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DFMA-Based Redesign of the M-Coat Tank for Plastic Sheet Coating Production at PT EA1

Ahcmad Fauzan
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Keywords: Bak M-Coat, DFMA, Planning, Coating

ABSTRACT

***Background**: Plastic film sheet production at PT EA1 requires a uniform M-Coat layer to meet product quality specifications; therefore, the suitability of the coating-media container is critical to process stability and coating consistency. **Objective**: This study aims to redesign the M-Coat tank so that its dimensions and configuration match the coating process requirements and the machine working mechanism. **Methodology**: The research employed an industrial case-study design, collecting data through observation, interviews, and documentation, supported by direct dimensional measurements of the product and equipment constraints. Data were analyzed using the Design for Manufacturing and Assembly (DFMA) method to develop and evaluate the redesigned tank concept in terms of manufacturability, assemblability, and operational suitability. **Findings**: The proposed M-Coat tank redesign is applicable to the production line and can be operated optimally to support the plastic sheet coating process at PT EA1. **Implications**: The results indicate that DFMA-based redesign of process equipment can improve implementation feasibility on the shop floor while supporting consistent coating performance in coating production environments. **Originality**: This study extends DFMA from conventional product/component redesign to coating-line process equipment redesign by integrating manufacturability and assembly considerations with real operational constraints in plastic sheet coating production.*

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DFMA-Based Redesign of the M-Coat Tank for Plastic Sheet Coating Production at PT EA1

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Abstract.
Background: *Plastic film sheet production at PT EA1 requires a uniform M-Coat layer to meet product quality specifications; therefore, the suitability of the coating-media container is critical to process stability and coating consistency.* ***Objective***: *This study aims to redesign the M-Coat tank so that its dimensions and configuration match the coating process requirements and the machine working mechanism.* ***Methodology***: *The research employed an industrial case-study design, collecting data through observation, interviews, and documentation, supported by direct dimensional measurements of the product and equipment constraints. Data were analyzed using the Design for Manufacturing and Assembly (DFMA) method to develop and evaluate the redesigned tank concept in terms of manufacturability, assemblability, and operational suitability.* ***Findings***: *The proposed M-Coat tank redesign is applicable to the production line and can be operated optimally to support the plastic sheet coating process at PT EA1.* ***Implications***: *The results indicate that DFMA-based redesign of process equipment can improve implementation feasibility on the shop floor while supporting consistent coating performance in coating production environments.* ***Originality***: *This study extends DFMA from conventional product/component redesign to coating-line process equipment redesign by integrating manufacturability and assembly considerations with real operational constraints in plastic sheet coating production.*

Keywords ~ *Bak M-Coat, DFMA, Planning, Coating*

INTRODUCTION

Plastic sheet coating operations at PT EA1 require an M-Coat layer to be deposited uniformly across the entire sheet surface to comply with product quality specifications. Coating non-uniformity such as incomplete coverage, thickness variation, and streaking can reduce functional performance and increase rework or scrap. Coated plastic sheets are widely used in high-value applications (e.g., packaging, optics, and electronics), making coating consistency and surface integrity critical in industrial practice (Jahangiri et al., 2024). Equipment readiness on the shop floor strongly influences coating stability because the coating medium must be supplied reliably with minimal contamination and

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residue accumulation; inadequate liquid handling can increase cleaning frequency and downtime, ultimately weakening production efficiency and coating repeatability.

Coating literature highlights that process routes and interfacial engineering materially affect coating quality and performance. Coating methods can yield different thickness and uniformity outcomes, where bar-coating tends to produce thicker and more uniform layers than dip-coating in polymer sheet applications (Jahangiri et al., 2024). Adhesion improvement strategies for coatings on plastics including layer-by-layer approaches and surface treatment routes have been shown to enhance bonding and durability, which is essential to mitigate delamination and maintain surface quality under operational conditions (Chen et al., 2016; Chunder et al., 2009; Wu et al., 2009). DFMA studies provide structured principles to simplify designs early, reduce manufacturing and assembly effort, and improve cost and lead time outcomes (Boothroyd et al., 1994; Koraishy et al., 2010; Shipulski, 2009), with CAD integration and cross-functional coordination strengthening DFMA execution in mechanical design contexts (Campi et al., 2022; Li, 2024). Product and machine design references further emphasize systematic planning, element selection, and safety considerations as prerequisites for reliable industrial equipment implementation (Ginting, 2009; Sularso & Suga, 2004), while prior DFMA case studies in industrial settings demonstrate measurable benefits from redesign focused on manufacturability and assembly efficiency (Hasibuan et al., 2013). Engineering validation practices, including material selection and structural safety evaluation, are also commonly employed to ensure redesigned equipment meets operational constraints (Wibawa & Diharjo, 2019). Participatory design methodology supports the practical need to incorporate operator and stakeholder input so that redesign decisions align with real shop-floor constraints and maintenance practices (Spinuzzi, 2005).

