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A Comprehensive review on In-Mould Labelling

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Abstract: *An advanced polymer processing method called In-Mould Labelling (IML) involves inserting a pre-printed thermoplastic label into the mold cavity before injection, blow molding, or thermoforming. This allows the label and molten polymer to fuse together during solidification. The procedure enhances surface finish, adhesion strength, and product durability while doing away with secondary labeling operations. For polypropylene systems, typical processing temperatures fall between 180 and 240°C, while injection pressures typically range from 50 to 150 MPa. A technical review of IML processes, important process parameters, comparative performance analysis, cost implications, and sustainability considerations are all covered in this paper. In comparison to conventional labeling methods, the review indicates that IML provides better mechanical bonding, shorter cycle times, and increased recyclability.*

Keywords:*In-Mould Labelling (IML), Injection Moulding, Blow Moulding, Thermoforming, Polyolefin Labels, Product Packaging, Durable Labels, Eco-Friendly Packaging, Pre-Decorated Plastic Products, Modern Packaging Technology.*

1. INTRODUCTION

In-Mould Labelling (IML) is a manufacturing process in which a pre-printed label is placed inside the mould before the plastic product is formed. During moulding, the molten plastic bonds with the label, making it a permanent part of the final product. The process mainly involves three steps: positioning the label inside the mould, injecting or forming the plastic, and allowing the product to cool and solidify. IML can be used with different moulding techniques such as injection moulding, blow moulding, and thermoforming. This method provides several benefits, including better appearance, improved durability, cost savings in large-scale production, and environmentally friendly recycling options. Potential defects such as misalignment or air entrapment can be minimized through proper process parameter control.

Fig.1 Applications of In-Mould Labelling (IML) in Plastic Packaging

2. LITERATURE REVIEW

In-Mould Labelling (IML) was introduced in the 1970s to overcome issues associated with traditional labelling methods, such as label peeling and additional processing steps. By integrating the label directly within the moulding cycle, the process improved production efficiency and product durability. Dominick V. Rosato explains that during injection moulding, molten polymer forms a strong bond with the thermoplastic label, resulting in superior adhesion and resistance compared to adhesive-based systems. Mikell P. Groover highlights that combining decoration with moulding eliminates secondary operations and enhances manufacturing efficiency, although it requires precise mould design and higher initial tooling costs. Comparative studies show that injection moulding-based IML provides stronger bonding due to higher cavity pressure, while blow moulding and thermoforming are more suitable for hollow and thin-wall applications. Sustainable packaging research further indicates that using polypropylene labels with polypropylene containers improves recyclability since both materials belong to the same polymer family.

3. METHODOLOGY

In-Mould Labelling (IML) is implemented through injection moulding, blow moulding, and thermoforming processes. The methodology involves accurate label placement inside the mould cavity, controlled polymer fusion under specific temperature and pressure conditions, and proper cooling to achieve strong bonding and defect-free surfaces.

3.1 Injection Moulding with IML

In injection-based IML, a pre-printed polypropylene label (typically 50–80 µm thick) is positioned inside the mould using robotic or electrostatic placement systems. Molten polymer is injected at temperatures ranging from **180–240°C** under injection pressures of **50–150 MPa**. The high cavity pressure ensures strong molecular bonding between the label and molten plastic.

Cooling time generally ranges between **10–30 seconds**, depending on part thickness. This method provides excellent adhesion strength, superior surface finish, and high dimensional accuracy.
Injection IML is widely used for rigid and precision components such as:

- Thin-wall food containers
- Consumer product housings
- Paint buckets
- Automotive interior panels

However, improper control of temperature or pressure may lead to air entrapment, label wrinkling, or misalignment.

3.2 Blow Moulding with IML

In blow moulding-based IML, the label is placed inside the mould before the heated parison (160–220°C) is inflated using compressed air at pressures between **0.5–1.5 MPa**. As the polymer expands, it presses the label against the mould wall, enabling fusion during cooling.

