

INTRAVITREAL INJECTION OF VEGF INHIBITORS – IMPACT OF DRUG CONTAINERS

Against a background of increasing use of intravitreal injections of vascular endothelial growth factor inhibitors in the treatment of numerous serious ocular diseases, Douglas Cusato, Director of Medical Rubber Business, Sumitomo Rubber, North America, provides a detailed comparative analysis of the regulatory requirements, patient risks, costs, benefits and other considerations when using either products supplied from pharma manufacturers in a prefilled syringe format, or from compounding pharmacies, which fill the formulation into general-use or insulin syringes.

BACKGROUND

Since the early 2000s, intravitreal injections of vascular endothelial growth factor (VEGF) inhibitors have become the treatment of choice for various eyesight-threatening eye diseases including macular degeneration (MD), diabetic retinopathy (DR), retinal vein occlusions (RVO) and retinopathy of prematurity (ROP).¹ Two common sourcing practices for clinics and hospitals include obtaining Avastin (bevacizumab) injections from compounding pharmacies in various syringe packaging configurations, or Lucentis (ranibizumab) in a traditional prefilled syringe (PFS) format.² A breakdown of the packaging configurations and materials of construction can be found in Table 1.³⁻⁵

Of course, there are various advantages and disadvantages linked with each configuration, including aseptic assurance, preparation steps, administration time, packaging system intended use and overall cost of the packaged drug product.

Essentially, the main driver for clinics and hospitals to use compounded Avastin in plastic general-use and insulin syringes is overall cost. A compounded Avastin injection costs an average of US\$50-60 (£39-47) versus \$1500 per dose for Lucentis.⁶ This has a significant impact on much of the healthcare system including health insurance reimbursements, patient out-of-pocket costs and overall financial liabilities for the clinics and hospitals.⁶ Additionally, considering there are numerous publications referencing the clinical performance of the two options and their comparability, it's reasonable to understand why this is a common practice.⁷⁻⁸ In short, some view it as a safe, effective and cheaper option.

INDUSTRY CHALLENGE

From 2006 onwards, numerous reports started to be published describing adverse events linked with compounded drugs for intravitreal injection such as Avastin including increase in intraocular pressure (IOP), infections and “floaters”.⁹⁻¹⁴ Floaters can be described as small particles that are visible to the patient following intravitreal injections and various reports conclude these are linked with silicone oil microdroplets. Due to the growing concerns, there has been an increase in regulatory security related to repackaging such drug products and additional supply restrictions have been imposed to minimise such practices in the future.¹⁵⁻¹⁶

With regards to publications, reports related to clinical outcomes demonstrate similar performance between both compounded Avastin and the traditional PFS Lucentis product. However, the outputs from product quality investigations are quite conflicting. Various reports observe favourable comparability, but others demonstrate significant variation between sources of compounded Avastin and the originally packaged vial product.¹⁷⁻²⁰

From a high-level view, the syringe selection used by compounding pharmacies to repackage Avastin makes a lot of sense. The selected formats enable fewer preparation steps via providing a PFS concept, lower overall product cost and access to pre-assembled syringes with some of the smallest gauge needles on the market. However, from a factual point of view, utilising plastic general-use and insulin syringes as a storage and drug delivery device for intravitreal injections comes with numerous challenges and risks. Most of the concerns stem from the fact that these syringes were designed to support an

