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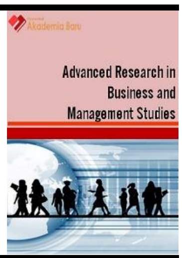

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Paint Waste Management in Industry

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ABSTRACT

Surface coating, paint and allied products industry is one of the major productions in the world due to the increase of urbanization and rapid development. Paint industry offers a variety of colours and types of paint to serve as needed. However, global production of paint consumption may lead to large volume of waste generated which affects people's health and creating environmental surroundings such as landfill area, stormwater drainage and natural waterways. Therefore, this paper highlights the application of paint generally in terms of productions, treatment processes and waste management, as well as finding out the necessary steps to be taken to minimise wastes caused by productions. Furthermore, the understanding of these wastes may contribute to reduce the negative environmental impact and provide sustainable development by utilizing and promoting the paint waste as building material.

Keywords:
paint waste, water-based paint, solvent, waste management, waste minimisation

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1. Introduction

Paints and surface coating industries have become major productions nowadays. The increase in paint consumption rises globally due to urbanisation and the need to meet some aesthetic requirements. Considerable amount of paints is utilised universally either for protection against mechanical, chemical and atmospheric influences, as well as for decorative purposes. Despite having economic downturns, the global coating market in 2011 still reached $106.7 billion, which may be attributed to the increased demand from the industry, building, transportation and others. This market is found to be higher within the Asia-Pacific region which make up a total of 37% of the total economic growth in the paint industry [1]. The sales of paint and surface coating material of the world in 2011 are shown in Table 1. The Asia-Pacific region alone is accounted for 44% of the global coating sales and produced 37% output value compared to the others. The increase is attributed to the factors of relatively cheap labour cost and abundant resources of the entire Asia-Pacific region that helps paint market expansion. However, according to the report, sales growth is predicted to

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accelerate the compound annual growth rate of 6.5%, a five-year period of 2011-2016 which is expected to drive the market value of $142.4 billion, to the end of 2016. High-growth markets including China, India, Indonesia and other leaders contribute to the Asia-Pacific region's largest market stands tall. As previously reported that China is top-ranked followed by India and Indonesia in the largest regionals for higher paint consumptions among the countries in the Asia-Pacific region [2]. Furthermore, the classification of production in 2011 in the global coating as tabulated in Table 2 shows that buildings have attributed the most, which occupied 51% followed by the industry, transportation, packages and others.

Table 1
Sales in 2011 the global coating [1]

Region	Asia-Pacific	Europe	North America	Latin America	Other	Total
Output [Million tons]	1557.6	849.6	601.8	318.6	212.4	3540

Table 2
Classification of production in 2011 global coatings [1]

Classification	Building	Industry	Transportation	Package	Other	Total
Paint (Million tons)	1805.4	1097.4	460.2	106.2	70.8	3540
Scale [%]	51%	31%	13%	3%	2%	100%

