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Original Article

PHARMACEUTICAL PACKAGING: CURRENT TRENDS AND FUTURE

VIKAS PAREEK*, DR. ALOK KHUNTETA

[1.]Lal Bahadur Shastri College of Pharmacy, Rajasthan University of Health Sciences, Government of Rajasthan, [2.]Professor: Lal Bahadur Shastri College of Pharmacy Registrar: Rajasthan Pharmacy Council.
Email: Vikaspareek@yahoo.com

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ABSTRACT

Pharmaceutical packaging is one market across the globe which is advancing at constant pace. It is expected that market will grow to worth $78.79 Billion by 2018 [1]. Packaging is a key for sale, safety and success. Like other packaged goods, pharmaceuticals packaging need to be in such a manner that it will provide speedy packaging, protection, identification, product quality, patient comfort, display and needs of security. Advancement in research of pharmaceuticals development had always being dependent on the packaging technology. Maintaining integrity of pharmaceuticals during storage, shipment, and delivery is assured by quality of packaging available. This article reviewing current pharmaceutical packaging trends and predicting the packaging outcomes in future.

Keywords: Pharmaceutical packaging, Current pharmaceutical packaging trends, Speedy packaging.

INTRODUCTION

Packaging is defined as a technique which allows containment of pharmaceutical product from the time of production in a unit till its use. Role of pharmaceutical packaging is to provide life saving drugs, surgical devices, blood and blood products, nutraceuticals, powders, poultices, liquid and dosage forms, solid and semisolid dosage forms. Packaging of pharmaceuticals essentially provides containment, drug safety, identity, convenience of handling and delivery. Pharmaceutical packaging has to balance lots of complex considerations. Leaving behind relatively simple issues such as developing good designs and communicating with customers, pharmaceutical packagers are concerned to more pressing concerns which include fighting with counterfeiting, encouraging patient compliance, ensuring drug integrity and balancing child-resistance and accessibility for the elderly. Issue of environment safety is also key concern for both developed and developing countries packaging industry.

Pharmaceutical packaging firms are some of the industry's leading innovators evident by the recent advancement in technology. The current trends are result of continuous series of challenges faced by industry. Packaging is a science which is continuously evolving and is a major success contributor for pharmaceutical industries.

Categorically differentiating pharmaceutical packaging:

1. **Primary Packaging:** This is the first packaging envelope which is in touch with the dosage form or equipment. The packaging needs to be such that there is no interaction with the drug and will provide proper containment of pharmaceuticals. E.g. Blister packages, Strip packages, etc.

2. **Secondary Packaging**: This is consecutive covering or package which stores pharmaceuticals packages in it for their grouping. E.g. Cartons, boxes, etc.

3. **Tertiary packaging**: This is to provide bulk handling and shipping of pharmaceuticals from one place to another. E.g. Containers, barrels, etc. [2]

Primarily two types of containers are used for packaging:

1. Glass Containers

2. Plastic Containers

Glass Containers: These need to be chemically inert, impermeable, strong and rigid proving FDA clearance.

Four types of Glass is being used in pharmaceutical industry,

1. **Type I-Borosilicate glass:** Highly resistant and chemically inert glass. Alkali's and earth cations of glass are replaced by boron and/or aluminum and zinc. These are used to contain strong acids and alkalis.

2. **Type 2-Treated soda-lime glass:** These are more chemically inert than Type I glass. The glass surface is de-alkalized by "Sulfur treatment" which prevents blooming/weathering from bottles.

3. **Type III- Regular soda lime glass:** Untreated soda lime glass with average chemical resistance.

4. **Type IV- General Purpose soda lime glass:** Glass is not used for parenterals, used only for products intended to be used orally or topically.

Colored glass is used to screen out Ultraviolet rays and is thus effective for protecting contents from light. Amber glass and red colored glass is used for this purpose.

Major disadvantage of glass as a packaging material is its fragility and weight.

Plastic Containers: Plastic containers of high quality can be easily formed with different designs. These packages are extremely resistant to breakage and leakage.

Primarily plastic containers are made from the following polymers:

1. **Polyethylene (PE)**: Provides good barrier against moisture, relatively poor one against oxygen and other gases. High density polyethylene is used with density ranging from 0.91-0.96 leading to four basic characteristics of container, (1) Stiffness, (2) Moisture-vapor transmission, (3)stress cracking and(4)clarity or translucency based on polymer density used.