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Syringe	Filling Source	Typical Syringe Materials of Construction
 <p>Plastic General Use Syringe</p>	Compounding Pharmacy	<ul style="list-style-type: none"> • Luer cone configuration • Polypropylene or polycarbonate syringe barrel (USP Class VI plastic) • Barrel silicone lubricant (medical grade from Dow Corning) • Polypropylene tip cap (drug contact) • Rubber plunger (polyisoprene, styrene butadiene rubber, butyl rubber and thermoplastic elastomer) • Plunger stopper lubricant (medical grade from Dow Corning)
 <p>Plastic Insulin Syringe</p>	Compounding Pharmacy	<ul style="list-style-type: none"> • Staked needle configuration • Polypropylene or polycarbonate syringe barrel (USP Class VI plastic) • Barrel silicone lubricant (medical grade from Dow Corning) • Polypropylene needle cover (non-drug contact) • Adhesive to hold cannula / needle in barrel • Rubber plunger (polyisoprene, styrene butadiene rubber, butyl rubber and thermoplastic elastomer) • Plunger stopper lubricant (medical grade from Dow Corning)
 <p>Glass Prefilled Syringe</p>	Pharma Company and/or CMO	<ul style="list-style-type: none"> • Glass syringe barrel (Type 1 glass) • Barrel silicone lubricant (medical grade from Dow Corning or baked-on silicone oil) • Rubber tip cap (bromobutyl rubber material (drug contact) with plastic rigid cover) • Rubber plunger (bromobutyl rubber material with fluoropolymer coating) • Plunger lubricant (medical grade from Dow Corning)

Table 1: Comparison of typical syringe packaging linked with intravitreal injections of anti-VEGF drugs.

entirely different use. More specifically, the larger challenges and risks include:

- Overall product requirements and product performance
- Supply chain management and change controls
- Fill-finish for insulin syringes and needle quality.

Design Requirements and Technical Specifications

Within the US, general-use and insulin syringes are filed and approved as medical devices. As such these devices receive approval via the FDA's 510k process and are developed under the construct of various inputs including but not limited to 21 CFR 820 and Design Control Guidance for Medical Device Manufacturers. From the Design Input section of the Quality System Regulation (21 CFR 820.30(c)), the FDA has listed this view point: "Each manufacturer shall establish and maintain procedures to ensure that the design requirements relating to a device are appropriate and address the intended use of the device, including the needs of the user and patient."²¹

The output of the design requirements feed the technical specifications for the final device.³⁻⁵ Although the technical specifications are certainly extensive and have proved favourable to support general

use and insulin syringes from development through decades of commercial use, there are several areas of concern that would typically be linked with PFS delivery systems for intravitreal injections that are not necessarily covered in the specifications for general-use and insulin syringes. These include:

- USP 789 compliance – Particulate for intravitreal injections
- USP 1207 alignment – Container closure integrity
- ISO 11040 compliance - Prefilled syringes
- ISO 11608 compliance – Needle based injection systems for medical use
- Drug potency following syringe storage
- Syringe functional performance following storage.

A degree of reassurance is provided by Appendix A of the FDA's Industry Guidance, "Mixing, Diluting, or Repackaging Biological Products Outside the Scope of an Approved Biologics License Application", covers various components including:²²

- Subvisible particulates
- Protein content
- Potency
- Product related impurities
- Sterility test at the time that its repackaged
- Sterility or container closure integrity (CCI) testing after ageing.

Although the FDA guidance mentioned above certainly promotes a reduction in risks related to use of compounded syringe products for intravitreal injections, there are additional factors to consider. For example, during a recent anonymous survey related to PFS / primary container design and development, 30 industry engineers from the various leading pharmaceutical companies, PFS manufactures, and well-known design consultant agencies shed some light on some of the common challenges they had experienced. The results of this study can be found in Figure 1.

Along with providing insight into the challenges linked with developing such devices, this data also provides useful feedback related to overall patient risks. Although challenges related to particulates, extractables and leachables, chemical compatibility and CCI of nominally designed syringe devices are well acknowledged, the most common development challenges are linked with overall product design, design robustness and impact of process capabilities / control plans. This is particularly interesting if you consider a gap analysis between the survey results and the contents in Appendix A of the FDA's Industry Guidance, "Mixing, Diluting, or Repackaging Biological Products Outside the Scope of an Approved Biologics License Application", versus the green highlighted section in the Figure 1 survey results graph.

