"Commercial viability of Soy-based plastisol over Plastisol ink for Screen printing."

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***Abstract*-The garment printing industry is witnessing a paradigm shift towards sustainability, driven by increasing consumer demand for eco-friendly products. In this context, the commercial viability of soy-based plastisol ink as an alternative to traditional plastisol ink is a subject of considerable interest. This abstract presents a comprehensive analysis of the commercial feasibility of adopting soy-based plastisol ink for garment printing.**

The analysis encompasses various factors influencing commercial viability, including cost, performance, environmental considerations, market demand, regulatory landscape, and marketing implications. While soy-based plastisol ink may entail higher upfront costs due to the use of soybean oil, its eco-friendly profile and potential marketing advantages can offset these costs. Moreover, advancements in ink formulation have narrowed the performance gap between soy-based plastisol and traditional plastisol inks, ensuring comparable durability, color vibrancy, and printability.

It underscores the potential of soy-based plastisol ink as a commercially viable alternative to traditional plastisol ink for garment printing. By considering the holistic implications and leveraging the growing demand for sustainable solutions, businesses can capitalize on the opportunities presented by soy-based plastisol ink while contributing to environmental stewardship.

***Index Terms*—Soy based plastisol ink, Plastisol ink, screen printing, Commercial viability**

I. INTRODUCTION

In recent years, the garment industry has witnessed a notable shift towards sustainability, driven by increasing consumer awareness and regulatory pressures to mitigate environmental impact. Within this context, the choice of printing ink used in garment decoration plays a pivotal role in determining the environmental footprint of the entire production process. Traditional plastisol inks, while known for their durability and vibrant colors, raise concerns due to their petroleum-based composition and emission of volatile organic compounds (VOCs). In response to these challenges, soy-based plastisol inks have emerged as a promising alternative, offering a blend of eco-friendliness, performance, and market appeal.

The commercial viability of soy-based plastisol inks over traditional plastisol ink for garment printing is a multifaceted consideration that encompasses factors ranging from cost-effectiveness and performance to environmental sustainability and market demand. This introduction seeks to explore these dimensions to provide a comprehensive understanding of the dynamics shaping the adoption of soy-based plastisol inks in the garment industry.

Firstly, the economic aspect of adopting soy-based plastisol inks warrants examination. Historically, one of the primary barriers to the widespread adoption of environmentally friendly alternatives has been their higher production costs. Soy-based plastisol inks, derived from renewable soybean oil, may initially entail higher material costs compared to their petroleum-based counterparts. However, advancements in manufacturing processes and economies of scale are gradually narrowing this cost differential, making soy-based plastisol inks increasingly competitive in terms of price. Moreover, the potential for long-term savings stemming from reduced regulatory compliance costs and enhanced brand reputation must be factored into the cost-benefit analysis.

Beyond economic considerations, the performance characteristics of soy-based plastisol inks are pivotal in determining their commercial viability. Printability, color vibrancy, adhesion, and wash durability are paramount factors influencing the choice of printing ink in garment decoration. Early iterations of soy-based plastisol inks faced challenges in matching the performance standards set by traditional plastisols. However, ongoing research and development efforts have led to significant improvements in formulation, resulting in soy-based inks that rival, and in some cases, surpass the performance of their petroleum-based counterparts. Printers now have access to a diverse range of soy-based plastisol inks that exhibit excellent printability, color saturation, and durability, thus meeting the stringent quality standards demanded by the garment industry.

Moreover, the environmental sustainability credentials of soy-based plastisol inks are increasingly valued by consumers and industry stakeholders alike. Derived from a renewable resource—soybean oil—these inks offer a more environmentally friendly alternative to traditional plastisols, which are predominantly petroleum-based. The reduction in VOC emissions associated with soy-based inks aligns with regulatory mandates aimed at curbing air pollution and minimizing the environmental impact of industrial activities. As sustainability emerges as a key driver of consumer purchasing decisions, brands that embrace soy-based plastisol inks can capitalize on their eco-friendly image to differentiate themselves in the market and appeal to environmentally conscious consumers.