2. **Polypropylene (PP)**: Polypropylene has features of polyethylene in addition it does not stress-crack in any condition. Hot aromatic or halogenated solvents soften the package. It has high melting point making it suitable for boilable packages and products needed to be sterilized. Brittleness at low temperature is its major disadvantages.

3. **Polyvinyl Chloride (PVC)**: Can be produced with crystal clear clarity, will provide good gaseous barrier and stiffness. Reduction in residual vinyl chloride monomers had further enhanced PVC quality. PVC is used as coating on glass bottles providing shatter resistant coating.

4. **Polystyrene**: Rigid and crystal clear plastic. Not useful for liquid products. Polystyrene has high water and gaseous permeability also

these are easily stretchable and breakable. To increase their strength and quality for permeability polystyrene is combined with rubber and acrylic compounds. Base on the composition these are classified as intermediate impact, high impact and super impact packages.

5. **Nylon (polyamide)**: Many dibasic acids and amines combine to provide numerous varieties of nylon. Nylon is extremely strong and is quite difficult to be destroyed by mechanical means. Nylon provides resistance to wide range of acids and alkali only disadvantage of it is being permeable to water vapor for some amount this can also be dealt with coating of PE over the container. Not used for long term storage of products.

6. **Polycarbonate**: Has an ability to be sterilized repeatedly. It has immense rigidity and is a possible replacement for glass, vials and syringes. It has qualities like high dimensional stability, high impact strength, resistance to strain, low water absorption, transparency, and resistance to heat and flame. Polycarbonates have impact strength five times greater than any other common packaging plastics.

7. **Acrylic multipolymers (Nitrile Polymers)**: These are polymers of acrylonitrile or methacrylonitrile monomers. These provide for packaging of those products which are not packed in usual packages as they provide for high gas barrier, good chemical resistance, and good strength.

8. **Polyethylene terepthalate (PET)**: Condensation polymer formed by reaction of terepthalic acid or dimethyl terepthalic acid with ethylene glycol. It has excellent strength and provides barrier for gas and aroma making it as a useful package for cosmetics, mouth washes and other products.

While there are different packaging materials approved by FDA for packaging it has to be known that FDA doesn't approve the container but its material that is being used. A list of substances considered by FDA are published as, "Generally recognized as safe (GRAS)". It's responsibility of manufacturer to prove the safety of a packaging material and to get an approval from FDA. The specific FDA regulation for drugs states, "Containers, closures and other component parts of drug packages, to be suitable for their intended use, must not be reactive, additive or absorptive to an extent that identity, strength, quality or purity of the drug will be affected." A material that is not included in GRAS can be used by manufacturer but prior to that manufacturer need to test the material and send the report to FDA for New Drug Application, NDA. [3]

Current trends in pharmaceutical packaging

"Need is mother of all Inventions", phrase is best describing the emerging technologies towards pharmaceutical packaging. Indian Packaging market is expected to grow up to US$ 55 billion by 2020 from the 2009 levels of US$ 12.6 billion, as per a McKinsey & Company report titled "India Pharma 2020: Propelling access and acceptance realising true potential". [4]

Counterfeit prevention

With counterfeiting accounting for annual losses estimated at $75bn [5], packaging always been at the heart of the industry's strategy to protect itself. It has employed an array of security techniques to combat this issue, with varying success, including : micro text, debossing and embossing, customized varnishes, holographic materials, tamper-evident stickers, RFID (Radio Frequency Identification) track-and-trace tagging and customized graphics and fonts.

1. **Ink technology:** Technique allows color to reappear when rubbed or scratched. E.g. "Secur" labels, Ad Tape & Label, Menomonee Falls, WI. Fig.1 (a) [6].

2. **Radio-frequency identification (RFID)**: RFID is another technology with anti-counterfeiting potential. RFID tags can help authenticate products and support data collection for pedigree records. Equipment that encodes and prints tag-equipped labels verifies the tag before and after encoding. If a nonviable tag is detected before encoding, the label is marked with a checkerboard pattern and ejected. Good labels are encoded and rechecked. If tags read properly, labels are printed and their bar codes are verified. If the bar code doesn't scan correctly, the unit pulls the label back in, imprints it with a checkerboard pattern, ejects it, and encodes and prints a new label "Smartline SL4M RFID" printer, Printronix Inc., Irvine, CA Fig.1 (b). For automated applications, encode, print, and apply unit is available. It performs all the checks of the RFID printer and applies the labels at a maximum rate of 100/min "Smartline SLPA8000" label printer applicator, Printronix [7].