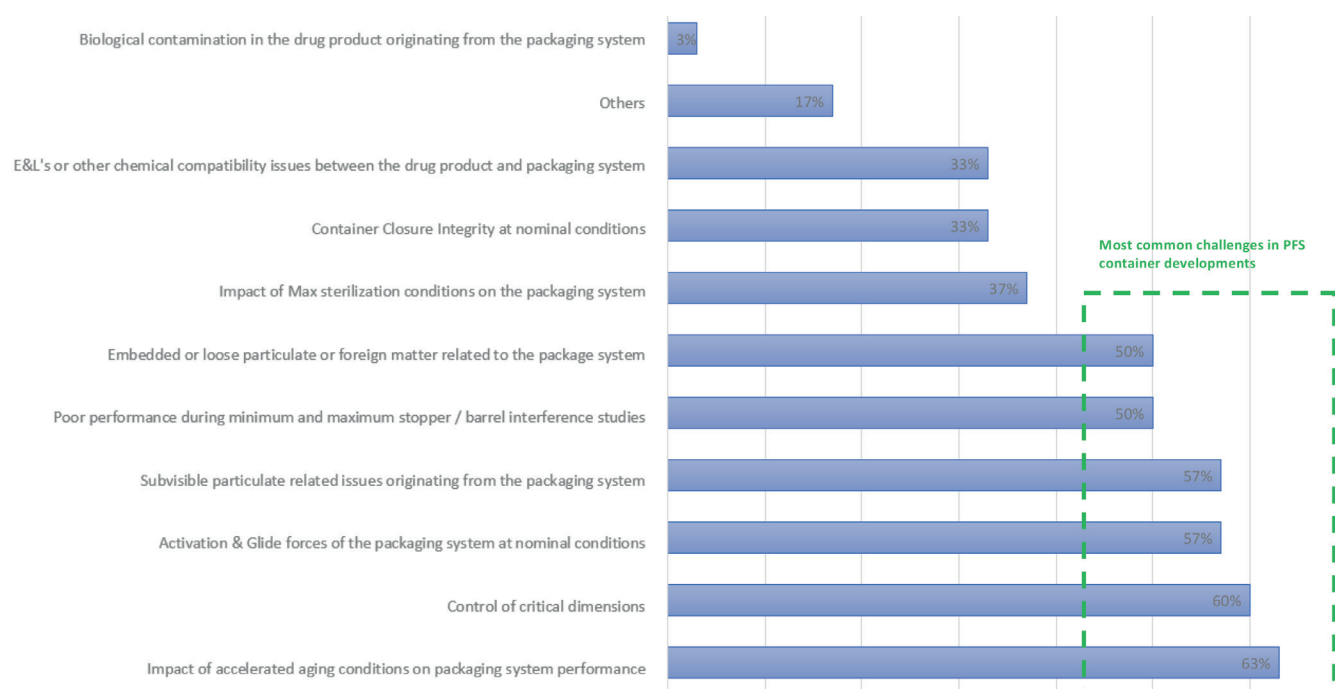


Figure 1: Survey results from 23 industry PFS R&D engineers

Supply Chain and Change Control

Another notable challenge is the drastic difference in supply chain management. Common practice for compounding pharmacies is to source sterile syringes from medical equipment distribution organisations. Such a supply chain inherently creates a more distant relationship between the owner of the final packaged drug product (e.g. compound pharmacy) and the design owner of the sterilised empty container (device supplier). This situation is completely different from the typical relationship within the traditional PFS industry, where device vendors and pharmaceutical companies essentially partner during most phases of the development process and continuously have transparent communications to ensure the product being manufactured is well characterised and the relationship between the device and the drug product are clearly understood. This also continues throughout the lifecycle of the drug.

Change control processes represent a critical aspect of supply chain management. In the traditional PFS space, pharmaceutical companies are given access to a host of technical and proprietary information related to material and manufacturing processes under confidentiality agreements. Not only are these details directly linked with buy specifications and supply agreements, they are also included within drug master files (DMFs). The DMF allows for the FDA to sanity-check technical inputs related to the packaging supplier and components and cross-check them against the final packaged

drug product description, labelling, etc. All this effort provides the foundation for a robust supply chain, that is well structured to manage the unavoidable changes that occur during lifecycle of a drug product.

