

# Review of Recycling Options for Hazardous Paint Waste

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**Abstract:** The objective of paper is to review possible opportunities of recycling of paint waste residues generated from automobile and engineering industry. Water based and solvent based paints are extensively used in automobile and storage solution industry to safeguard metal parts and for their aesthetical betterment. This painting process generates large quantum of paint wastes that are hazardous by nature and their conventional disposal mechanism involves negative environmental impacts.

**Keywords:** Paint Waste, Recycling, Disposal, Hazardous waste, options, construction, paint.

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## I. INTRODUCTION

Hazardous waste is waste the waste or substance poses substantial or potential threats to public health or the environment. In India, the treatment, storage, and disposal of hazardous waste is regulated under Hazardous Waste Management & Handling Rules, 2008. The major area of concern with respect to industrial waste management is hazardous waste generated during various processes.

Characteristic hazardous wastes are materials that are known or tested to exhibit one or more of the following four hazardous traits: Corrosivity, ignitability, explosivity, toxicity, reactivity

One of such extensively generated hazardous waste from automobile or other painting industries is paint waste. It is characterized by high calorific and ignition values and content of VOCs and toxic chemicals. The painting of metal parts at a large assembly plant generally occurs in a series of large enclosures called paint spray booths. The protective coating, the prime coat, the basecoat and the clear coat are applied in the main color booths. Painting by spraying generates wastes due to the overspray or the paint not reaching the target. The overspray washed with the help of circulating water gets collected in a sludge pit. This mixture of water and over sprayed paint is called paint sludge. Paint sludge is a very complex material; the paint component contains uncured polymer resins, pigments, curing agents, surfactants and other.

Effects of conventional disposal of paint waste:

Conventional methods for disposal of Paint waste includes incineration as most prominent option. Various ill effects of such disposal through incineration are as below

### 1) Effect on eco-system

This not only consumes natural resources during operations but activities of it are responsible for As per CPCBs report, it was estimated that in 2010 there were about 41,523 hazardous waste generating industries in India. The quantity of hazardous waste generated from these industries was about 7.90 million per year with increase of 27% over its last year generation. Maharashtra (22.84%), Gujarat. (22.68 %) and Andhra Pradesh (13.75 %) are the top three HW generating States in the country. Thereafter Rajasthan, Tamil Nadu, Madhya Pradesh and Chhattisgarh States are in second line with a generation of more than 2.5 lakh tonnes per annum. These seven States together, are generating about 82% of country's total hazardous waste. Maharashtra and Gujarat putting together, are generating 62.87 % of country' total incinerable

hazardous waste. the details of the facilities available in the country are as follows - Common Incinerators - 14 Nos. in 7 States

Individual Incinerators - 127 Nos. in 12 States

Total incineration capacity – 3,27,705 MTA

Present generation of - 4, 15,794 MTA Incinerable waste in the country. Deficit of Incineration capacities - 88,089 MTA.

This deficit is critical parameter from hazardous waste disposal point of view. Suggesting unscientific management of this incinerable waste and creating alarming situation from environmental impact point of view.

This study thus has chosen one major industrial hazardous waste viz. paint waste residues and will search the recycling opportunities of the same

## II. MATERIAL & METHODOLOGY

### A) *Problem Statement*

Convention waste disposal of paint waste by causes severe environmental, social and economical losses. The detailed elaboration can be as below:

#### a) **Effect on ecosystem**

The waste management by traditional landfilling and incineration methods exert pressure on ecosystems. These operations are responsible for generation of large quantity of green house gases that are responsible for global warming and increase overall carbon footprint. Also, incineration plants incorporate use of varied natural resources such as petroleum and other products, natural gas, electricity etc that create burden on existing resource pool.

#### b) **Effects on Air Quality**

Each ton of waste burnt releases around 5000 cubic meters of gases containing many pollutants. The pollutants are transported in the air and deposited in water and soil, both near and far from the incinerator. Even though the gases coming from the chimney-stack often appear clean (it may sometimes appear as if nothing is coming out), they contain very fine particles of dust. Metals in the waste vaporize and become attached to the dust particles formed by incineration. Some are caught in filters and become fly ash, others are washed out in the gas-cleaning unit and the rest are released into the air from the chimney-stacks.

#### c) **Effects on water and ground water**

Several metric tons of ash is generated from incineration plant as by product.. The ashes, which are contaminated with heavy metals like lead and cadmium as well as toxic compounds like dioxins, are usually deposited in landfills leaving a toxic heritage for future generations. These pollutants can leach out posing a more immediate threat to ground water and rivers. The highest concentrations of pollutants are in residues from the pollution control devices. These residues are supposed to be sent to “special waste” landfills

#### d) **Effects on health**

Studies confirm that a typical incinerator releases a mix of toxic chemicals, including dioxins, lead, cadmium, mercury and fine particles, SPM, into the atmosphere. Heavy metals, including lead, cadmium and mercury are also emitted. Heavy metals cannot be destroyed by incineration. Heavy metals are toxic in nature. Particulates Pollution control devices can do little to prevent ultra-fine particles from being released, which are the most dangerous particles for human health.