In multipanel labels, at least one label converter can incorporate ultrahigh-frequency (UHF) or high-frequency (HF) RFID inlays to support product security, inventory control, and track-and-trace functions "InfoPac label," Tursso Companies, St. Paul, MN Fig. 1(c) [8].

RFID can be combined with cryptography, to enable on- or off-network authentication. When the tag is encoded with the electronic product code EPC (Serialized 96-bit that can be encoded at a rate of as many as 550/min) it also receives a digital signature using public key infrastructure (PKI) based on IEEE 1363a [9].

Dual-function tags - RFID with temperature sensing, having cost less than traditional devices for temperature monitoring e.g. integrates a sensor, microchip, battery, and antenna on a paper-thin label e.g. 13.56 MHz "TempSens " smart label, KSW- Microtec, Dresden, Germany [10]. This type of smart sensor label–equipped blister package is being used by the National Institutes of Health (Bethesda, MD), for a multiyear study of chronic obstructive pulmonary disease that will involve nearly half a million individual doses of medication.

Radio-frequency identification (RFID) tagging helps to simplify shipping, receiving, inventory location, and control has been mandated by the department of defense, several other retailers, and various hospitals. Carry and collect the data needed to track and trace product through the supply chain prevent counterfeiting and diversion coupled with sensors to monitor conditions during shipping and storage and provide alerts if parameters are exceeded.

3. **Tamper-evident stickers**: Needs a special substrate designed for the purpose. The cellulose acetate film is very intricately designed so that it has adequate strength to undergo conversion into label stocks in roll form. The stickers can be automatically dispensed on automatic label dispensers and when attempted to be removed these break-up into very small pieces. Vinyl had now replaced acetate film being cost effective.

4. **Holographic materials**: Large and important part of the security label market and are an ideal choice for product authentication. The holographic foil an optically variable device is usually made using a polyester film base. The perception of the holographic image by the human eye makes it ideal for brand promotion and security. Packages reveal the holographic image when tilted against light source. By increasing the complexity of hologram manufacturer can make it difficult for counterfeiters to duplicate the products. Many holograms besides offering brand authentication also offer tamper evident properties. If the hologram is attempted to be removed, the top polyester layer will peel off leaving the hologram on package.

Fig. 1(a): "Secur" labels, Ink technology [6], (b) "Smartline SL4M RFID" printer, Printronix Inc. [7] and (c) "InfoPac label," Tursso Companies [8]

Child resistance packaging

Child resistant packaging is essential criterion for highly potent pharmaceuticals. New child-resistant (CR) blister are designed to offer improved peel ability and printability while establishing protective qualities that prevent children from accessing pharmaceutically potent contents.

Sliding CR blister pack by UK packaging producer "Burgopak" presents an example by introducing a blister pack that can only be opened by applying pressure at two separate points on the packaging. The blister pack and information leaflets are placed with the outer box ensuring that the product is never separated from its packaging. Burgopak Healthcare & Technology - won the award for the 'Most Innovative Child Resistant Packaging Design' for the same at the Pharmapack Paris exhibition on 16th February 2012 Fig. 2(a) [11].

A CR peel–push lid stock was formulated to eliminate the frustration linked with hard-to-peel CR, paper-based lid stock. The lid stock can be printed in seven colors to maximize brand identity on packages. The absence of a paper layer diminishes the issue related with moisture absorption and increases the time the material can be stored while awaiting conversion e.g., "Safety-Pak plus PP," Alcoa Packaging, Richmond, VA Fig.2(b) [12]. A full-panel-peel version accommodates delicate tablets for storage and delivery e.g., "Safety-Pak Plus PL," Alcoa Packaging.

A CR folding carton has die-cut slots on the one end flap that align with die cut tabs present on the inner wall of the carton to lock the flap in proper place. Opening of carton requires a die-cut key to be removed from the carton's external panel. The key slides into the slots and pushes down the tabs to free the end flap. Material for packaging includes polypropylene (PP) or poly-coated paperboard e.g., "KidKey" carton, Chesapeake Pharmaceutical Packaging, Lake Success, NY Fig.2(c) [13].