Although not specifically related to intravitreal injection, a nonetheless relevant example of the challenges that can be created with the compound pharmacy supply chain model for syringes occurred in 2015. In the summer of 2015, the FDA published multiple warning letters that specifically identified risks linked with compounded or repackaged drug products in general-use syringes that were being utilised as both a drug storage and delivery device. Overall, this included a considerable number of different sized general-use syringes (1, 10, 20 and 30 mL) and the focus was mostly on various products on the FDA drug shortage list including fentanyl, rocuronium, neostigmine, morphine, midazolam, methadone, atropine, hydromorphone, cisatracurium and remifentanyl.²³ According to reports related to this circumstance, risk of potency loss was linked with any syringe stored for more than 24hrs,²⁴ which is a far shorter duration than some compounded drug products experience in syringes.

In the abovementioned potency loss situation, an alternative plunger stopper supplier that was utilised within the popular syringe product line was identified as the root cause. The FDA later announced that the syringe supplier had completely converted all syringes back to the original stopper supplier.²³

With a traditional PFS drug product, such a scenario should be impossible as the primary packaging components are approved by regulatory bodies as essentially a constituent of the drug product and are very much treated with the same level of scrutiny as, for example, excipients within the formulation. Any significant modification of the manufacturing process or change to the raw materials utilised to produce these packaging components is considered a significant change. When a component does need to be changed, a situation that certainly arises within industry, pharmaceutical companies steer towards the conservative side and implement formal change control processes including new drug compatibility, extractables and leachables and toxicology assessments, product functional studies and ageing studies, to ensure the change in the device still supports a safe and effective product for the end patients.

Needle-Point Concerns

Lastly, an additional set of concerns that are specifically linked with compounded drug products for intravitreal injections that are repackaged in insulin syringes includes:

- Needle-point quality following fill via transfer from a Luer lock syringe
- Needle-point quality following re-assembly of the rigid plastic needleshield
- Needle-point contamination during re-assembly of the rigid plastic needleshield

During the compounding process with insulin syringes, various techniques are utilised including withdrawing the drug product from the originally packaged vial. Some pharmacies use a technique in which multiple doses are withdrawn from the vial using a general use Luer lock syringe, followed by the insulin syringe needles being inserted into the Luer cone and a final dosage being drawn up within the insulin syringe.²⁵ With regards to the second concept, insulin syringes are clearly not designed to be inserted into a Luer cone. Even highly skilled operators could struggle with such a manual process and thus repeatability is a major concern. If the needle is damaged via colliding with the Luer cone during this process and not detected prior to use, patients could experience a significant increase in pain perception or even more extensive damage to the eye itself.

Following either of the filing techniques for insulin syringes mentioned above, the protective rigid needleshield is reassembled over the needle and onto the syringe hub. With regards to the manual re-assembly process, the main challenge experienced by common syringe users (e.g. insulin dependent diabetics, nurses, doctors, etc.) is that continuously aligning the cap over the syringe needle takes a set of steady hands, good visibility and high level of attention. This could have significant risks linked with transfer of bloodborne pathogens. The other concern is that if the plastic cap collides with the needle tip, it could damage the point. Again, if not detected prior to use, the results could be similar to those mentioned for the needle colliding with the Luer cone – pain or damage to the eye.

POTENTIAL SOLUTIONS AND MOVING FORWARD

It is clear that compounded VEGF inhibitors for intravitreal injections will continue to have a future within industry; they have several advantages. Thus, the question is, what development concepts, technologies, products and processes can support such a concept in the future to improve patient safety and reduce risk, mitigating the concerns detailed here? This is a broad question with numerous inputs and potentials and warrants continued discussion. Potential areas to explore for improvement include:

- Development structure of compounded products in storage / drug delivery devices

- Supplier relationship between device suppliers and compound pharmacies
- Advanced syringe components / syringe system technologies
- Syringe fill-finish technologies.

Development Structure

With regards to development structure, it clearly makes sense to treat compounded products in any syringe that is both a storage and drug delivery device as a traditional PFS. As such, there are various things to consider including development team structures and expertise and design controls. PFS development project teams are normally composed of leading experts in product design, statistics, usability, regulatory, design control and manufacturing technology. Such skilled individuals working towards a common goal leads to a robust product, built on a solid foundation of data that focuses on critical regulatory inputs and most importantly the needs of the user and patient. It is quite feasible that these skill sets could create a significant financial burden for the smaller compounding pharmacy to absorb. Thus, another option is for such organisations to outsource this to device development firms or the suppliers of the devices.

