint cans from the market, homes, industries and counties. These paints are used for producing stucco, plasters, driveway sealers and recycled latex-based paints. This article will also discuss the paint process, how it effects the environmental system and how the reuse of oil paints offers both economic and ecological benefits.

Process

Important things to consider with solvent-based paints and resins include:

- solvent and resin structure, compatibility, density and boiling point;
- sorting, batch making and production.

Solvents play an important role in recycling paints and resins, as they determine the compatibility and the recycling family "house" the paint or resin will go to. If we initiate a manufacturing process without a proper understanding, we risk having non-favourable batches. Material may turn into cake-like formations, lumps, chips, harden like rock or lose viscosity. Successful recycling is based on the study of the molecular structure, boiling point, dispersing ability and density of the solvent used in paint or resin.

Solvent and Resin Compatibility

Hansen Solubility Parameter Values

Hansen solubility parameter values are based on dispersion bonds (δD), polar bonds (δP) and hydrogen bonds (δH). These contain information about the inter-molecular interactions with other solvents and also with polymers, pigments, nanoparticles, etc. This allows for rational formulations knowing, for example, that there is a good HSP match

Table 1: Comparing nonpolar, polar aprotic and polar protic molecules to determine compatibility.

Solvent	Chemical Formula	δD Dispersion	δP Polar	δH Hydrogen Bonding
NONPOLAR SOLVENTS				
Hexane	$CH_3CH_2CH_2CH_2CH_2CH_3$	14.9	0.0	0.0
Benzene	C_6H_6	18.4	0.0	2.0
Toluene	C_6H_5-CH_3	18.0	1.4	2.0
Diethyl ether	CH_3CH_2-O-CH_2CH_3	14.5	2.9	4.6
Chloroform	$CHCI_3$	17.8	3.1	5.7
1,4-Dioxane	/-CH_2-CH_2-O-CH_2-CH_2-O-\	17.5	1.8	9.0
POLAR APROTIC SOLVENTS				
Ethyl acetate	CH_3-C(=O)-0-CH_2-CH_3	15.8	5.3	7.2
Tetrahydrofuran(THF)	/-CH_2-CH_2-O-CH_2-CH_2-\	16.8	5.7	8.0
Dichloromethane	CH_2CI_1	17.0	7.3	7.1
Acetone	CH_3-C(=O)-CH_3	15.5	10.4	7.0
Acetonitrile (MeCN)	CH_3-C=N	15.3	18.0	6.1
Dimethylformamide(DMF)	H-C(=O)N$(CH_3)_2$	17.4	13.7	11.3
Dimethyl sulfoxide(DMSO)	CH_3-S(=O)-CH_3	18.4	16.4	10.2
POLAR PROTIC SOLVENTS				
Acetic acid	CH_3-C(=O)OH	14.5	8.0	13.5
n-Butanol	$CH_3CH_2CH_2CH_2OH$	16.0	5.7	15.8
Isopropanol	CH_3-CH(-OH)-CH_3	15.8	6.1	16.4
n-Propanol	$CH_3CH_2CH_2OH$	16.0	6.8	17.4
Ethanol	CH_3CH_2OH	15.8	8.8	19.4
Methanol	CH_3OH	14.7	12.3	22.3
Formic acid	H-C(=O)OH	14.6	10.0	14.0
Water	H-O-H	15.5	16.0	42.3

between a solvent and a polymer. Rational substitutions can also be made for "good" solvents (effective at dissolving the solute) or "bad" solvents (expensive or hazardous to health or the environment). **Table 1** shows that the intuitions from nonpolar, polar aprotic and polar protic molecules are put numerically – the polar molecules have higher levels of δP and the protic solvents have higher levels of δH. Because numerical values are used, comparisons can be made rationally by comparing numbers. For example, acetonitrile is much more polar than acetone, but exhibits slightly less hydrogen bonding.

When studying the detailed characteristic properties of the solvent bond with resin, pigment metals and fillers, we can ascertain the use and breaking of such bonds into newer or similar products for use.