This method is primarily used for hollow products such as:

- Bottles
- Containers and jars
- Chemical storage cans

Compared to injection moulding, bonding strength is relatively lower due to reduced internal pressure, but it is economical for high-volume packaging applications.

3.3 Thermoforming with IML

In thermoforming-based IML, plastic sheets are heated to **120–180°C** and formed along with the label under pressures of **0.3–0.8 MPa**. This technique is suitable for thin-wall packaging products.

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Typical applications include:

- Dairy tubs
- Disposable food containers
- Lids and trays

Although tooling cost is comparatively lower, bonding strength may be reduced when compared to injection-based IML due to lower forming pressure.

Table 1: Process Parameter Comparison of IML Techniques

Parameter	**Injection IML**	**Blow IML**	**Thermoforming IML**
Pressure Level	High (50–150 MPa)	Medium (0.5–1.5 MPa)	Low (0.3–0.8 MPa)
Bond Strength	Excellent	Good	Moderate
Surface Finish	Superior	Good	Moderate
Tooling Cost	High	Medium	Low
Suitable Products	Rigid precision parts	Hollow containers	Thin-wall packaging

4. FIGURES AND TABLES

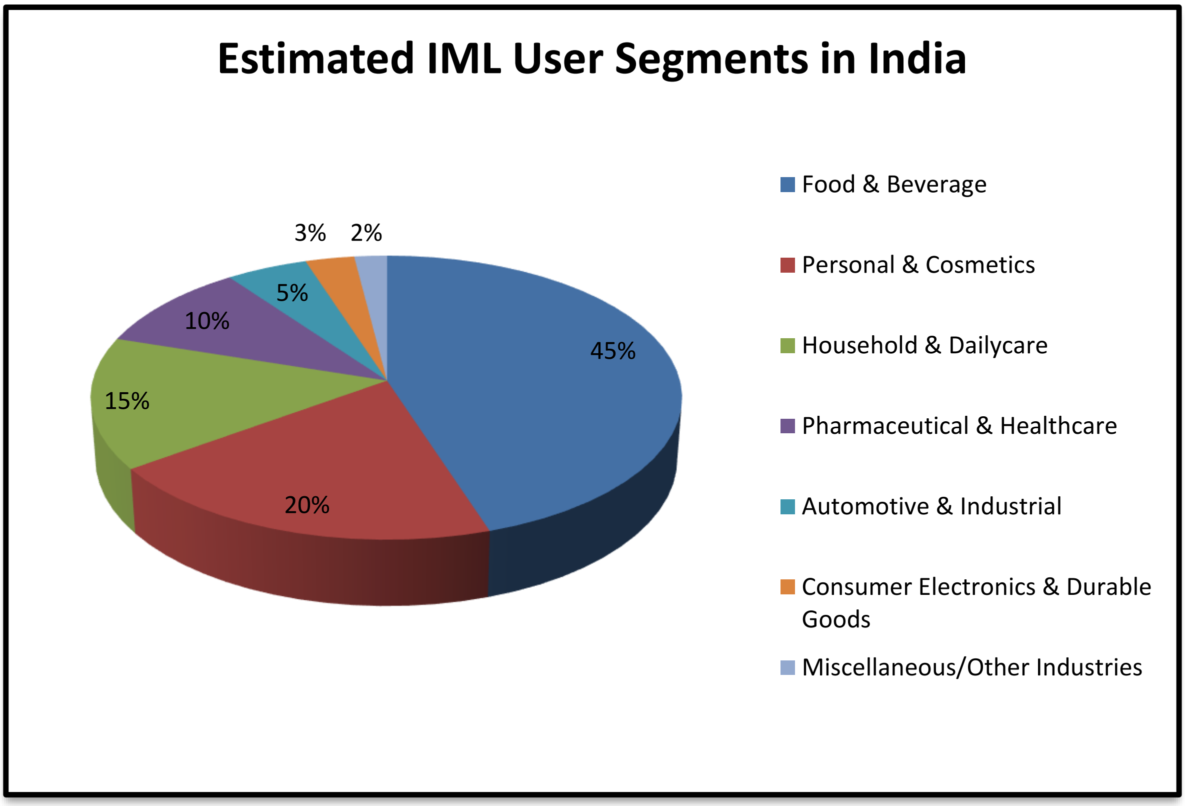

Fig.2 IML market Segmentation by Industry in India

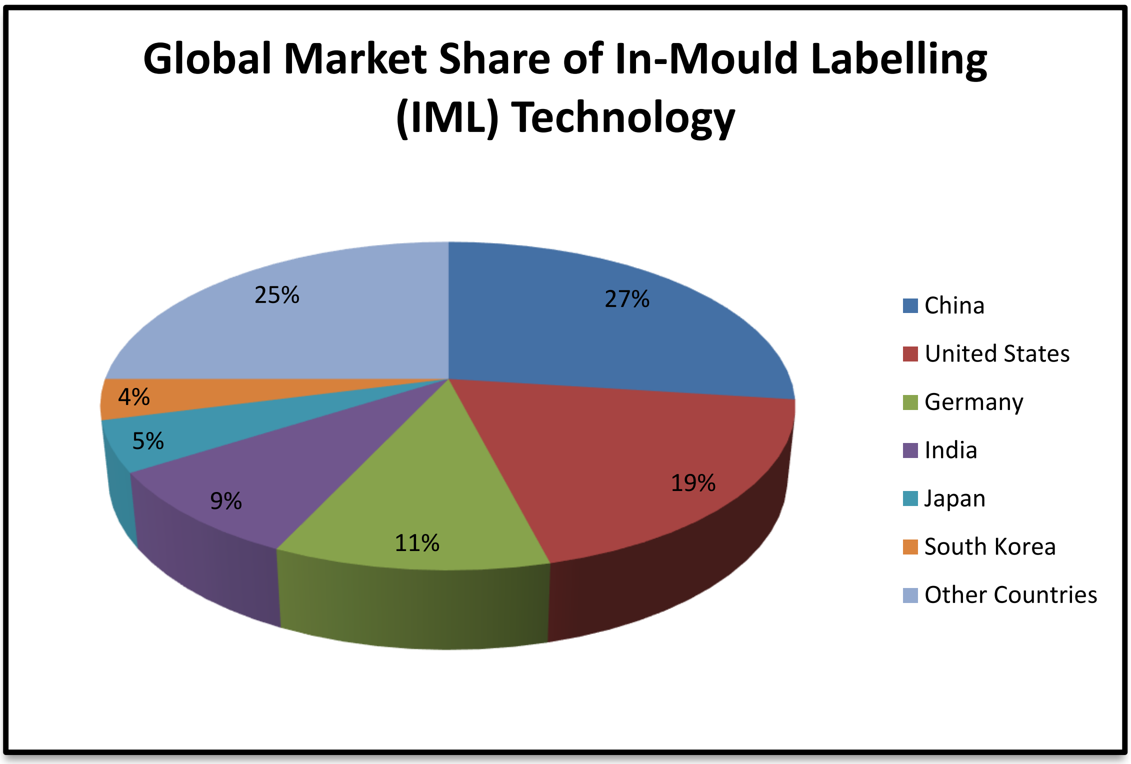

Fig.3 Global Market Share of In-Mould Labelling (IML) Technology

Table.2 Essential differences between IML and traditional labelling/printing methods

Method	Label/Pattern location	Integrated Moulding?	Durability	Eco-friendliness (Same-material Recycling)	Typical Application Scenarios
Traditional glue stickers or pressure-sensitive labels	Applied after product moulding	No	Average (prone to curling, falling off)	Poor (requires separation of different materials)	Low-end products
Screen printing and pad Printing	Directly printed on product surface	No	Medium	Average	Mid-to-low-end products
IML	Label fused with plastic during moulding	Yes	Excellent (Highly durable against wear, oil, and temperature changes)	Excellent, (Improves recyclability as the label and container are made from the same polymer)	High-end food, daily chemicals, thin-wall containers