Prevention of product tampering

Cyclic olefin copolymer (COC) is being used for tamper resistant packaging it offers an alternative to coated polyvinyl chloride (PVC). COC is capable of 5-in. extensions and can be coextruded to polyethylene terephthalate glycol or PP for enhanced barrier properties. Available in 10–48-mm thicknesses, the material uses the same tooling machineries as required by PVC. Unlike PVC, it doesn't discolor over time too.

Two-layer(poly vinyl chloride) PVC–PVDC (polyvinylidene chloride) film exhibits excellent lay-flat properties, clarity, and mach inability, it requires less sealing heat and dwell time, usually runs on standard PVC tooling. The 10-mm/120 g/m_2 structure provides barrier properties equivalent to mid-range Aclar structures

For ultrahigh barrier requirements, a PVDC with high crystalline nature is applied in a 120-g dispersion to create three-layer symmetrical PVC–PVDC–PVC films. These films provide lay-flat property of finished packages and eliminate confusion about the location of the PVDC layer.

For rigid packaging, multilayer barrier structures includes COC–ethylene vinyl alcohol (EVOH)–COC, polyethylene terephthalate (PET)–EVOH–PET, and PP–EVOH–PP, as well as other tailored resin combinations are used for such packages. The multilayer, injection blow-molded barrier containers meet US Pharmacopeia requirements for extractables and are compatible with a wide pH range, are sterilizable, depyrogenable, and shatter-resistant. Some structures can be specified in place of Type I glass e.g., "MLx" plastic vials, O-I Healthcare Packaging Fig. 2(d) [14].

Cyclo olefin polymer (COP) is as comparative as COC, it is moving from high precision optics to injection-molded pharmaceutical bottles, vials, and prefilled syringes. Flexible packaging such as IV bags is also being possible from COP. The material offers a good moisture barrier, extremely low residual-metals content, glass-like transparency, and compatibility with ethylene oxide and gamma sterilization e.g., "Zeonex COP," Zeon Chemicals LP, Louisville, KY.

For sensitive dry powders and solid-dosage forms, desiccant material can be compressed and shaped to fit or drop into inhalers or containers. The compressed absorbers can absorbs twice the moisture and is cost-competitive with pouch-packed desiccants e.g., "Coated Solid Form" sorbents, Multisorb Technologies, Buffalo, NY.

Mixing the absorber with the resin used to injection-mold a component is a way to incorporate desiccants into pharmaceutical packaging; such a dispensing device is designed to release one tablet or capsule at a time. The dispensing control leads minimization of exposure to remaining contents by microbes, pathogens, and other contaminants and can eliminate the need for cotton fill e.g., "Flow-Limiter" equipped with "Advanced Desiccant Polymer," Süd-Chemie Performance Packaging", Belen, NM [13].

Cold-form foil provides maximum barrier to moisture, gases, and light. A new nylon–foil–PVC lamination can be reverse-printed in as many as eight colors for improved graphics and brand merchandising. Its three-layer structure permits a 15% deeper draw than competing materials, resists delamination, and runs at the highest machine speeds e.g., "Cold Form 3000" laminate, Alcoa Packaging.

Fig. 2(a): "Burgopak" Sliding CR blister pack [11], (b) "Safety-Pak plus PP," Alcoa Packaging [12] (c) "KidKey" carton, Chesapeake Pharmaceutical Packaging [13] and (d) "MLx" plastic vials, O-I Healthcare Packaging [14]

Dispensing accuracy & Promotion of patient compliance with product dosage schedules

Majority of compliance designs are based on blister cards. E.g., "Helidac Therapy Kit" from Procter & Gamble Pharmaceuticals Cincinnati, OH, is a multi pill frequent-cycle regimen used to treat the Helicobacter pylori infections responsible for most stomach ulcers. The kit organizes the regimen into 14 daily-dose blister cards, each divided into four doses Fig 3(a) [15].Similarly "Prempro/Premphase EZ DIAL" dispenser from Wyeth Pharmaceuticals, Collegeville, PA, relies on a 28-count blister card housed inside a dispenser Fig.3(b) [16].

An increasingly popular version of blister-card compliance packaging is the wallet pack, which typically positions a blister card or cards in a paperboard folder. E.g."Lamictal" GSK, NC. The "Dosepak" design from MeadWestvaco, NY, combines a folding carton with a blister card to deliver compliance, tamper evidence, child-resistance, and senior-friendliness with geriatrics Fig 3(c) [17].