Some of the advantages to leveraging the expertise of the supplier is that compound pharmacies will create an improved supplier relationship and gain accessibility to components and tools to support a more robust development. For example, suppliers can provide min/max challenge devices (size, sterilisation, silicone, etc) to support product characterisation and ensure a clearly defined design space is realised.

PFS development projects are commonly resourced to support the evaluation of tens-of-thousands of assembled devices with quality requirements that are linked with ppm-level defect rates in order to demonstrate appropriate process controls. This is clearly an area for improvement with regards to compounded syringes, as today it is far more common that all testing takes place using a limited sample of commercial production products. Such practices don't necessarily capture batch-to-batch variation.

Also related to the actual development process, it has become an industry standard and required by CFR 820 for organisations to host formal design reviews for drug delivery device development efforts. Such reviews intentionally include leading experts that thoroughly review design inputs, product requirements and supporting data,

to ensure the PFS / drug delivery device product is a robust and safe solution for end users and patients.

Within CFR 820, the following can be referenced regarding design reviews: "Each manufacturer shall establish and maintain procedures to ensure that formal documented reviews of the design results are planned and conducted at appropriate stages of the device's design development. The procedures shall ensure that participants at each design review include representatives of all functions concerned with the design stage being reviewed and an individual(s) who does not have direct responsibility for the design stage being reviewed, as well as any specialists needed. The results of a design review, including identification of the design, the date, and the individual(s) performing the review, shall be documented in the design history file (DHF)".²¹ It seems practical to assume resources from device companies or external consultant firms could support such design reviews as a subject matter expert. By hosting such reviews, compound pharmacy organisations would ensure they have formal industry expertise reviewing the product for overall robustness and safety.

Supplier Relationship Management

Supplier management relationship efforts can support improved product quality and end-user risk reduction related to compounded products in syringes via multiple mechanisms. As mentioned above, change control agreements could be integrated to support the specific needs of compound pharmacies. Of course, this concept will cost more time and resources and ultimately will create discussions related to overall product sales price. However, such concepts are supported by phrases such as "total cost of ownership". Within such models, paying more for a robust drug delivery system, certainly outweighs the impact linked with a major market recall or, even worse, injury to end users. Additionally, documentation utilised by the PFS industry including, for example, technical files and DMFs, could be referenced by compound pharmacies to ensure the container systems are well defined. This would inherently limit the potential for changes to be made to the container system without prior notification.

Advanced Components / Syringe Technologies

Advanced rubber plungers for syringe systems, fully or partially coated with fluropolymer film, are generally linked

with low extractable and leachable rubber materials. The coating material is applied to at least the drug contact area of the rubber stopper surface. The halobutyl base-rubber formulations used are already low in extractables and leachables and composed of inert materials, especially compared with the more conventional / legacy polyisoprene or SBR formulations. Along with the base polymer being composed of a more inert polymer material, premium rubber components use far less ingredients than legacy materials. An example of a premium rubber formulation can be found in Table 2.²⁶

Most of leading vendors within industry have such offerings within their product portfolio but it's not common practice for these to be utilised within general-use plastic syringe systems, which tend to use conventional / legacy materials.

The coating of advanced plungers provides an additional source of risk reduction for improved patient safety and overall improved drug product quality via better drug compatibility, reduction in extractables and leachables.

Advanced plungers can also enable silicone-free primary packaging, contributing directly to a reduction in

Premium Rubber Component Composition		
Ingredient	phr	Description
Brominated isobutylene-co-para-methylstyrene	100	Elastomer
Polestar 200R	90	Filler
Parapol 2255 plasticiser	5	Plasticiser
Polyethylene wax	3	Processing aid
TiO2	4	Colourant
MgO	1	Curing agent
Diak 1 vulcanising agent	0.75	Curing agent

Table 2: Premium rubber composition.

silicone-related subvisible particles (SbVPs). Silicone-related SbVPs have been identified as a source of “floaters” experienced by ophthalmic patients following intravitreal injection. Additionally, the overall design of premium-coated stoppers supports a reduction in activation and glide forces (AGF) compared with legacy components. Figure 2 shows examples of commercially available partially and fully coated stoppers.