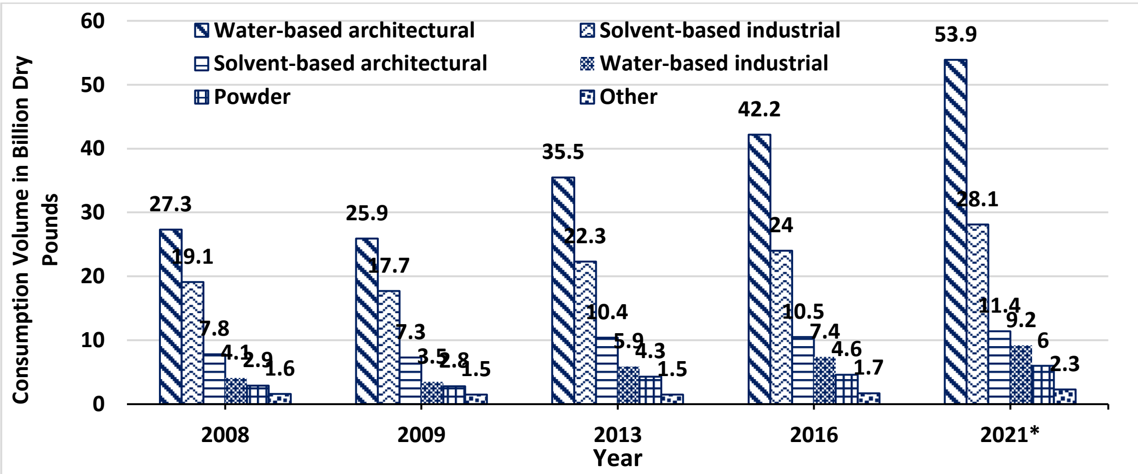

Fig. 1. Coating consumption volume worldwide from 2008 to 2021, by technology [in billion dry pounds] [3]

Compared to current statistic data as reported by [3] that the consumption volume of coatings worldwide from 2008 to 2016 and the projection volume until 2021. It is denoted that the water-based architectural coatings are higher followed by solvent-based industrial coatings, water-based, powders and others in terms of paint consumptions as shown in Figure 1. From these data, it shows that these industrial is increasing due to demanding item for the urbanization, industrial and maintenance work. Therefore, understanding of this matter would give standpoints of energy-saving and conservations of natural resources and also provide alternative constituents in construction materials. The objective of the study was to carry out an overview of paint production and management of waste in general as well as the utilization of solid wastes from waste generation from the production of paint in construction materials. Each section provides a discussion of the respective topics including the materials produces and their effect for general applications.

2. Paints Classification

Generally, products in the paint are broadly categorised according to their use. These categories involve architectural coating, products coating and the special purpose coating. In some cases, these products are further categorized by vehicles or carriers [solvent-based or water-based]. The vehicles, solvents or water evaporates after the paint has been applied to the surface of the object being painted. While that, a non-volatile coating is classified according to the method of curing which includes powder coating, radiation cured coating and two-part catalysed paints [4]. The main driving forces of behind changes in paint productions is due to the environmental regulations and health concerns of the solvent used. The restrictions on volatile organic compounds [VOCs] driven by environmental and health concerns, is to reduce or eliminate VOCs and any solvents considered hazardous air pollutants [HAPs]. Therefore, many researchers are attempts to reduce the effect of VOC in paint production. For instance, liquid coatings formulation must simultaneously meet VOC limitations and HAP restrictions by shifting to high solids, low-solvent coatings as well as water-borne coatings [5], production of new waterborne acrylic binder for zero VOC paints [6], and measuring the VOC parameters by using the ventilated chamber experiments to characterize the emission behaviour [7]. The straight regulations on the emission of VOCs leading to the paint maker produced more water-based paint compared to other paint products as shown in Fig 1.

3. Paint Manufacturing and Processing

The major raw materials used in the manufacture of paints are resins, solvents, pigments, extenders and fillers. The types and the proportion of each component determine the properties of a particular paint. For instance, the function of pigments and fillers is not to provide the colour to the surface, but to reflect the destructive wavelength of light, and thus prolong the life of the paint. Extenders and fillers reduce the costs of manufacturing paints and improve durability [4,8]. The production of paint is a complex process involving dispersion of pigments and additives into a solution of resin and solvent, followed by relatively simple mixing operations. The important step in the process is the initial pigment dispersion known as grinding. Different types of paint are manufactured by changing raw materials used and their relative quantities [9].