The oval "Track Pack" design by American Health Packaging, Columbus, OH, permits patients to begin the regimen on any day of the week. The large, printable area on the compact package permits larger type for instructions, which improves readability.

The Talking Packaging: "Self Talk"

There are two developments in talking packaging:

1. **The "Talk Pack " from Wipac Walsrode** (GmbH in Germany), is a system, which can be invisibly integrated into any printed image on any packaging material, but needs a special scanning pen a development by VTT Technical Research Centre of Finland. It involves special pen-shaped reader used to retrieve the stored information and to replay it as audio files and render speech, music or sounds audible and thus the consumer can obtain information regarding manufacturer, brand, shelf-life or other

information. Talk Pack does not require any RFID or microchips. The dot code is simply printed on top of images and texts using a special varnish. This technology can be used with all printing technologies and package types used.

2. **NFC tags - VTT Technical Research Centre**: NFC tags - VTT Technical Research Centre NFC tags are added to any packaging so a consumer could touch the code on the packaging with their NFC-enabled mobile phone to download text, audio or web page product information, which can be played back on his handset. Provided spoken dosage instructions from pharmacy staff, to aid a visually impaired or blind person. Currently, the number of mobile phones with NFC technology is limited but VTT believes that it is a growing market Fig 3(d) [18].

Fig. 3(a): "Helidac Therapy Kit" from Procter & Gamble Pharmaceuticals [15], (b) "Prempro/Premphase EZ DIAL" dispenser from Wyeth Pharmaceuticals [16], (c) "Dosepak" design from MeadWestvaco [17] and (d) NFC tags - VTT Technical Research Centre [18]

Eco-friendly pharma packaging:

The pressure to develop sustainable, eco-friendly products is pressurizing packaging industry and has even begun to affect pharmaceutical packaging, one of the industry's most complex sectors. The development of sustainable packaging is a difficult task for companies serving the pharmaceutical industry - environmental considerations must not lead to any compromise on a package's safety or accessibility.

Ecoslide-RX sustainable compliance packaging from Keystone Folding Box Company and Legacy Pharmaceutical Packaging introduces industry with environmentally balanced formulation of packages. The pack is made from 100% recycled material, using unbleached paperboard and a clay-coated surface designed to house blister packaging with a minimum of unsustainable film and foil. The slide package meets all the modern expectations for child-resistance and accessibility for seniors, but doesn't require heat sealing in the manufacturing process, reducing both costs and energy usage Fig 4(a) [19].

Syreen prefilled syringe design: Instead of glass, cyclic olefin polymer (COP) is used in syreen syringes where COP provides secondary packaging altogether. Packed syringes can be clipped into places provided this eliminated need for packaging materials like cardboard and Styrofoam. Overall packaging leads to reduction in packaging weight and volume. Syreen prefilled syringe design had extended the environmental awareness criterion to syringe market too Fig 4(b) [20].

Speed up in packaging innovations leading cost and time reduction

Advancement in research of pharmaceuticals development had always being complemented by the pace in packaging technology development. Quality of packaging maintains integrity of pharmaceuticals during storage, shipment, and delivery. So, development in field of packaging is correlated with development of NDA Pharmaceuticals in market. Software and technology services will greatly accelerate packaging design for pharmaceutical products. The services will be designed to improve speed-to-market while also increasing the accuracy of design and testing, thus bringing significant cost savings to the customer and developer.

These new innovations lead packaging industry where, materials are used more efficiently, the number of samples to be tested for stability decreases, fewer people are required, less time required, and fewer types of equipment are used. 3D design software is used to design a blister cavity that maintains an optimal thickness distribution for the high-performance packaging material. During Design optimization various other mechanical parameters are judged that will protect the drug from external conditions (environment, tamper resistance, etc.). With one or more potential cavity designs being selected, the software is then used to develop initial designs and configurations for the complete blister card packages.

Fig. 4(a): Ecoslide-RX sustainable compliance packaging from Keystone Folding Box Company [19], (b) Syreen prefilled syringe design [20]

With the use of Finite Element Analysis (FEA) software kp's BlisterPro® then allows package designers to predict the stability performance of blister designs with great accuracy. The software is able to model Moisture Vapor Transmission Rate (MVTR) and Oxygen Transmission Rate (OTR) performance of packages.

