Brief Communication

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Dual-Chamber Technology: Safe and Convenient Drug Delivery for Lyophilized Biologics

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Biologics present a challenge to both the manufacturer and end user. They must usually be formulated as parenterals. However, they are often unstable in liquid form, due to their complex structure and composition. In that case, they must be manufactured using highly specialized processes, such as lyophilization (freeze-drying). Lyophilization nearly eliminates stability issues. Reducing a compound's sensitivity to temperature prolongs its shelf life. However, reconstitution can be cumbersome, involving multiple steps that increase the potential for error. Dual-chamber technology provides an effective alternative, combining a lyophilized drug and diluent in a closed system and enabling reconstitution in a few simple steps.

Keywords: Dual-chamber, Lyophilization, Injectable device

Introduction

1. Traditional versus dual-chamber technology

Traditionally, users have received lyophilized drug products in a vial (Fig. 1). To administer it, the user meters the diluent into a syringe and then adds the diluent to the lyophilized vial. Next, the reconstituted drug is withdrawn from the vial and, after changing the needle, administered to the patient. This process requires careful measuring, manual dexterity, and numerous steps. It is unwieldy for medical professionals in the clinic and especially for patients and their caregivers who self-administer in non-clinical settings.

Dual-chamber technology is an all-in-one closed system. The lyophilized drug resides in one chamber; the liquid resides in the other (Fig. 2). Immediately prior to administration, in a few simple steps, the diluent is pushed through a channel between the two chambers to reconstitute the drug, which can then be injected.

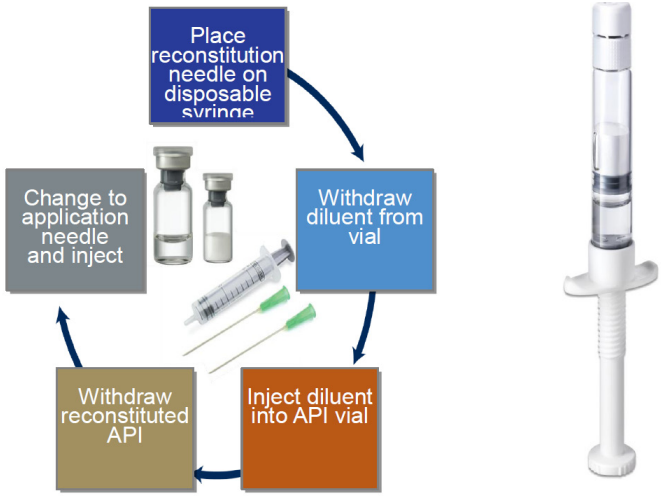

Fig. 1. Drugs in vial and dual-chamber syringe.

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(A) (B)

Fig. 2. (A) Dual-Chamber Cartridge for PEN, (B) Dual-Chamber Syringes.

2. Manufacturing process

While the dual-chamber system is simple to use, its manufacture is highly sophisticated, requiring lyophilization of the drug within the delivery system. The process begins by washing, siliconizing, and sterilizing the glass barrels, which are then each separated into two chambers by a middle stopper. Liquid drug is filled into the front chamber, and a closure is set in place. The drug is then lyophilized to produce a stable lyocake, after which the closure is sealed. Diluent is then filled into the second chamber, and the end stopper is put in place.

Expertise is required throughout. Primary packaging components must be carefully selected to withstand the manufacturing process and prevent them from adversely affecting the drug; during lyophilization, temperatures can reach as low as –60°C under a vacuum. Moreover, compounds can interact with silicone and rubber formulations, so it is necessary to precisely match the drug with the container components.

3. Benefits for users and manufacturers

1) Increased safety, accuracy, and ease

Dual-chamber systems increase dosing precision, since the drug and diluent are premeasured and sealed. They decrease the risk of medication error by eliminating the use of multiple vials and needles. Additionally, because of their simplicity, dual-chamber systems allow patients or their caregivers to administer drugs at home, eliminating regular trips to the clinic (Fig. 3).

2) Increased API yield

Dual-chamber systems increase API yield by reducing overfill requirements. Vials require greater overfill to ensure enough of the drug is available to manually draw into a syringe. Dual-chamber systems are closed and efficient, requiring less overfill, which can result in substantial cost savings in high-value API.

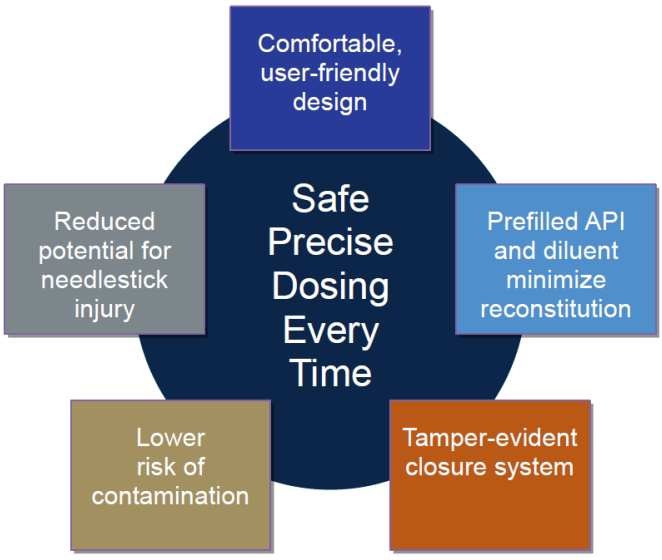

Fig. 3. Benefits to users.

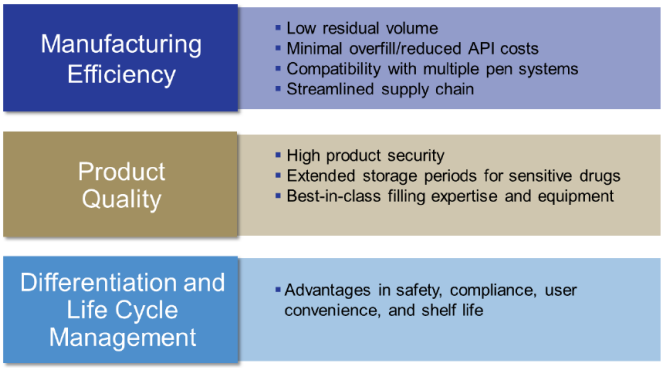

Fig. 4. Benefits for manufacturers.

3) New markets

Dual-chamber systems are user-friendly and can help meet the demands of the consistently growing homecare sector. Dual-chamber syringes are used with single-dose drugs. If medication is being offered in multiple doses, a dual-chamber cartridge with a pen system can be used.

4) Product differentiation. Dual-chamber technology sets a product apart from its competitors. It can play an important role in its lifecycle management strategy at initial launch or in later generations (Fig. 4).

Conclusion

Since the lyophilization of dual-chamber technology nearly

eliminates the stability issues of biologics and increased safety, accuracy, and ease are provided with dual-chamber systems for the users and manufacturers, injectable devices using dual-chamber technology have become more familiar to patients and their caregivers.