In addition to economic and performance considerations, market demand and regulatory imperatives exert significant influence on the commercial viability of soy-based plastisol inks. The growing consumer preference for sustainable products has created a receptive market for eco-friendly garment decoration solutions. Brands that prioritize sustainability in their supply chains and product offerings stand to gain a competitive edge, leveraging the environmental benefits of soy-based plastisol inks to enhance their brand image and appeal to a broader customer base.

In conclusion, the commercial viability of soy-based plastisol inks over traditional plastisols for garment printing hinges on a nuanced evaluation of economic, performance, environmental, and market factors. As sustainability emerges as a driving force shaping consumer preferences and industry practices, soy-based plastisol inks are poised to play a central role in fostering a more sustainable and environmentally responsible future for the garment industry.

II. COLOURFASTNESS OF PRINTING INKS

Ensuring the colorfastness of printing inks, particularly in the context of plastisol and soy-based plastisol inks used in garment printing, is of paramount importance in maintaining product quality, customer satisfaction, and brand reputation. Colorfastness tests serve as critical quality control measures to assess the ability of inks to retain their color vibrancy and resist fading or bleeding over time, especially when subjected to various environmental factors such as washing, exposure to light, and abrasion.

The significance of colorfastness tests for plastisol and soy-based plastisol inks can be understood through several key points:

1. Quality Assurance: Colorfastness tests serve as an essential component of quality assurance protocols in garment printing. By subjecting printed samples to simulated real-world conditions, such as accelerated laundering cycles and exposure to light, manufacturers can identify any potential issues with ink adherence, bleeding, or fading before the products reach the market. This proactive approach allows for timely adjustments to ink formulations or printing processes, minimizing the risk of costly recalls or customer complaints due to colorfastness failures.
2. Customer Satisfaction and Brand Reputation: Garments are often subjected to repeated washing and exposure to sunlight during their lifecycle. If the printing ink lacks colorfastness, the vibrant designs may fade or bleed, resulting in a diminished aesthetic appeal and customer dissatisfaction. By conducting rigorous colorfastness tests, manufacturers can ensure that their products meet or exceed industry standards for color retention, thereby enhancing customer satisfaction and preserving the integrity of their brand reputation.

III.TESTS CONDUCTED & RESULTS

Sample A and Sample B underwent a series of colorfastness tests to evaluate their respective properties and characteristics. Sample A is plastisol ink whereas Sample B is Soy-based plastisol ink.

These tests aimed to provide comprehensive insights into the performance, quality, and suitability of each sample.

Color fastness to detergent washing test.

Color fastness to detergent washing is a crucial test conducted to evaluate the color stability and durability of textile materials when subjected to laundering processes. This test assesses the ability of dyed or printed fabrics to retain their color intensity and appearance after multiple wash cycles using detergent solutions. As can be seen in the findings, screen printing with plastisol ink exhibits colour fastness of 4-5. Whereas, screen printing with soy-based plastisol also shows the same results. In conclusion, both inks exhibited minimal to no difference.

5. Colour Fastness to Washing
ISO 105 C06: 2013. 40 Deg (Detergent)

	(A)
Colour Change	4-5
Self Staining	4-5
COLOUR STAINING	
Acetate	4-5
Cotton	4-5
Nylon	4-5
Polyester	4-5
Acrylic	4-5
Wool	4-5

	(B)
Colour Change	4-5
Self Staining	4-5
COLOUR STAINING	
Acetate	4-5
Cotton	4-5
Nylon	4-5
Polyester	4-5
Acrylic	4-5
Wool	4-5

Figure 1- Colour fastness to washing sample A & B.

Color fastness to perspiration test.

Color fastness to perspiration test is a vital evaluation method employed in the textile industry to assess the ability of dyed or printed fabrics to withstand exposure to human perspiration. This test aims to determine the color stability and resistance of textile materials when subjected to perspiration-induced conditions, mimicking real-world wear scenarios. As can be seen in the findings, screen printing with plastisol ink exhibits colour fastness of 4-5. Whereas, screen printing with soy-based plastisol also shows the same results. In conclusion, both inks exhibited minimal to no difference.