For example, toluene and benzene are more compatible with xylene than mineral spirits. However, xylene is compatible with mineral spirits as well. Certain solvents are soluble with each other, some are soluble only to an extent and some are non-soluble. When reacted with resins and pigments, solvents change the loyalty towards their "house," becoming more compatible most of the time. The use of additives, extenders and fillers plays an important role.

Boiling Point

The boiling point is an important property because it determines the speed of evaporation. Small amounts of low-boiling-point solvents like diethyl ether, dichloromethane or acetone will evaporate in seconds at room temperature, while high-boiling-point solvents like water or dimethyl sulfoxide need higher temperatures, an air flow or the application of vacuum for fast evaporation (**Table 2**[1]).

- Low boilers: boiling point below 100 °C (boiling point of water)
- Medium boilers: between 100 °C and 150 °C
- High boilers: above 150 °C.

1 Solvent Properties – Boiling Point Archived 14 June 2011 at the Wayback Machine. Xydatasource.com. Retrieved on 2013-01-26.

Table 2: The boiling points of various solvents.

Solvent	Boiling point (°C)
ethylene dichloride	83.48
pyridine	115.25
methyl isobutyl ketone	116.5
methylene chloride	39.75
isooctane	99.24
carbon disulfide	46.3
carbon tetrachloride	76.75
o-xylene	144.42

"The intention is to have a final brand of such products in the market from local facilities. The use of these coatings is minimal in developed countries, but can serve as a major help in the economies that need infrastructural development. The infrastructural zones of developing countries can be served with these durable, eco-friendly products that are created from solvents and oil paints."

Density

Most organic solvents have a lower density than water, which means they are lighter than and will form a layer on top of water. Important exceptions are most of the halogenated solvents like dichloromethane or chloroform, which will sink to the bottom of a container, leaving water as the top layer. This is crucial to remember when partitioning compounds between solvents and water in a separator funnel during chemical syntheses.

Often, specific gravity is cited in place of density. Specific gravity is defined as the density of the solvent divided by the density of water at the same temperature. As such, specific gravity is a unitless value. It readily communicates whether a water-insoluble solvent will float (SG < 1.0) or sink (SG > 1.0) when mixed with water.

Sorting, Batch Makings and Productions

Once we have classified the groups of compatibles together, we sort the materials on the basis of sheen, color, density and gloss. Depending on the inventory, the products with common sheens, colors and densities are mixed together into batch sizes as an intermediate pulp. This is an important ingredient mix check stage, where pulp is created from the oil paint, resin, solvent, pigment or waste/scrap/lots. These pulps are usually made keeping in mind the usability for the final product. We again check the pulp batches on the final gloss and resin/solvent/pigment/filler ratio on the basis of density, hardness, gloss, weight and viscosity.

We finally craft final product batches of floor paints, primer paints, stucco items, texture coatings, topcoats, bitumen paints, etc. All the formulations, blends, processes and other ingredients remain an important part of chemistry. These various products are served in several brands and markets. Regent Paints is able to serve the markets with a final recycled product that saved many important ingredients from land burial or fuel blending. These products are also created without the extraction of resources, resulting in energy savings, which is environmentally beneficial.

Scope

The scope of recycling is based on the requirements of paint reuse projects, cost/financial benefits, and research and development.