This study aims to redesign the M-Coat tank used in the plastic sheet coating process at PT EA1 by applying the Design for Manufacturing and Assembly (DFMA) approach. The redesign is developed from field measurements of product dimensions and consideration of the machine working mechanism, followed by DFMA-driven evaluation to improve manufacturability and assembly efficiency while maintaining functional requirements for stable coating delivery. The work targets practical improvements relevant to production implementation, including design simplification, improved maintainability/cleanability, and compatibility with existing equipment constraints (Boothroyd et al., 1994; Campi et al., 2022; Koraishy et al., 2010).

A DFMA-based redesign is expected to reduce design complexity (e.g., part count and assembly effort) and improve operational robustness (e.g., reduced leakage risk, minimized residue accumulation, and shorter cleaning-related downtime), which together support more stable coating performance on plastic sheets. Novelty is positioned in extending DFMA from typical product/component redesign to process equipment redesign for a coating line by integrating manufacturability-assembly criteria with coating-process requirements and maintainability considerations under real retrofit constraints (Boothroyd et al., 1994; Li, 2024; Shipulski, 2009), while reinforcing engineering feasibility through systematic planning, element selection, and safety-oriented validation practices (Ginting, 2009; Sularso & Suga, 2004; Wibawa & Diharjo, 2019) and incorporating stakeholder input consistent with participatory design principles (Spinuzzi, 2005).

METHODS

The study was conducted as an industrial case study on the M-Coat tank used in the plastic sheet coating line at PT EA1. The research began by preparing the operational and engineering data required to support a DFMA-based redesign, including component identification, component dimensions, material types, functional and usage requirements, the operating method of the coating equipment, and manufacturing/assembly information relevant to fabrication and installation. Primary data were obtained directly from the shop floor through observation of the coating process and the tank's role in supplying coating media, supported by semi-structured interviews with operators, maintenance personnel, and supervisors to capture practical constraints, recurring problems, and expected performance targets. Documentation was used to strengthen the dataset, covering available company records, product and equipment specifications, existing work instructions, photographs, and technical references related to DFMA and coating equipment. Dimensional data for each part and interface were recorded to ensure the redesigned tank would match the required capacity and fit the existing machine and piping constraints.

Data analysis was performed using the Design for Manufacturing and Assembly (DFMA) method by first evaluating the existing tank design as a baseline and then developing redesign alternatives based on the identified shop-floor issues and constraints. The DFA aspect focused on mapping the bill of materials and assembly structure, identifying joints and fastening interfaces, and describing the assembly sequence to determine which parts could be integrated or simplified without compromising function, serviceability, or safety. The DFM aspect assessed manufacturability by reviewing feasible fabrication processes at the company (e.g., cutting, forming, welding, machining, and surface finishing), the complexity drivers of each component, and the practicality of material selection and surface requirements for coating media handling, including considerations to minimize residue buildup and facilitate cleaning. Each redesign alternative was compared against the baseline using DFMA-oriented indicators such as part count, assembly operations, and qualitative manufacturability/maintainability considerations, while ensuring compatibility with operational requirements of the coating process. Operational measurements used in the evaluation such as repeated timing observations or repeated dimensional checks were verified using a data uniformity test to confirm the consistency of observations and a data adequacy test to ensure the number of samples was sufficient for reliable conclusions. The final design was selected based on the best balance between improved manufacturability and assembly efficiency, operational suitability for stable coating delivery, and practical implementation within PT EA1's production environment