Next-generation siliconised syringe options are offered by multiple vendors. They offer a variety of sizes and configurations including both Luer lock

and staked-needle designs. These syringes are offered in plastic and glass materials and the siliconisation technologies utilised during the manufacturing of these products supports reduction of risk related to silicone SbVPs.

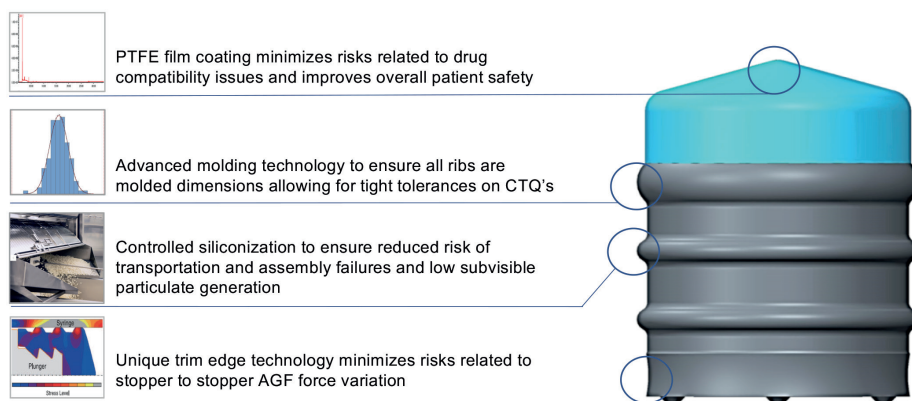
Based simply upon surface area, siliconisation in the syringe barrel has a far greater impact on silicone-related SBVPs particulates compared with rubber. However, both provide opportunities for risk reduction. For siliconised syringes, the silicone is a critical feature of the syringe and supports the assembly of the stopper into the barrel after filling and the actuation forces of the syringe, although other syringe features also play a role such as inner diameter of the needle itself and viscosity of the drug product.

A selection of example advanced PFS systems are described in Box 1.

One challenge linked with most of the innovative technologies mentioned in Box 1 that significantly limits their use in compounding pharmacy setting includes the syringe products' final configuration and packaging. Unlike general-use and insulin syringes, the technologies mentioned above are delivered with the stopper and plunger unassembled from the syringe barrel. Thus not only is filling required but assembly is required as well. Unfortunately, without proper fill-finish equipment, safe and effective filling and assembly of such syringe would be extremely challenging. An advantage to using the nested syringes is that they are not filled via the needle end of the syringe. This avoids the need to manipulate or reassemble the syringe during the filling process, and inherently reduces risks linked with reassembly of the rigid cap onto the syringe.

As final packaging linked with all the technologies on Box 1 are configured

PARTIALLY COATED



FULLY COATED

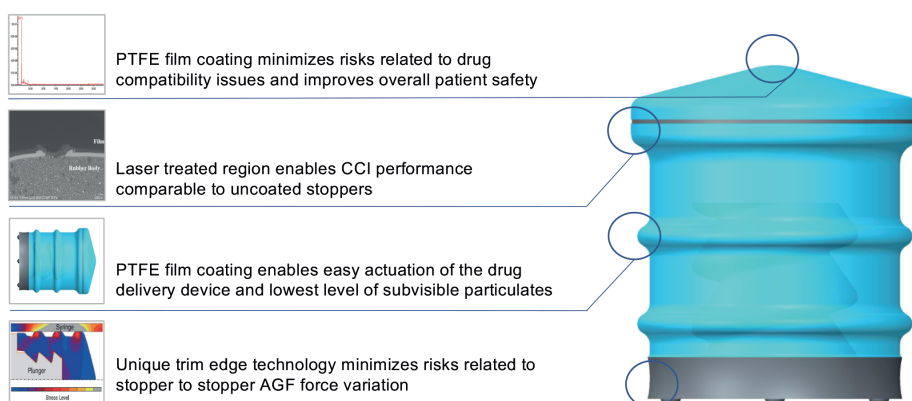


Figure 2: Partially coated and fully coated plungers.

