

Current Trends in Packaging Technology



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Introduction

Packaging is an art or skill of designing packages that mainly includes the safety of the product during storage or distribution. It is the uttermost stage of product development that provides not only aesthetic value but also a detailed description of the quality of the product. Furthermore, it not only protects the product inside and makes it transportable, but also shows some extra features like being intelligently constructed, functionally designed, and adequately printed, as well as must contain product information, making products sortable, and being environmentally friendly (1).

Packaging technology includes the technique needed for the packaging and labeling of product from the bulk form to its final product. Similarly, in the pharmaceutical industry, this technology includes all activities starting from manufacturing through drug distribution systems to the final step that is reaching the consumer. It protects the product against physical, chemical, and microbiological contamination and protects against any damage and breakage while maintaining the physical quality of all doses. In the pharmaceutical industry, some drugs are sensitive to light and water, so there must be disseminated important information on packaging and proper and clear labeling needed for this type of drug (2). Pharmaceutical packaging is significantly more intricate than other types of packaging. If not done correctly, there might be serious implications because medications and drugs are a matter of life and death.

Nowadays technology is evolving at a dizzying pace. Due to this evolving technology the rise of the highly competitive e-commerce industry is causing a surge in demand for innovative packaging solutions which will respond to altering customer attitudes, and emphasize the necessity for advanced packaging technology. To meet these surging expectations, the packaging equipment sector is progressively utilizing technology to create novel solutions for future-ready packaging. Automation is one of these solutions (3).

Packaging automation is an effective approach to simplifying the entire packaging process. These devices can fill, cap, seal, and label packages of different sizes and shapes without the involvement of human interventions. To regulate, oversee, and improve equipment efficiency in packing lines, packaging machinery is automated using a variety of aids such as human-machine interfaces (HMIs), motion-control devices, and sensors. The use of industrial IoT

(IIoT) in packing machines is becoming more prevalent. This technology not only improves packing line efficiency, but also clears the path for improved machine-to-machine, machine-to-infrastructure, and machine-to-operator connections, opening the way for a more digital future for packaging equipment within the next decade.

Different packaging machines used in the pharma industry are,

- E-liquid full-line packaging solution
- Automatic blister packing machine
- Semi-automatic capsule filling machine
- Bottle packaging line

Recent advancements in packaging technology

Smart-I packaging: -Smart-I assists us with package tracking, monitoring, analysis, and patient communication and is custom-made for our needs. It is built around a central user interface and an integrated packaging chip, which provides control of a variety of functionalities inside the complete interface.

Nanotechnology: -Nanotechnology will also be utilized to reduce packaging waste and increase sustainability, with bio-nano composites potentially replacing non-biodegradable, petroleum-based plastic. With this only by swiping a card or scanning a smart device, packaging provides functions like advanced tracking, theft protection, additional information, dynamic visuals, online connection, integrated product interaction, active monitoring, and many other innovative features (4).

Digital printing packaging: - Printing on the packaging has several issues, including precision, low color quality, and high labor expenses. This allows for process innovation through digital printing, making it one of the top packaging industry developments. Here there is not necessary to use separate plates for distinct prints, as compared to typical offset or flexo printing procedures. In digital printing, all the product is printed in a single pass, making it less labor-demanding. Direct thermal printing is one of the thermal imaging printing techniques that is used to print labels and flexible packaging without the usage of inks (5).

3D printed packaging: - For packaging, 3D printing will be a considerably superior solution to present technologies, providing flexibility, efficiency, and cost savings by combining design and production. As printing quality, speed, and material options improve over the next ten years, 3D printing will influence the packaging industry more than previously thought. It would almost likely result in smaller, smarter places that use large-scale printing for products and packaging (6).

Premium Packaging: -Most buyers say they are substantially more inclined to buy a luxury product again if it comes in premium packaging. Premium packaging may enhance any industry's presentation and promotional needs by improving and adding value to both the products as well as the brand.

RFID (Radio Frequency Identification) packaging: - RFID is a technology that uses RFID chips and RFID ports to identify objects. It is a type of packaging in which a unique chip is used that processes the information, such as the number of units and the location, read by ports. This way, they will always have access to the relevant information not only on the product but also able to track their exact location whenever they need it (7).