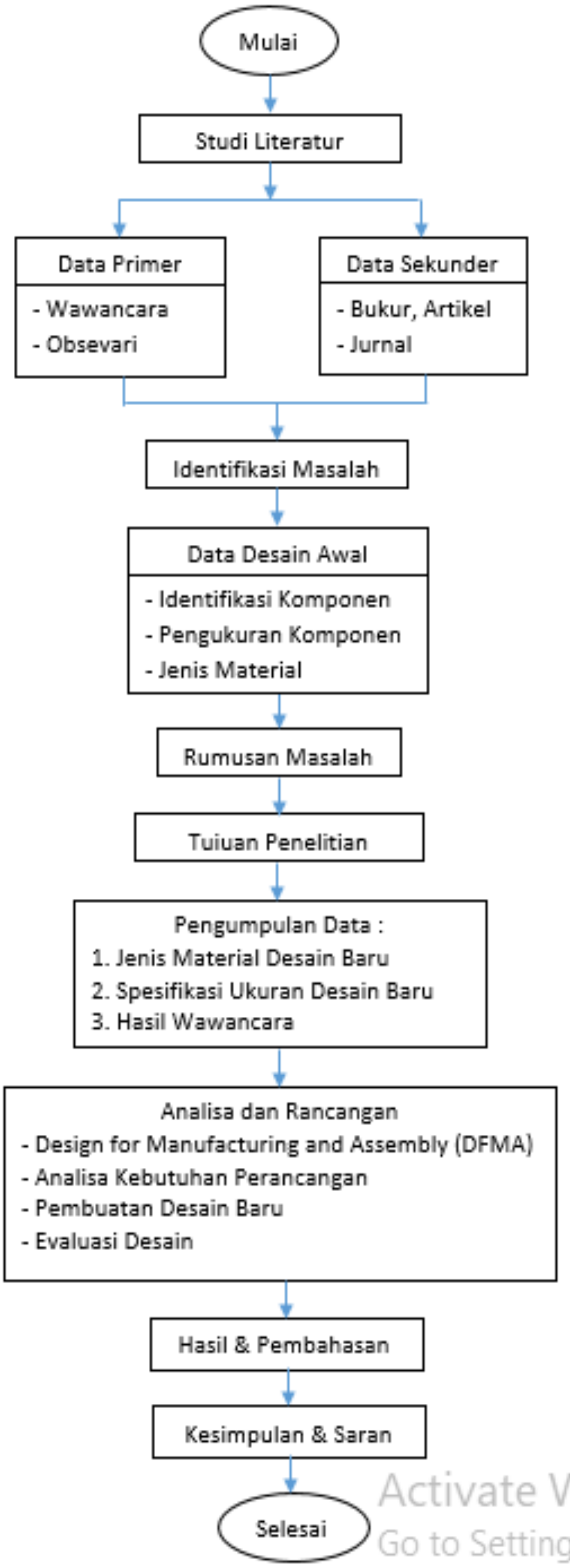

Figure 1. Research Process Flow

RESULTS & DISCUSSION

In the previous model of M-coat tub that was used, there were several obstacles because the M-Coat material for plastic products stuck to the surface of the tub and did not flow perfectly, so that the circulation of the M-Coat material liquid was uneven and caused the plastic film product not to be coated with the liquid perfectly, as in the following image.

Figure 3. M-Coat attached to the gutter (Side View)

Uneven M-Coat liquid can also cause the coating on plastic film products to have a surface that does not meet the standards set by the company.

Planning

In collecting data on the size or dimensions of the M-Coat tank, manual measurements were carried out using several tools such as meters, sihmats, and others. From the measurement results, the design process was continued using Autocad software. The following are the sizes or dimensions of the M-Coat tank and its gutter as follows:

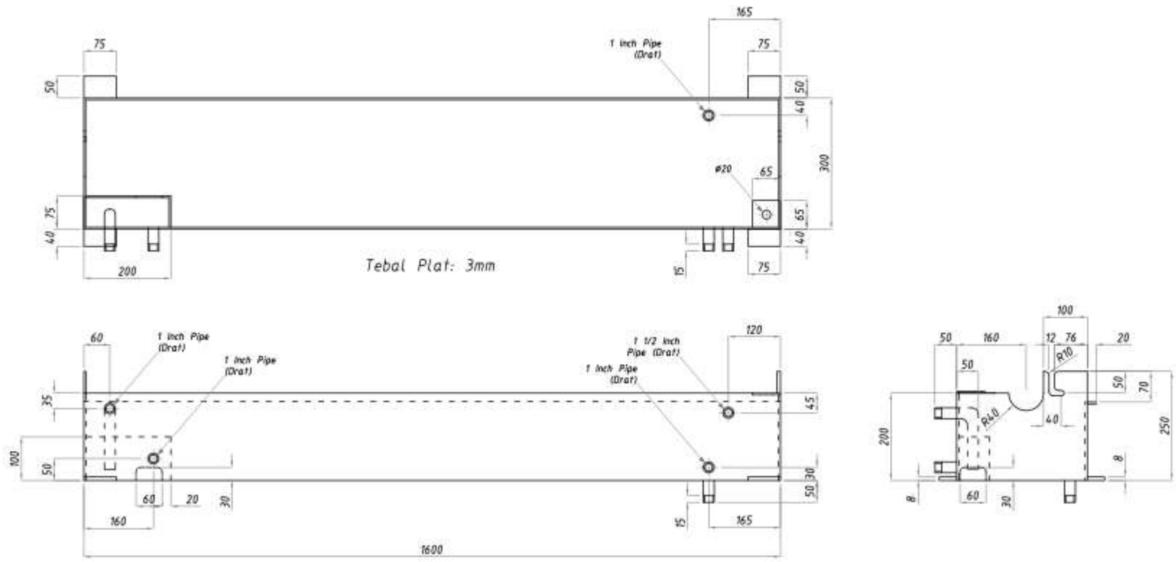

Figure 4. M-Coat Tank Size

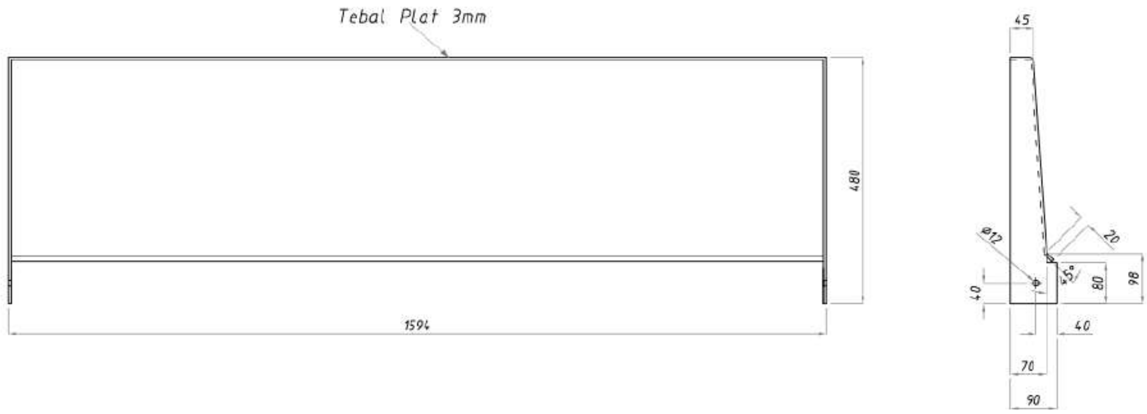

Figure 5. M-Coat Gutter

In the design of the M-Coat Tank for the plastic film product coating process, it is adjusted to the length of the plastic product roll size to maximize the M-Coat coating process, and is sufficient to accommodate the M-Coat liquid so that it does not spill or drip around the production area. The length of the M-Coat Tank is 1600mm, width 300mm with a height of 250mm. while the size of the gutter has been adjusted in such a way with a length of 1594mm, has a width of 400mm, with a slope angle of 15^{the}so that the M-Coat liquid that falls into the gutter area can go directly into the tank and does not settle in the gutter area, the material used is stainless steel (SUS) 304. The main function of the Teflon (PTFE) coating on the M-Coat Tank is to protect the surface from corrosion, chemical reactions, and contamination due to its inert (non-reactive) nature towards most aggressive chemicals, including strong acids, bases, and solvents. This maintains the integrity of the M-Coat Tank, extends its service life, and prevents the release of hazardous substances, making it ideal for the chemical, pharmaceutical, food, and laboratory industries. Because the resulting plastic film products are usually used for food packaging, it must be avoided from unnecessary material contamination. Attached below is complete data regarding component requirements and the quantity and cost required for each part.

Table 1. M-Coat Tank Component Data

No	Component Name	Material Type	Size	Amount (Comp)	Price/Cost (RP)
1	Bak M-Coat	SUS 304	1600x300x200mm	1	15.000.000
2	M-Coat Tub Gutter	SUS 304	1594x400x90mm	1	4.125.000
3	Teflon Coating	Teflon	-	1	11.926.000
4	Hexagon builds	Galvanized	M16 x 20	6	50.000
5	Wall	Galvanized	M16 x 20	6	15.000
					31.116.000

Figure 6. New Model M-Coat Tank

CONCLUSION

Based on the design results of the new model M-Coat Tank and given a coating with Teflon material on the surface of the Tank, the M-Coat liquid does not stick and accumulate on the surface of the Tank, so that the condition of the Tank remains clean and the circulation of the M-Coat liquid is optimal and evenly distributed on the surface of the plastic film it passes through, and produces quality that meets company standards.

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