The most notorious of incineration by-products are dioxins. These are long-lived organic compounds, which form when chlorinated substances in the waste, such as PVC plastic, are burnt. While dioxin emissions to air from incinerators are thought to have decreased significantly in recent years, the amounts in ash may well have increased. Moreover official figures of dioxin emissions are unreliable and are probably significantly under-estimated. Inorganic acidic gases Inorganic acidic gases such as hydrogen chloride, hydrogen fluoride, hydrogen bromide, sulphur oxides and nitrogen oxides are also

formed and emitted by incinerators. Exposure to nitrogen and sulphur oxides has also been linked to adverse impacts on respiratory health.

**B) Methodology Adopted**

Preliminary study: This includes

- Study of properties of waste component

Collection of sample hazardous paint waste got done from Industrial premises.

The paint waste in pure red oxide form and mixed proportion got collected. The appearance of paint waste is as photographed in fig.1.

- Obtaining reports for tests carried out earlier by authorized laboratory

It is very important to understand first properties of research component by scientific method to confirm nature of waste and its characteristics. Thus comprehensive analysis got done for paint waste under study. The results are conducted as per methods stated in table I

**TABLE I**

Parameter	Unit	Method
Specific Gravity	g/cm <sup>3</sup>	ASTM D5057-2010
Calorific Value	Cal/g	IS 1350:Part 2- 1975
Flash Point	Degree c	USEPA 1998 SW-846;1020 A
LOD @105c	%	USEPA 1998, SW-846;1684
LOI @550	%	USEPA 1998, SW-846;1684
pH at room temp.	-	APHA 22 <sup>nd</sup> edition 2012;4500H+B
WSI	%	APHA 2540 C



**Fig.1: Paint Waste**

**Collection and review of primary and secondary data**

Various sources such as books, published journals, scientific papers, thesis, internet are referred for collection of useful data and scrutinization. The major crux of the survey can be as given below

**a) Co-generation from Incineration:**

Cement manufacturing plants at various places make use of paint waste inclusive co-generation technology for energy generation and resource recovery. It is also known as combined heat and power process. Wherein heat evolved by burning

of fuel in controlled condition is used for power generation. Since high temperatures are required in this process it also consumes lot of fuels to reduce quantum of fuels and make optimistic use of waste, paint waste as they carry high calorific value are used as replacement for fuel.

This makes use of boiler, steam turbine and generator.(as shown in fig.2)

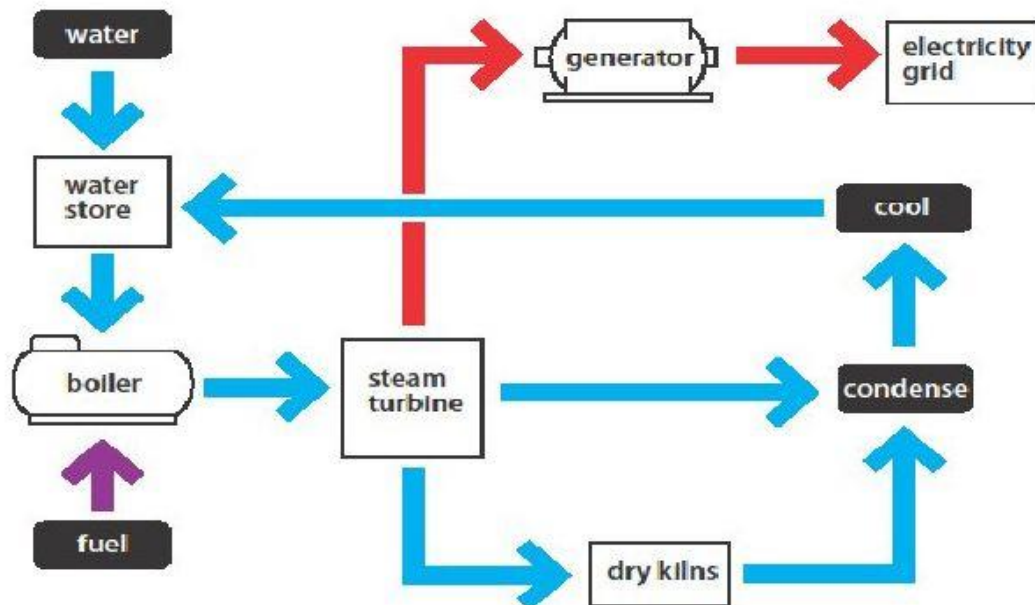


Fig.2 Typical diagram of co-generation plant

**b) Use for paint preparation**

Various methods are developed by researchers for recovery and preparation of fresh paint from waste paint.

The process involves pigment separation and use technique by centrifugation or by adding chemicals or additives.