BOX 1: ADVANCED PFS SYSTEMS: OVERVIEW AND EXAMPLES

Becton Dickinson launched a premium quality syringe called Neopak™ XSi™.²⁷ According to publicly available information on BD's website, Neopak XSi provides overall improved product quality and a significant reduction in silicone-related SBvPs compared with traditional siliconised PFS; >95% in one published study, which also reported that XSi does not sacrifice actuation performance.²⁸

Gerresheimer offers siliconised glass syringes with a baked-on silicone technology called Gx® Baked-on RTF® glass syringes. The company's published information states that the product is patented in Europe and the US for the packaging of sensitive biotechnological medications that may interact with free silicone oil droplets. The intent of this product is to reduce the number of free silicone oil droplets significantly. As well as enabling a reduction in silicone related subvisible particulates, the Gx® Baked-on RTF® technology offers reliable hydrophobic properties and especially low breakloose and gliding forces that remain stable throughout the storage period.²⁹

The TopPac® line from Schott is one of the most successful plastic PFS offerings on the market today. According to public company information, the TopPac cyclic-olefin copolymer (COC) syringe product is injection moulded, which enables significantly improved dimensional tolerances over glass. The tighter dimensional tolerances along with Schott's crosslinked siliconisation process provide consistent glide forces, resulting in precise and smooth drug delivery. The crosslinked siliconisation process is applied after the moulding step and cooling phase. A reactive silicone is applied to the internal surface of the syringe system followed by a curing process. The process is designed to ensure consistent distribution of silicone throughout the syringe barrel along with extremely low levels of free silicone oil.³⁰

Silicone-free syringes have also been under development throughout industry for many years and various products have launched across the world. In reality, there continues to be some market concern related to product functionality such as actuation forces and container closure integrity.³² However, improvements have been made. For example, Terumo launched the PLA-JEX™ plastic silicone-free syringe system that utilises an inert cyclic-olefin polymer (COP) and high-quality rubber stopper with a proprietary coating. Based upon a technical report published by Terumo, the PLA-JEX™ product line demonstrated a SBvP count of 2/mL versus 900/mL for a traditional siliconised syringe.³³ Earlier this year Terumo announced that this syringe system had been qualified with a manufacturer of a biosimilar version of Humira (adalimumab) and had received European regulatory approval.³⁴

to support fill-finish operations such as Isolator technologies, a barrier limiting their usage by compounding pharmacies is proper fill-finish equipment. Historically, such fill-finish equipment has been designed for volumes in the billions of units.³⁵ Additionally, as mentioned in the previous section, compounders have become very comfortable with manual operations under a hood with laminar flow.

However, in recent years, several leading fill-finish suppliers have begun to develop and launch unique modular technologies that are suitable for clinical- and small production-volume filling. Additionally, most of this equipment is being designed to support the filing of multiple packaging configurations via the modular unit concept and simple change parts. This provides a means for compounding pharmacies to leverage the efficiencies compared with manual filing, and ultimately support return on investment in the cost of the sophisticated fill-finish equipment.

During an interview at INTERPHEX

2016, Bausch + Stroebel representatives explained the value of the company's flexible modular VarioSys® equipment, highlighting continuing opportunities of these machines for compounding pharmacies undertaking

with small-batch filling, quick changeovers and a diverse portfolio of container closure system designs including nested vials, PFS and cartridges, for example.

Various organisations are working to support compounding pharmacies with proper fill-finish equipment, for example, AST Technologies with their GENiSYS® c20 isolator, and Colanar Inc.

During a recent discussion, Colanar President Bernd Stroeter explained that “503B compounding pharmacies have been converting from manual vial filling operations to benchtop vial filling machines in recent years. These benchtop filling machines are particularly suited as the first automated filling equipment due to a number of advantages, from their compact design and high build quality to their reasonable cost and ease of use. Further advantages are their flexibility to process vials, PFS and cartridges on the same machine, and their ability to be used in laminar flow workbenches, RABS enclosures, and isolators. Since the pharma industry is rapidly moving towards isolator technology, compounding pharmacies will also have to adopt this technology and acquire additional technical know-how in order to be able to operate this increasingly complex equipment”.