Combining Computer Numerical Control (CNC) technology one can immediately move into production of prototypes. The ease and speed of producing prototypes with these new technologies means that testing for shelf-life, marketing and labeling, and other user acceptance considerations can proceed in rigorously with requests for design refinements and newly-revised prototypes, thus speeding progress toward the final design.

Once packaging considerations are reviewed and accepted, production of samples containing actual product can begin. This allows Kp to validate the performance of the sample packaging against the FEA software's virtual models Fig 5 [21].

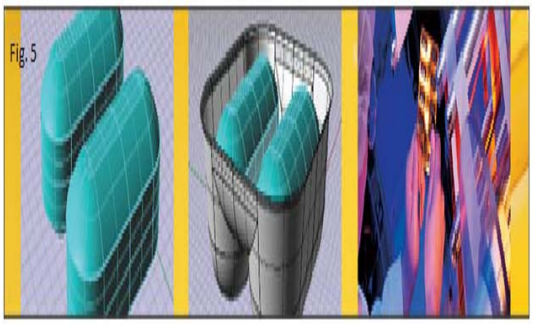

Fig. 5: Kp's BlisterPro® Packaging technology [21]

The effects of a blister design change and material selection can be determined and directly related to shelf life by day. This means that

only the most promising and most likely to succeed designs can be brought through prototype and testing, thus greatly reducing time and cost.

Future of Pharmaceutical Packaging

Pharmaceutical industry, research and manufacturing technologies are continuously evolving with demands of environmental ethics, patient compliance and novel medicaments this had driven significant developments in packaging and delivery systems. Increased investment in R&D sector had lead to formulation of large-molecule biopharmaceutical drugs some are still in development pipelines this has led to an increase in the need for injectable packaging and self administration systems. The earlier used old glass and elastomeric closure systems may not provide the effective barrier properties much needed for high-value, life saving therapies. Packaging R&D provided us with new materials and technologies that ensure extended drug-product shelf-life. Lyophilization had led to the formulation of liposome's and further the pro-liposome's, the therapies which are unstable in liquid form are lyophilized or converted to dry powder dosage forms. Lyophilized drugs need special care for storage and administration for the optimal performance by products. Lyophilization chambers with proper, non sticky stoppers are used for dose accuracy.

Advancement in research of pharmaceuticals development had always being dependent on the development in packaging technology. To maintain integrity of pharmaceuticals during storage, shipment, and delivery, quality of packaging provides assurance for all these. So, development in field of packaging is correlated with development of NDA Pharmaceuticals in market. Use of 3D design software to design efficient pharmaceutical packages and their assessment with software's like Finite Element Analysis (FEA) need to be promoted in Pharmaceutical Packaging. This approach of virtual to real packaging can produce product right from scratch using software to create their models and then testing them with certain parameters virtually based on the data only the prototypes are created this eliminates the need for the customer to set up costly and time-consuming production runs at their sites for testing at all stages of development.

Increase in self-administered therapies forces pharmacy research to formulate packages for self administration rather than for healthcare revolving around hospital care. In present healthcare often starts at hospitals/clinics but maintenance therapy revolves around the home. For treating chronic conditions such as arthritis, cancer, multiple sclerosis, Alzheimer's and other diseases that require frequent medication, self administration had led packaging to be evolved in such a way to provide compliance for therapy. Usually maintenance therapies are delivered by injection, demanding a need for patient-friendly administration systems. Packaging systems is required to ensure that the potency of the drug must be preserved and it should promote compliance with a dosing regimen, ensuring dosing accuracy, and be as safe, easy to use and painless as possible for patients. Manufacturers involved in packaging for the self drug administration process need to provide delivery systems that will simplify drug reconstitution before use, especially for nonprofessional caregivers.

Cost and time effective packaging technology need to be enhanced in Industry. E.g. Bags with corrugated linings are developed by Jumbo bags (Chennai, India) with weight capacity of 500kgs to 2000kgs Fig. 6 [22]. These bags are cost effective then the drums normally used, also these bags require lesser area since these can be folded when not in use. Robots/ Automated devices also lead to increase in flexibility of packaging equipment, decrease in time consumption, increased output and reduced labor cost. E.g., ESS Technology, FUNAC System.

What's next?

Trend of Blister Packaging for Emerging Markets targeting developing countries

Blister packages are well established in Developed. countries now the increase is expected in developing countries where benefits of blister packaging will bring to emerging market the product protection, patient compliance. Emerging countries offer an opportunity both for pharmaceutical manufacturers as well as packagers due to their increasing populations, rising standards of living and improved access to prescription medications. Blister packaging effectively addresses these requirements of challenges faced in these markets.