Some of the methods for the same are as given below-

- Use of use of waste Ferric Phosphate (FePO4) sludge obtained from metal pretreatment zinc phophating process to provide different paint composition
- The paint sludge is soaked in the solvent mixture over 1 to 72 hours for preparation paint waste. the solvent is selected from the group consisting of toluene, xylene, benzene, acetone, isobutyl alcohol, n-butyl alcohol, isopropyl alcohol, methyl ethyl ketone and any other conventional solvent or any mixture thereof.
- The resin added is selected from the group consisting of maleic resins, ketonic resins, petroleum resins (cumran indene resins).
- The invention the solvent mixture comprises toluene or benzene in an amount of 28 to 40 %, xylene in an amount of 22 to 38 %, n-butyl alcohol or methyl isobutyl ketone or methyl cellosolve in an amount of 5 to 12 %, diacetone alcohol in an amount of 3 to 10 %, cellusolve acetate or amyl acetate in an amount of 2 to 5 % by weight expressed in terms of the amount of the paint sludge to be treated
- Drying and centrifugation followed with addition of resins

**c) Use of paint waste in bitumen for road construction**

It is observed through literature that, use of paint waste is possible in road construction. This is either by replacing slag used for construction application or by adding resin to the heated sludge and bitumen mixture in the form of a solution in a solvent selected from the group consisting of toluene, toluene with butyl acetate, benzene with butyl acetate and benzene with xylene or any other conventional solvent used for paints.

**d) Use for colored concrete**

In this method paint is dried and crushed. Centrifuges are used to separate pigments which then in turn are used along with concrete ingredients that give peculiar color to concrete. Or simply impurities from liquid paint are filtered out and liquid paint is applied along with concrete ingredients. This improves aesthetics of concrete.

**e) Use of paint waste in sealant Industry**

A method for treating waste paint sludge in sealant industry makes use of water, uncured resin and liquid hydrocarbons.

The waste material, typically in the form of sludge, is processed in a heating and resin curing procedure whereby water and VOCs, in the form of liquid hydrocarbons, are evaporated so that the solid discharged after heating is in a substantially dried particulate solid form. The heating step is also designed to cure the uncured polymeric paint resins.

**f) Use for charcoal preparation**

One invention on paint recycling talks about pyrolysis process wherein paint sludge is mixed with potassium Hydroxide and is heated in controlled condition in absence of air at 600 °c for preparation of char-coal particles.

### III. RESULTS AND DISCUSSION

All above mentioned options are associated with pros and cons on various lines such as practical application, feasibility in implementation, economic viability and consequences of offering. Thus evaluation of alternatives is subject to various factors at specific sites. The analysis of the same can be given as below:

Sr.No	Method of Recycling	Benefits	Constraints
1.	Use for cogeneration in cement plants	Resource Recovery. Replacement of fossil fuel. Waste to energy option.	Location constraint. Limited to cement plant nearby locations. Involves transportation to long distance that can lead to accidents during transports. Also causes emissions during burning.
2.	Use for paint preparation	Best example of rejuvenation of life cycle of product.	Quality of paint produced is limited to secondary applications. Limited facilities that make use of the technology. Costly. Prone to fire hazard
3.	Use of paint waste in bitumen for road construction	Abounded application in road construction. Resource reuse. Financially viable. Simple technique.	Limitations in use due to involvement of govt bodies that can sanction road projects. Scattered sources of generation. Generation of emissions.
4.	Use for colored concrete	Symbiotic association. Win-win solution. Environmentally friendly.	Difficulty in set up implementation. Limited use.
5.	Use of paint waste in sealant Industry	Industrial application.	VOC emissions.
6.	Use for charcoal preparation	Can be used for laboratory, medical, filtration and other purposes.	Not possible for small quantum of waste. Scope limitations

### IV. CONCLUSION

From above all discussion, it is clear that recycling paint waste is need of time; since traditional disposal methods have lot of negative aspects related. Also quantum of such waste is increasing in exponential way leading to alarming situation. Globally situation is more dangerous since it has major concern of generation of GHGs and thus contributing most sensitive problem of global warming followed with glacier melting, sea level rise and overall environmental and ecological imbalance. The recycling methods will not only reduce environmental and social impacts but also will reduce financial pressure on industries and resolve legal compliance issues.

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There are many options researchers have worked on and found out very modest solutions. The solutions range from use in construction industry, paint manufacturing, sealant industry, coal industry, energy industry etc. They provide varied offerings in all the sectors with multiple applications. The utility and selection of recycling mechanism though challenging task due to matter of facts related to legal sanctions, location constraints, technology constraints and financial constraints.

Still, wise choice of option can be made by doing SWOT (strength, weakness, opportunity and threat) analysis and evaluating measurable impacts. Thus the risk of environmental hazard can be converted into opportunity for future if actuated and managed in systematic way.

The planning at right stage will also help industries to find sustainable solution. Along with this more research in future may offer better solution.

Some of the industries have set benchmarks by adopting practices mentioned above. Most of industries near cement plants are already taking advantage of co-generation process. Paint preparation is also successfully achieved in foreign countries and has started spreading in India. Use of colored concrete is also demonstrated on pilot basis. The increased demand for environmentally friendly technologies will definitely increase use if such techniques in future.

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