Water-based paints are typically composed of water, pigments, resins, extenders, ammonia, dispersant, antifoam additives, polyvinyl alcohol emulsion and a preservative. On the other hand, solvent-based paints are typically composed of solvents, pigments, extenders, resins, plasticizers and drying oil. The manufacturing of water-based paints begins by mixing water, ammonia and dispersant together in a mixing tank. Ground pigment and extenders are then added to this mixture. When mixing is complete, the material is then ground in a mill and transferred to an agitated mix tank. In an agitated mix tank, resin and plasticizers are added to the mixture, followed by the preservative and antifoaming agent, and then polyvinyl acetate emulsion. The manufacturing of solvent-based paints is done by first mixing ground pigments, resins and extenders in a high-speed mixer. Solvents and plasticizers are also added during this operation. The batch is then transferred to a mixing tank, and tints and solvent thinner are added. Finally, the products are filtered to remove any undispersed pigment, packaged, and loaded into containers [4,8,10].

4. Wastes from the Paint Manufacturing Industry

Most paint manufacturers produce many different types and colours of paint, including both organic solvent and water-based paints. However, each production generates wastes, and these provide negative impact on the environment which is against the world concept of sustainability. There are many major wastes from paint manufacturing facilities. Of these wastes, equipment cleaning is the largest source of wastes from paint manufacturing accounting of 80% of the industry's wastes [4,8,9]. Process equipment is routinely cleaned to prevent product contamination and/or restore operational efficiency. Since paint manufacturing is essentially a blending operation and not a chemical conversion operation, the compounds present in the wastes are the same compounds that are present in the input material. Paint manufacturing facilities typically segregate their wastes to the extent required by the waste disposal contractor. With increasing treatment and disposal costs, and impending land disposal bans, paint companies are turning to waste minimization which includes source reduction and recycling [10].

5. Possible uses of Paint Waste as Construction Material

With regards to the volume of wastes generated from the paint industry annually, it is possible to utilize these wastes in the construction industry. Selection of appropriate paint wastes is necessary to enhance the performance of concrete or mortar properties. For instance, water-based paint or solvent-based paint has polymer properties. Typically, polymers are added in the paint for polymer film continuity and adhesion to the substrate. The polymer is the main component that remains after the paint has cured or in a drying process [13]. According to [14–16], the polymer is added in the concrete to improve or modify specific properties especially in durability properties.

Polymer used in paint production is basically from the aqueous polymer dispersion such as polyvinyl acetate which extensively used in emulsion paints particularly in interior paints since the polymer has superior properties compared to styrene-butadiene and less expensive than acrylics. These coatings are flexible and durable, adhere well, dry quickly, and generally do not discolour [8]. On the other hand, polymer waste which obtained as results from paint productions in the form of effluents and sludge as an admixture in concrete has recently studied [17–22]. Expiry paint or waste latex paint also used to modify the concrete. However, the utilization of these wastes may improve properties of concrete in terms of fresh and hardened state, bonding to the concrete substrate, increase resistance to penetration by water and chemicals, and decrease permeability [23–25]. It is observed that the utilization of paint waste also used in the production of brick-making [26,27].

The finding improves that the strength properties of brick and provide ease of transportation due to lightweight compared to normal brick. Table 5, shows the summary of the waste material used from paint production as an attempt to determine the possibilities of using as construction materials.

7. Conclusions

From the above, it can be concluded that the management of waste disposal is important to provide environmental sustainability. Knowledge about paint production waste management would be beneficiary to prohibit unnecessary wastage and save operating cost. Paint wastes can be utilized as a source of polymers in concrete to produce good concrete. Incorporating waste polymer in concrete may improve the superiority of concrete particularly in durability.

Table 5
Summary of previous study incorporating of waste generation from paint production in concrete and mortar

Nos	Material from paint industries waste	Authors
1	Polymer dispersion effluents	[28]
2	Polymer dispersion effluents	[29]
3	Polymer dispersion effluents	[21]
4	Waste water from resin production	[17]
5	Waste latex paint	[23]
	Waste latex paint	[25]
6	Waste latex paint	[30]
7	Waste latex paint	[24]
8	Paint sludge	[22]
9	Paint sludge	[27]
10	Paint sludge	[26]
11	Paint sludge	[31]
12	Paint sludge	[20]

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