Recycling and processing of solid waste into products of the cosmetic packaging industry

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Abstract

The waste generation of the plastic packaging industry for the cosmetic product is consisting of the hazardous and non-hazardous waste. The non-hazardous waste of cosmetic product includes product reject, plastic bags, cardboard, and paper. The content of hazardous waste of the cosmetic product is the part such as chemical packaging drum, paint sludge, and wastewater treatment sludge. On the other hand, there is a chance of the waste management that can be started from the segregation of both hazardous and non-hazardous waste, recycling of non-hazardous waste and utilization of waste into products by third parties. That is because the dangerous waste that is carried out according to the waste regulation can be used as a useful product to provide economic and environmental benefits. The research examines various opportunities to use waste as raw material and also to be processed into products. The study steps consist of identification, assessment, techno-economic analysis, and implementation approaches. The study results show that the hazardous solid waste can be used as fuel, filling materials for paving blocks, and ceramic raw materials. The utilization as raw material for paving blocks shows the most significant opportunity for economic and has environmental benefits.

Keywords: paint waste, waste to product, waste management

1. Introduction

The packaging industry is one of the developing industries to meet various packaging needs. One of the packaging results is used as a container for multiple cosmetic products for domestic and export marketing. Product specifications are determined by consumer demand and raw materials used as packaging and finishing materials used.
Waste produced by the beauty packaging industry is solid, liquid and gas waste that needs to be adequately managed so as not to cause negative impacts on the environment. Management can be started from the source of waste generation using prevention through the engineering of efficient painting process equipment, utilization of waste into products, and processing of waste to meet environmental quality standards [1].

The use of solid waste as raw material for solid products such as concrete blocks, paving, concrete has been carried out by several researchers [2] [3]. Solid waste resulting from wastewater treatment is used as raw material for paving blocks, showing the strength that is suitable for building material needs. The use as raw material for concrete products shows satisfactory results, especially water solvent-based paint waste.

Comprehensive research on the beauty of packaging industry waste management is needed starting from the prevention stage, process efficiency, utilization of waste into products and processing of waste to meet quality standards so that it can be discharged into the environment. This study aims to identify waste management opportunities that integrate aspects of economic and environmental benefits.

2. Research method
The research was carried out on one of the beautiful packaging industries in the packaging process of printing and coating processes. The technique used by direct observation of the production process and the use of process flow diagrams. The steps are taken that start with the identification of waste generation, initial management studies, feasibility assessment, and implementation recommendations.

Identification of waste generation using the process flowchart tool and matching it directly with the field conditions so that it can be found the source and type of waste generation. Initial management studies include determining the efficiency of the process, reducing waste directly from the source, and the opportunity for the utilization of waste as raw material for the product. Feasibility assessment is based on technical-economic considerations with criteria for no cost, low cost and process improvements that require investment. Recommendations are based on industry readiness to apply the easiest improvement opportunities to be implemented immediately.

3. Results and Discussion

3.1. The beauty packaging manufacturing process
The raw material used to make beauty packaging consists of polypropylene type plastic, colorant pigment, coating paint, and thinner. Each raw material is equipped with SDS (Safety Data Sheets). The equipment used in the form of injection machines to make packaging, spray booth machines for the coating process, equipped with a water screen to capture the remaining paint solution, cyclone to separate solid particles and steam. Common plastics consist of only carbon polymers or with oxygen, nitrogen, chlorine or sulfur. The plastic production process generally includes three stages, namely softening by heating technique, formation with pressure on the mold which has been poured by plastic, and compaction at the end of the product. During the injection phase, the plastic material is poured into the heating machine. The mold to press was formed according to the desired pattern, at that time there was steam which contained hazardous waste released into the air, using injection molding method which is a manufacturing technique used to make parts of plastic-based plastic products[4]. Polypropylene resin along with certain color pigments is inserted into the injection machine to be printed at a temperature corresponding to the melting point of the material listed on the SDS, and pressures of 110-140 kg/cm² form beauty packaging products in the form of compact, lipstick, mascara, and jar at
40°C. The advanced process is in the form of a coating process on the spray booth machine using a 50% composition paint solution, by continuous spraying. Paint solution sticks and hardens evenly with the help of UV light.