Fig. 6: Jumbo bags [22]

Accuracy and Precision in packaging need to be enhanced

Accuracy and precision needed to be maintained for whole life cycle of a product any deviation will lead to the ailment of packaging.

MD&M West 2014: Touch screen system makes it easier for customers with validation needs. Machine seals pouch, then date-code, all in one step. It prevents operator from selecting incorrect setting, maintaining validation repeatability [23].

BFS Technology will grab it's extensions in packaging market the technology with all units place in one go provided the high level of accuracy and precision in packaging and this further need to be extended in the field Fig. 7 [24].

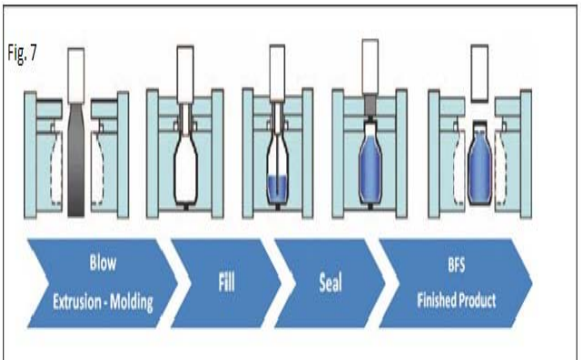

Fig. 7: Blow Fill Seal Technology [24]

Labeling with full description:

Label should provide all the information that is required. Packaging style with ample space for label will provide for better compliance. E.g. "Pharma-Tac Plus", a multifunctional label from Schreiner MediPharm for infusion bottles, took first place in the "Multi-Process" category at the 2013 TLMI Awards for its innovation on labeling Fig 8 [25]. The innovation was to equip a label for infusion bottles with enough space for extensive information, stable hanging, and easy administration documentation. An integrated booklet label, a hanger, and detachable label parts achieved these functionalities. The paper booklet provides an extended area for multilingual text on ingredients and instructions for use. It is firmly connected to the plastic base label, and can be opened and closed with ease by means of a starter tab. The robust hanger is an integral component of the label, and is easy to separate from the label construction for activation. The detachable documentation labels ensure reliable tracing of the medication and allow safe handling, even while wearing gloves. More innovative ideas like Codes which can be decoded by simple means can be useful for labeling purposes also.

Improvising Patient Compliance

Incidence of Alzheimer's and other age related disorders are going to be a major cause of worry in near future. By 2020 14.2 % of above 60 age population will be In India only. This led us to work out with packaging in such a way that it will provide patient compliance with its own ease. Walmart's new compliance pack launch is one of its kinds to help patient compliance the portable, calendar-style prescription packs are aimed to increase patient adherence to drug regimens. Pack provides a physical printed reminder and an opportunity for consumers to see whether a dose for a certain day has been taken or not. Greater adherence improves patient compliance/outcomes and ultimately reduces healthcare costs across the supply chain [26].

Fig. 8: "Pharma-Tac Plus", a multifunctional label from Schreiner MediPharm for infusion bottles [25]

The market today is equipped with packaging systems that can provide tracking features and product authentication throughout the supply chain. The wider use of technologies against counterfeiting will develop in near future, such as RFID tags affixed to the seal; use of UV inks for seals may be seen. The coatings with near-total barrier properties e.g., PICVD, PET-EVOH-PET, PP-EVOH-PP coatings may capture a potential market in future. The global pharma packaging market was valued at $47.8 billion in 2010. The market is forecast to grow at a compound annual growth rate (CAGR) of 7.3 per cent from 2010–2017, to reach a value of $78 billion by 2017. The global pharmaceutical industry is currently registering rapid expansion, with advances in manufacturing processes, and technology innovation and integration, which are the main factors behind the growth of the pharmaceutical packaging industry globally. This growth is expected to be highest in the emerging economies of India and China, primarily on account of increasing generics and contract manufacturing activities in these countries, Pharmaceutical Packaging Industry – 2011 Yearbook [27]. Although prediction is made based on past and future is always dependent on efforts, one can definitely predict that as pharmaceutical research will continue to develop life saving therapies, therapies for advanced life the packages required to carry and administer those therapies will also maintain its pace by advancement in design innovations and discovery through material sciences.

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