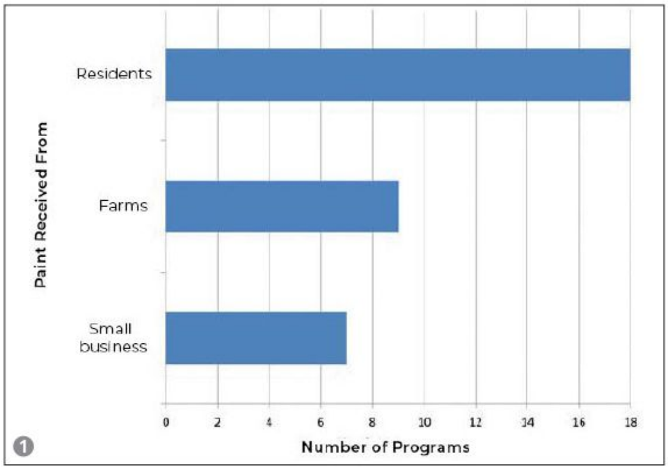


Figure 1: **Programs that receive latex paint.**

Recycling and Utilization of Latex-Based Paints Compared to Oil-Based Paints

Figures 1-4 show the opportunity to fill the gap between collection and reutilization. A project can be created for savings in the cost of disposal and the cost of manufacturing oil paints. This data was obtained from results of a DNR/DATCP survey, conducted summer 2015 (Wisconsin State).

Costs and Benefits of Reusing Oil Paints

Table 3[2] gives an example of the approximate cost of disposal of paint-related items. In all calculations the cost of disposal of the products is included. As an environmental lifecycle calculation, the cost of solvent-based paint on extraction is about twice the cost of disposal.

2 https://admin.ks.gov/docs/default-source/ofpm/procurement-contracts---adds/tradebe-treatment-recycling.pdf?sfvrsn=2

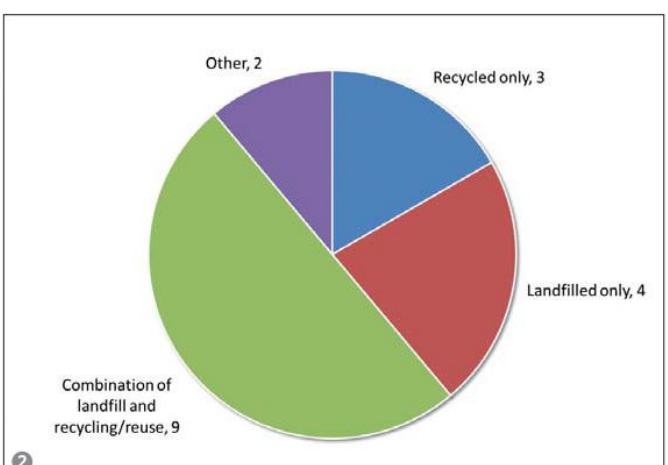
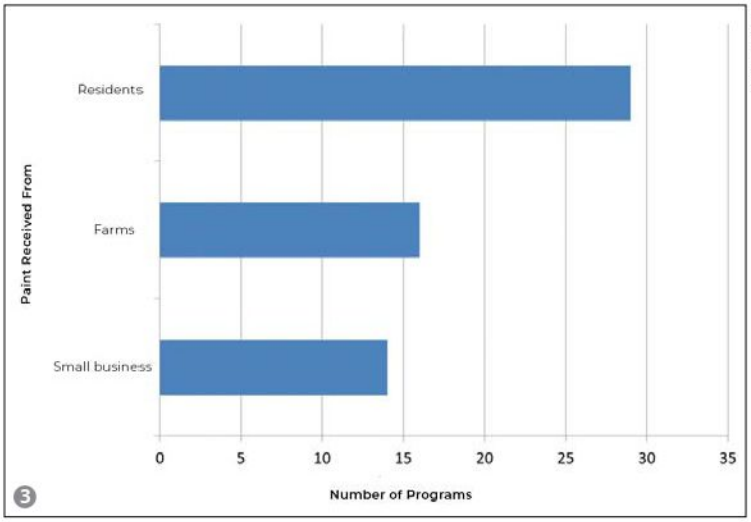


