4 Sterile product packaging systems

This chapter deals with sterile product container systems, both conventional and more advanced systems. In chapter 7, more attention is devoted to the specific chemical and physical properties of glass, rubber, and plastic and issues surrounding extractables and leachables. Also packaging systems with respect to container/closure integrity testing are discussed in chapter 30.

STERILE PRODUCT CONTAINER SYSTEMS

There are six basic primary packaging or container systems:

1. Ampoules—glass
2. Vials—glass and plastic
3. Prefilled syringes—glass and plastic
4. Cartridges—glass
5. Bottles—glass and plastic
6. Bags—plastic

Generally, vials comprise about 50% of small volume injectable packaging, syringes 30% and ampoules 10%, and cartridges and bottles/bags filling the rest.[1] Usage of all packaging types, except ampoules, are trending upward, especially prefilled syringes. Each of these packaging systems for parenteral drug delivery has significant advantages and disadvantages. Generally, advantages involve user convenience, marketing strategy, handling during production and distribution, volume considerations, and compatibility with the product. The primary disadvantage with all these packaging systems is the potential reactivity between the drug and other ingredients in the formulation (e.g., antimicrobial preservatives) and the packaging components. The reactivity is typically manifested through the appearance of particulate matter, detection of extractables, evidence of protein aggregation, and other physical and chemical incompatibilities.

This chapter covers each of these primary packaging systems, advances in primary packaging for special delivery systems, and needle technology.

Selection of the packaging system not only depends on compatibility with the product formulation and the convenience to the consumer, but also on the integrity of the container/closure interface to ensure maintenance of sterility throughout the shelf-life of the product. Container/closure integrity testing has received significant attention and usually is an integral part of the regulatory submission and subsequent regulatory good manufacturing practice (GMP) inspections. While it is beyond the scope of this chapter to discuss the various container/closure integrity testing methods (these methods are covered in chap. 30), it is emphasized that formulation scientists developing the final product including the final package must appreciate the need to develop appropriate methods to ensure that the selected packaging system possesses the proper seal integrity to protect the product during its shelf-life from any ingress of microbiological contamination.

Ampoules

For decades, glass-sealed ampoules (Fig. 4-1) were the most popular primary packaging system for small volume injectable products. To the formulator, ampoules offer only one type of material (glass) to worry about for potential interactions with the drug product compared with other packaging systems that contain both glass or plastic and rubber.

Two disadvantages of glass ampoules are the assurance of the integrity of the seal when the glass tip is closed by flame and the problem of glass particles entering the solution when the ampoule is broken to remove the drug product. There exist "easy-opening ampoules,"

[1] Based solely on author's experience and perception.