Table 1 – Some recent technologies used in packaging (8,9,10)

S.N.	Type	Unique feature
1	Cypak's Advanced Medication Monitoring and Report-Card Systems	Enables Patients to connect with healthcare providers through printed technology, record the actions performed by the user, feedback on side-effects and treatment efficacy, and upload
2	Burgopak's Sliding Blister Pack	Opened by applying force at two different points on the packaging (child resistant)
3	Pharma Small Hands Resistant (SHR): A Re-closable and Tear resistant Carton	Reclosable and tear-resistant paperboard package system for highly toxic drugs used by senior adults
4	Ecoslide-RX Sustainable Compliance Packaging	100% recycled material using unbleached paperboard and clay-coated surface
5	Decomer Technology	It is an Estonian Biotech firm that provides an edible and water-soluble plant-based packaging material and the material is tasteless, transparent, and hypoallergenic
6	Corn-based Foil Packaging	It consists of PACK'ON, a packaging foil made of polylactic acid (PLA) generated from corn, and the use of silver nanoparticles as antibacterial additions in the foil makes the solution appropriate for packing.
7	Prefilled dual chamber devices	It provides high stability, seals integrity, sterility, and compatibility with biopharmaceuticals as well as the capacity to avoid leachability and needle stick injuries
8	Talk-Pack–WIPAC	A specific pen-shaped reader is used on packaging to retrieve information on the manufacturer, brand, shelf-life, or other any other information related to the product, and also no RFID or microchips are required.
9	Cellulose-based materials packaging	It is able to replace plastics, waxes, and other non-biodegradable packaging materials with cellulose.
10	An anti-counterfeit solution	It includes a unique security number installed on each product that offers both brand owners and consumers to trace things all along the supply chain.

Effects on packaging sector in COVID pandemic

With the start of 2020, all of us were looking at the pharma industry as COVID-19 cases were progressing & vaccines and treatments were landing all around the pharma sector.

There was increased demand for vaccines and therapies in health clinics. Various techniques using mRNA, DNA, protein, and viral vectors were being utilized for developing the COVID-19 vaccine by companies. Throughout, the COVID-19 pandemic period, the pharma packaging section was at a challenge as each vaccine has a different set of requirements for storage, preparation, and administration, and specific packaging only can ensure the safety and efficacy of the therapeutic products are protected.

The pharma packaging industry has been gaining potential growth in the past several years, and it could touch nearly 84 billion dollars by 2024. This pandemic has also enabled a chance for the packaging sector to a head start in the pharma market. It will continue in the coming years as well, as vaccines booster doses will be needed each year (11).

Future aspects in packaging technology

We are grateful for newer innovations and recent medical treatments, that there is always an opportunity for further expansion and development in this sector of the pharma industry. As the future advances rapidly owing to new technologies developed day by day, the concerns about sustainability, technology, and regulation rise to the fore, and the packaging sector are experiencing fast upheaval. From new extended producer responsibility legislation to eco-labeling initiatives and to how AI is influencing the packaging design. Packaging is India's fifth largest industry and one of the fastest growing businesses in the country. According to the Packaging Industry Association of India (PIAI), this sector is expanding at a rate of 22% to 25% every year. One of the major pharmaceutical dilemmas India faces is its reliability on plastic packaging, which has spawned questions about recycling and consumer sustainability understanding. So, the Indian pharmaceutical packaging industry is now aiming to develop novel features such as digital timers, alarms on pill bottles, dosage monitoring, and revolutionary automated blister packs. Although projecting the future is difficult but one thing, we can predict is that, as pharmaceutical research continues to develop, so lifesaving medications and packaging technology systems will keep growing with the breakthrough in material science and innovative design (12).

Conclusion

Packaging technology has become a significant technique in almost every industry in this recent era. Pharmaceutical product packaging is a multiphase procedure that requires more care than other products. These life-saving medications and pharmaceutical goods must be carefully packed in the pharmaceutical industry to retain their purity and stability until they reach the customer. It is a crucial technique because it protects the products, identifies them, protects them from physical damage, increases the products' attractiveness, and enhances patient compliance. Due to the ongoing evolving scenario of market expansion, new marketing methods have surged the demand for innovative packaging technologies. Many industrial

organizations are attempting to improve packaging operations in order to lower the high cost of packaging pharmaceutical and food products. As a result, creative packaging techniques will improve product demand and sales.

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Unscramble the Global Pharmaceutical Packaging Companies

1. AATRP
2. PLSSNAI NCPITORROAO
3. CRECNEED TDMSSSYEEM
4. YSASCPK GBHM
5. ERAMNE
6. ONORD
7. AKIAUMTHH ELIFBELX KACPGIAGN
8. RSATM SINK EGNLSOCHOTIE

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