5. PRACTICAL AND RESEARCH IMPLICATIONS

5.1 Cost-Effectiveness of In-Mould Labelling

In-Mould Labelling (IML) requires a somewhat higher initial tooling cost, typically about 10–20% more than conventional labelling systems, mainly due to precision mould design and automated label placement mechanisms. However, this higher investment is offset by savings during production.In traditional labelling, adhesive application and separate label placement usually add 5–10 seconds per unit to the production cycle. Since IML integrates labelling directly into the moulding process, total cycle time can be reduced by approximately 5–15%, depending on product design and production volume. This reduction increases productivity and lowers labour involvement. IML also eliminates adhesive usage, reducing material and maintenance costs. Improved bonding further minimizes defects such as peeling or misalignment, potentially reducing scrap rates by 3–5%. As a result, in high-volume manufacturing, IML can achieve an estimated 5–15% reduction in long-term per-unit production cost, making it economically beneficial despite higher initial tooling expenses.

5.2 Lifecycle and Sustainability Improvement

From a lifecycle perspective, IML offers clear environmental advantages. When polypropylene (PP) labels are used with polypropylene containers, both components belong to the same material family. This simplifies recycling because no material separation is required.Unlike traditional adhesive-based systems, IML avoids contamination of recycled material and reduces waste generation. Integrating labelling into a single manufacturing step also helps lower energy consumption and product rejection rates. Consequently, IML supports improved recyclability and more sustainable production practices.

5.3 Comparison with Traditional Labelling

Table 3: Economic and Lifecycle Comparison Between Traditional Labelling and IML

Parameter	Traditional Labelling	In-Mould Labelling (IML)
Initial Tooling Cost	Lower	10–20% Higher
Production Cycle Time	Longer	5–15% Shorter
Adhesive Usage	Required	Eliminated
Labour & Handling	Higher	Reduced
Long-Term Unit Cost	Higher	Lower (High Volume)
Recyclability	Limited	Improved

6. CONCLUSION

In-Mould Labelling (IML) is an efficient polymer processing technique that integrates labelling within the moulding cycle, eliminating secondary operations. Comparative analysis shows that injection-based IML provides superior bonding performance, while blow moulding and thermoforming are suitable for specific packaging applications. Although the initial tooling cost is slightly higher, IML reduces cycle time, eliminates adhesive usage, and lowers long-term production costs in high-volume manufacturing. The use of same-polymer systems also improves recyclability and supports sustainable production. Overall, IML offers a practical balance between technical performance, cost efficiency, and environmental benefits for modern packaging industries.

REFERENCES

[1] Rosato, D. V., Rosato, D. V., & Rosato, M. G. (2000). Injection Molding Handbook (2nd ed.). Springer, Boston, MA.
[2] Osswald, T. A., Turng, L. S., & Gramann, P. J. (2008). Injection Molding Handbook (3rd ed.). Hanser Publishers, Munich.
[3] Groover, M. P. (2020). Fundamentals of Modern Manufacturing: Materials, Processes, and Systems (7th ed.). Wiley, Hoboken, NJ.

[4] Goodship, V. (Ed.). (2004). Injection Moulding: A Practical Guide. Smithers Rapra Technology, UK.
[5] Thiriez, A., & Gutowski, T. G. (2006). An environmental analysis of injection molding. Journal of Cleaner Production, 14(9–11), 789–801.
[6] Hopewell, J., Dvorak, R., & Kosior, E. (2009). Plastics recycling: challenges and opportunities. Philosophical Transactions of the Royal Society B, 364(1526), 2115–2126.
[7] IMDA – In-Mold Decorating Association. (2023). White Paper on In-Mold Labeling (IML) Recyclability and Sustainable Packaging. IMDA Technical Publication.
[8] European Plastics Converters (EuPC). (2018). In-Mould Labelling Technology and Recycling Compatibility Report. EuPC Technical Publication.
[9] Malloy, R. A. (2010). Plastic Part Design for Injection Molding (2nd ed.). Hanser Publishers.
[10] Osswald, T. A., & Hernández-Ortiz, J. P. (2006). Polymer Processing: Modeling and Simulation. Hanser Publishers.