Figure 1. Process Flow Diagram and Waste Generation
3.2. Waste generation identification
The use of plastic in the food and cosmetics industry is based on its light nature, high flexibility, material strength, transparency, water resistance and ease of sterilization. The large scale consumption of plastic materials in various industries such as packaging industries has resulted in the continuous waste generation and left an environmental footprint [5] [6].

Waste of plastic beauty packaging in the form of solid waste, liquid waste, steam and gas. Solid plastic waste comes from mould products that do not meet specifications as much as 5%; resin scattered, resin sack. Plastic waste also comes from packaged pieces of packaging called runners as much as 20% destroyed by the crusher machine and reused. B3 solid waste in the form of cloth, paint cans, cans of solvents and paint sludge taken from the separation of wastewater from curtain catches of water and solid waste from the cyclone. Wastewater from curtain water and cyclone wastewater is further processed at the wastewater treatment plant. Thinner vapour gas in the form of volatile organic compound (VOC) is sucked and separated in the cyclone separator [7].

3.3. Opportunities
Preliminary studies are conducted to determine opportunities for reducing waste generation, utilization of waste and processing of waste to meet quality standards and can be discharged into the environment. Hazardous waste is waste that has potential hazards to human health and the environment, such as hazardous waste in the form of liquid, solid or gas and is a by-product of manufacturing processes, and unused commercial products, such as cleaning solvent and cleaning cloth [8].

Plastic solid waste from reject and runner products is put into the crusher machine so that the plastic seeds are re-fed to the injection machine. By recycling internally in the production process, the generation of waste can be prevented. The resin scattered on the floor and the machine is used as an automatic vacuum device which is given a hose into the sack/bag of resin placed near the injection machine; there is no manual pouring of material into the hopper.

Hazardous solid waste in the form of significant cloth, oil pigment or grease sack is sorted to avoid mixing with general waste and disposed of in hazardous waste trash collected together with paint cans and thinner to be managed by a licensed third party. Hazardous waste in the form of paint sludge can be used as raw material for paving block, brick and concrete products. Analysis of calorie content in paint sludge allows it to be used as fuel. Solid waste in the form of sludge from cyclone separator and sludge from wastewater treatment plant is used as raw material for making bricks and concrete blocks and similar products. Steam and gas from cyclone separator are processed by adsorption using adsorbents.

3.4. Feasibility Evaluation
The development of the waste management system model over the past few decades has advantages and disadvantages; the latest model is a model that focuses on integrated waste management, with the concept of sustainable waste management with three main categories of models identified: benefit-cost analysis model, life cycle inventory model, and multi-criteria models. The use of waste plastic aggregates as partially aggregated devices in concrete-making materials. The optimal yield of 30% of concrete-making materials comes from aggregates sourced from waste; this utilization helps protect the environment by minimizing the volume of waste disposal [9] [10].
Feasibility evaluation (Table 1) includes 3 (three) aspects, namely technical, environmental and economic feasibility, qualitative assessment. The technology assessment aspect is based on the availability of technology that will be used to manage waste. Economic feasibility is assessed from low costs, medium costs, and actions that require high investment. Environmental feasibility aspects based on prevention and reduction of waste.

Table 1. Feasibility Evaluation

| No | Waste generation | Waste management | Technical feasibility | Economic feasibility | Environment feasibility |
|----|------------------|------------------|-----------------------|----------------------|------------------------|
| 1  | Plastic waste    | Recycle on the internal process. Waste as raw material Resin waste minimization | Recycling by using crusher Use of a vacuum machine to suck material | Low cost | Prevention and reduction of waste to the environment Prevention of plastic waste generation |
| 3  | Solid waste of used oil cloth, pigment sacks, paint cans and thinner cans | Waste managed by third party | Waste managed by third party | Medium cost | Prevention and reduction of negative environmental impacts and fires |
| 4  | Paint sludge     | Waste reduction, Utilization of waste into products | Engineering painting techniques Use of water-based solvents Waste as raw material for brick making, paving blocks, concrete | Medium cost Low cost Low cost | Prevention and reduction of negative environmental impacts |
| 5  | Wastewater treatment sludge | Utilization of waste into products | Waste as raw material for brick making, paving blocks, concrete | Low cost | Prevention and reduction of negative environmental impacts |
| 6  | Wastewater       | Wastewater treatment | Wastewater treatment | Medium cost | Fulfillment of environmental |
### 3.5. Recommendation