Colanar has supplied various benchtop vial filling systems that can be incorporated into hoods with laminar flow, which seems to be the comfort zone for many organisations. Additionally, there is growing interest for further vial filling machines, and companies like Colanar Inc are now starting to get requests for syringe filling machines. Illustrations of Colanar's various platforms to support compounding vial and syringe fill-finish operations can be found in Figure 3.

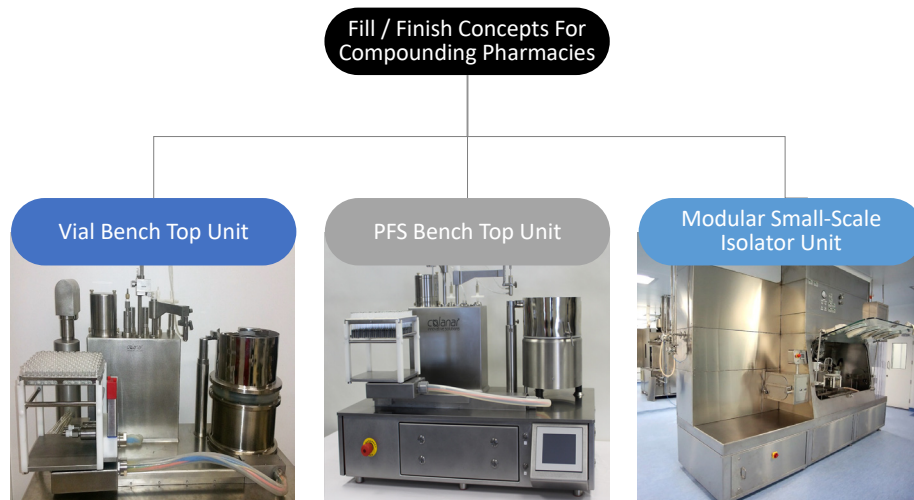


Figure 3: Colanar's modular vial, PFS, cartridge fill-finish equipment. (Images provided by Colanar, Inc.)

CONCLUSION

Overall, intravitreal injections of VEGF inhibitors continue to be a growing trend within industry. As regulatory guidance continue to provide clarity and compounders capture the value from premium packaging systems, the robustness and safety of the compounded products will continue to improve.

In the meantime, it is critical that industry communicates on the challenges and ideally establishes best practices regarding fill-finish process and equipment,

packaging system selections, and testing structures, to ensure proper syringe system functionality and overall compounded product safety.

It also makes sense for compounders and device suppliers to improve partnerships, as pharma and PFS device suppliers have done with considerable effectiveness. Compounders will continue to fill and sell compounded drug products in general-use and insulin syringes, so a transparent relationship is needed to ensure the safety of the device is established and maintained throughout the lifecycle of the commercial

relationship. All this certainly requires time, resources, effort and, more than likely, investment too, but the level of risk reduction that these practices bring to the overall situation is priceless.

ABOUT THE COMPANY

Since its founding in 1909 as the first modern rubber factory in Japan, Sumitomo Rubber Industries has strived to produce advanced, environmentally friendly products based on the latest innovations in rubber technology. The medical rubber group is focused on providing the highest quality products and ultimately dedicated to improving the lives of people around the world. Utilising the latest in material and process innovations and a global manufacturing footprint, Sumitomo Rubber Industries delivers consistent high-performing products and provides strong assurance of supply.

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ABOUT THE AUTHOR

Douglas Cusato is Director of the Medical Rubber Business for Sumitomo Rubber, North America. In this regional leadership role, he is responsible for all aspects of the North American business including strategy, R&D, operations and sales. Mr Cusato has been active in the parenteral packaging industry since 2006 and has served in various technical leadership roles with a focus on technology and platform development. He has chaired multiple industry taskforces and participates in numerous groups as a subject matter expert in elastomeric components for parenteral packaging applications. Mr Cusato holds a Bachelors' degree in Chemistry from Rutgers University (NJ, US).

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