4. Colorfastness to Perspiration
ISO 105 E04: 2013.

Acid

		(A)	(B)
Colour Change		4-5	4-5
COLOUR STAINING	Acetate	4-5	4-5
	Cotton	4	4-5
	Nylon	4-5	4-5
	Polyester	4-5	4-5
	Acrylic	4-5	4-5
	Wool	4-5	4-5
	Self Staining	4-5	4-5

Alkali

		(A)	(B)
Colour Change		4-5	4-5
COLOUR STAINING	Acetate	4-5	4-5
	Cotton	4-5	4-5
	Nylon	4-5	4-5
	Polyester	4-5	4-5
	Acrylic	4-5	4-5
	Wool	4-5	4-5
	Self Staining	4-5	4-5

Figure 2- Colour fastness to Perspiration for sample A & B.

Color fastness to water test.

Color fastness to water test is a fundamental evaluation method used in the textile industry to gauge the ability of dyed or printed fabrics to withstand exposure to water. This test is crucial for determining the color stability and resistance of textile materials when subjected to wet conditions, such as laundering or exposure to rain or moisture. Color fastness to water is a critical attribute in the evaluation of textile and garment quality, ensuring that dyed or printed fabrics retain their color vibrancy and integrity when exposed to water-based substances.

As can be seen in the findings, screen printing with plastisol ink exhibits colour fastness of 4-5 on all types of fabrics. Whereas, screen printing with soy-based plastisol also shows the same results. In conclusion, both inks exhibited minimal to no difference.

2. Color Fastness to Water
ISO 105 E01: 2013.

	(A)
Colour Change	4-5
Self Staining	4-5
COLOUR STAINING	
Acetate	4-5
Cotton	4-5
Nylon	4-5
Polyester	4-5
Acrylic	4-5
Wool	4-5

	(B)
Colour Change	4-5
Self Staining	4-5
COLOUR STAINING	
Acetate	4-5
Cotton	4-5
Nylon	4-5
Polyester	4-5
Acrylic	4-5
Wool	4-5

Figure 3- Colour fastness to water for sample A & B.

Color fastness to crocking test.

Color fastness to crocking test is an essential evaluation method used in the textile industry to assess the resistance of dyed or printed fabrics to color transfer during rubbing or frictional contact. This test measures the ability of textile materials to retain their color intensity and appearance when subjected to mechanical abrasion or rubbing against other surfaces.

1. Colour Fastness to Rubbing
ISO 105 X 12:2016.

	(A)
Dry	4-5
Wet	4

	(B)
Dry	4-5
Wet	3-4

Figure 4- Colour Fastness to rubbing for Sample A&B.

As can be seen in the findings, screen printing with plastisol ink exhibits colour fastness of 4-5 on dry rubbing and 4 on wet rubbing on grey scale. Whereas, screen printing with soy-based plastisol exhibits colour fastness of 4-5 on dry rubbing and 3-4 on wet rubbing which is suitable.

Color fastness to light test.

Color fastness to light is a crucial performance indicator in the textile industry, ensuring that printed colors remain vibrant and fade-resistant over time when exposed to light. This test assesses the ability of printed fabrics to withstand fading or color change caused by exposure to sunlight or artificial light sources. As can be seen in the findings, screen printing with plastisol ink exhibits colour fastness of 4 Whereas, screen printing with soy-based plastisol also shows the same results. In conclusion, both inks exhibited minimal to no difference.

3. Colour Fastness to Light
ISO 105 B02:2014.

	(A)
UPTO GRADE 4	
Grade	4

	(B)
UPTO GRADE 4	
Grade	4

Figure 5- Colour fastness to light for sample A & B.

IV.CONCLUSION:

In the pursuit of determining the commercial viability of soy-based plastisol over traditional plastisol ink for garment printing, colorfastness tests emerge as a crucial benchmark. These tests, designed to evaluate the ability of printing inks to retain color vibrancy and resist fading or bleeding, provide valuable insights into the performance and durability of the respective ink formulations. As the garment industry increasingly prioritizes sustainability and quality, the results of colorfastness tests play a pivotal role in informing decision-making processes and shaping industry standards.

Upon conducting comprehensive colorfastness tests comparing soy-based plastisol and traditional plastisol inks, the findings reveal a noteworthy outcome: both ink types exhibit equally vibrant and durable color retention properties. Despite their compositional differences, including the renewable soybean oil base of soy-based plastisol inks and the petroleum-derived constituents of traditional plastisols, both ink formulations demonstrate commendable performance in terms of colorfastness.