Figure 2: **Disposal methods for latex paint.**



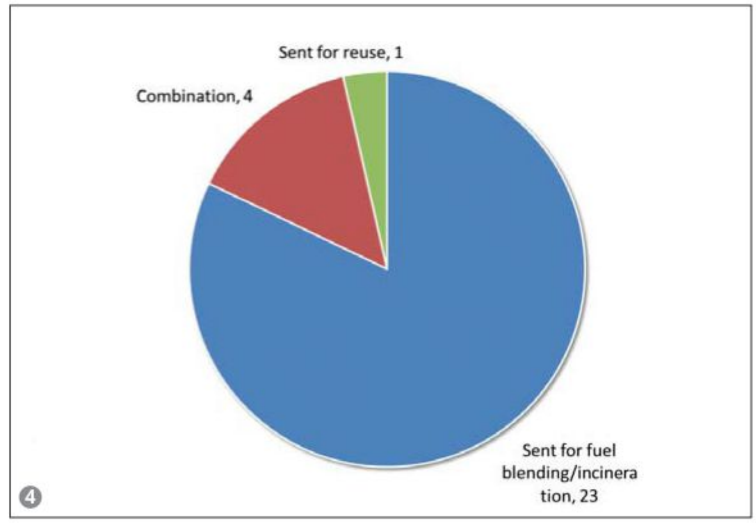


Figure 3: **Bulk waste streams.**

Figure 4: **Disposal methods for oil-based paint.**

The process and cost of making paint from scratch is saved when paint is reused.

For example, when making paint, resins are cooked in a reactor with amines, natural agricultural oils, phallic anahydrides, penta, maelic and monomers. The process utilizes energy, resources, power and rare blends of nature. If we are able to reuse the paint, we save the ingredients and the energy that would have been spent creating those raw materials.

Additionally, when we fuel blend these items in fire, we are unable to save them. The cycle of generation of newer resins, solvents, metallic driers, pigments, additives, etc. has to take place. We have to extract more gums from more trees, erode more mountains for minerals, and extract the oils from the sea to create specialty monomers and hydrocarbons to attain solvent-based paints. Such savings offers much more in value and utility than the fuel blending properties a paint can provide. Also, in most cases certain grades of paint do not help the burning process, and in fact hamper the fuel blending costs.

Patent Products, Research and Processes

Regent Paints has performed detailed scientific studies over several years. It has been working in the industry for five decades, and now has presence in recycling, paint manufacturing and raw materials on multiple continents. The company was able to patent with the United States Patent and Trademark Office with oil paint recycling and Regent Recycling dollar concept of free paint against recycling, with a vision to initiate a process of oil paint reuse and recycling. The patents cover a total program of recreating a product form solvent-based items at the same cost of latex recycling.

Table 3: Bulk waste streams.

BULK WASTE STREAMS				
Type		Quantity	Cost	Disposal
1	Bulk Halogenated	55 gal	$129.38	Fuel Blend
2	Bulk Non-Halogenated*	55 gal	$74.52	Fuel Blend
3	Paint Waste	55 gal	$108.68	Fuel Blend
4	Ink Waste	55 gal	$98.33	Fuel Blend
5	Lab Wastes	55 gal	$175.95	Treatment
6	Bulk Corrosive Liquids	55 gal	$175.95	Treatment
7	Filter Waste	55 gal	$155.25	Recycle
8	Mud Pit Wastes	55 gal	$112.82	Treatment
9	Bulk Solids or Liquids (HAZ)	55 gal	$263.93	Stabilization/ Landfill
9.1	Bulk Solids or Liquids (nonhaz)	55 gal	$87.98	Stabilization/ Landfill

* Bulk Non- Halogenated: >5000 BTU's and <5% Chloride

The intention is to have a final brand of such products in the market from local facilities. The use of these coatings is minimal in developed countries, but can serve as a major help in the economies that need infrastructural development. The infrastructural zones of developing countries can be served with these durable, eco-friendly products that are created from solvents and oil paints. There are markets who use these items as economical coatings to protect items.

Regent Paints produces bitumen paints and several coatings that use lower-end resins and solvents in the formulations. Such primers serve as an undercoat. The company has also formulated several primers for wood and metals. It has listed technical data sheets with the ministry of Kuwait with the element of alkyds and its CAS details as a part of the new formulation. These products have been tested in the market.

Fuel blending may be appropriate with other petrochemicals, oils or flammable items. Solvent-based paints like alkyd enamels, stains, ink products, primers, paint thinners, tank washing solvents, alkyd resins, epoxies, hardeners, etc., can be reutilized, saving costs, ingredients and the environment.