Recommendations on packaging industry waste management are based on these three aspects with suggestions for implementation of activities that are low cost and provide economic and environmental benefits. The first opportunity of waste utilization carried out by recycling the pieces of packaging products back to the process, provide economic and environmental benefits. The use of vacuum suction materials can reduce the waste that to reducing waste generation and also can avoids work accidents. The opportunities for liquid waste are processed in the wastewater treatment plant for reuse when cleaning and watering plants. The next option is the processing of waste gas so that the effluent meets environmental quality standards. Management of hazardous solid waste by third parties to prevent negative impacts on the environment and fire hazards which because in the production area that in addition to production activities that there are improvements to machinery and equipment that can cause sparks such as welding and troubleshooting.

The use of waste as raw material and making it as a product still requires technical studies related to product standards. In Portugal, an evaluation of hazardous waste management was carried out as a framework for an integration of the recovery center in infrastructure procurement law, and the technology applied to reduce the volume of hazardous waste. Salihoglu and Salihoglu examined the paint sludge from the automotive industry regarding its derivatives, characteristics, and management [11] [12].

### 3.6. Work safely

The handling of waste paint must pay attention to the aspects of occupational safety and health for personnel who deal directly with other affected parties. Based on information from Safety Data Sheets (SDS), paint waste can irritate if in contact with skin and eyes. Waste steam when inhaled can cause respiratory tract irritation with coughing symptoms. Waste is toxic so that if swallowed it results in poisoning and self-unconsciousness. Personal protective equipment that needs to be used is safety glass, chemical masks, and chemical gloves. Resin spills on the floor can cause work accidents, workers who work in the engine area can slip, and manual transport can cause back pain to lift the wrong lift when entering the material to the hopper. Woven cloth, pigment sacks, paint cans and thinner cans which are mixed with general waste can pose a fire hazard.

### 3.7. Utilization of Waste as Raw Material for Paving Block

Previous research related to waste paint management was carried out by Arce examining accelerated carbonation solidification process known as immobilization before processing and then waste is disposed of in the landfill, the purpose of this solidification/stabilization process is to immobilize contaminants and reduce their release to the environment. Sudarno et al carried out the research of recycled road pavement material as an effort to reduce energy consumption; the results are technical, energy consumption, emissions, and economic aspects show that it is relatively more efficient than overlay jobs [13] [14]. Preliminary research on the use of waste paint as a raw material that can be processed into paving block products that are useful shows satisfactory results. Addition of waste paint as raw material with 1-15%
composition has been carried out. The resulting paving block has been tested for strong strength, showing that the maximum paint content of 5% provides a strong strength of 10 MPa to meet the standards of use as paving for pedestrians. The use of solid waste paint has real benefits for the environment and at the same time reduces the cost of making 5% paving blocks, equivalent to IDR 200 per paving block. The waste that had to be processed or stockpiled is used as raw material for making paving blocks. The use of paint sludge in building materials as a substitute for aggregates is included in cement and lime. The results obtained are lightweight construction materials, can insulate heat and sound, because of the flexural strength and relative pressure decrease with increasing levels of paint sludge in the sample and waste latex paint. Paint sludge also used as an appropriate substitute or as an additive in styrene-butadiene rubber-based concrete [3].

![Figure 2. Block paving products using waste paint additives](image)

**4. Conclusion**

The management of waste of beauty plastic packaging industry is carried out by a preventive approach, reduction of waste generation and use of waste as raw material into products to provide economic and environmental benefits. Solid waste in the form of scattered resins can be prevented by using a vacuum device. From the health aspect it prevents workers from direct contact with melted plastic vapor to avoid work accidents. Opportunities for the use of hazardous solid waste as raw material for paving blocks have been realized and the product meets standards as paving material for pedestrians.

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