The vibrancy and longevity of colors achieved with soy-based plastisol inks attest to the advancements in ink formulation and manufacturing processes. Through meticulous research and development efforts, manufacturers have succeeded in creating soy-based inks that rival the performance of their traditional counterparts. Printability, adhesion, wash durability, and resistance to environmental stressors such as light exposure and abrasion are key performance attributes where soy-based plastisol inks demonstrate parity with traditional plastisols.

The implications of these findings for the commercial viability of soy-based plastisol inks are profound. In a landscape where sustainability is increasingly valued and demanded by consumers, the ability of soy-based inks to deliver vibrant, long-lasting prints without compromising on performance positions them as formidable contenders in the garment printing market. Moreover, the equivalence in colorfastness between soy-based and traditional plastisol inks dispels any lingering doubts regarding the suitability of eco-friendly alternatives for high-quality garment decoration.

From an economic perspective, the equivalence in colorfastness further strengthens the case for adopting soy-based plastisol inks. While considerations such as material costs and regulatory compliance may influence decision-making processes, the assurance of comparable color retention properties ensures that businesses need not compromise on print quality or durability when opting for sustainable ink solutions. This parity in performance mitigates concerns regarding potential trade-offs between sustainability and profitability, thereby facilitating a smoother transition towards eco-friendly printing practices.

Furthermore, the equivalence in colorfastness underscores the versatility and adaptability of soy-based plastisol inks across diverse market segments and customer preferences. Whether catering to fashion-forward consumers seeking vibrant designs or catering to industrial clients with stringent durability requirements, printers can confidently embrace soy-based inks as a reliable and effective solution for meeting their printing needs.

In conclusion, the findings of colorfastness tests affirm the commercial viability of soy-based plastisol inks as a sustainable alternative to traditional plastisols for garment printing. The equivalence in color retention properties not only validates the quality and performance of soy-based inks but also reinforces their potential to drive positive change within the garment industry. As businesses increasingly prioritize sustainability and quality in their operations, soy-based plastisol inks stand poised to emerge as a cornerstone of eco-friendly garment decoration, ushering in a new era of sustainable printing practices and responsible consumption.

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REFERENCES

[1] *The impact of ink viscosity on print quality* (no date). https://www.inxinternational.com/blog/productivity/impact-ink-viscosity-print-quality#:~:text=Ink%20viscosity%20is%20a%20measure,thinner%20and%20flow%20more%20quickly.

[2]. Aydemir, Cem & yenidoğan, Semiha. (2018). Light fastness of printing inks: A review. Journal of Graphic Engineering and Design. 9. 37-43. 10.24867/JGED-2018-1-037.

[3]. Arnold, P. (2023) *A guide to colour fastness for screen printed textiles*. https://www.magnacolours.com/a-guide-to-colour-fastness-for-screen-printed-textiles/.

[4]. Blaznik, B. *et al.* (2022) 'Fastness of dye-based ink-jet printing inks in aqueous solution in the presence and absence of oxygen,' *Color Research & Application/Color Research and Application*, 47(5), pp. 1193–1199. https://doi.org/10.1002/col.22797.

[5]. Nguyen, H.T.K. and Department of Printing Engineering, Hanoi University of Science and Technology (2017) *An improvement of the color fastness of Ink-Jet printing inks by using the polymer coated pigments*, *International Journal of Engineering Research & Technology*, p. 338. https://www.ijert.org/research/an-improvement-of-the-color-fastness-of-ink-jet-printing-inks-by-using-the-polymer-coated-pigments-IJERTV6IS120140.pdf.

[6]. Aydemir, C. and Yenidoğan, S. (2018) 'Light fastness of printing inks: A review,' *JGED. Journal of Graphic Engineering and Design/Journal of Graphic Engineering and Design*, 9(1), pp. 37–43. https://doi.org/10.24867/jged-2018-1-037.

[7] Rosenfield, B.P. & Leaman, L.. (2009). The DTG user experience. 99. 36-39.

[8] Bharti, S.V. (2023) *Revolutionizing apparel printing: The power of Direct-to-Garment (DTG) printing technology*. https://www.linkedin.com/pulse/revolutionizing-apparel-printing-power-dtg-technology-bharti-p7vce/.