Handbook of Aseptic Processing and Packaging

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The U.S. markets for aseptic packaging

Thomas Szemplenski

3.1 Development

Even though aseptic processing and packaging was invented decades before, there was no significant activity in the commercialization of aseptic processing and packaging until the late 1960s and early 1970s when the Dole Canning System was used by food processors with foresight. These processors started to aseptically process and package shelf-stable milk, puddings, and soup. At about the same time, Tetra Pak, a Swedish company, introduced its laminated paper-aluminum foil-plastic container to the United States. The system was, at that time, a continuous form–fill–seal system for fluid pasteurized milk and beverages. The container was a tetrahedron. This package was extremely efficient in material use but complicated to pack or stack, and a real challenge to open. The U.S. licensee of this system was the Milliken Company in South Carolina, and in conjunction with Real Fresh of California, the Tetra system was modified to include a chlorine sterilizing bath of the packaging web. This allowed sterilized milk to be filled and sealed aseptically in a hermetically sealed container. These packages were followed by fruit products being aseptically filled using the aseptic bag-in-box system developed by William Scholle in the early 1970s.

In 1981, Tetra Pak returned to the United States with a new and improved container. The basic system remained the same with a web of laminated material being formed, filled, and sealed in a continuous motion. What was different was that after the container was sealed and cut from the web, it was formed and folded into a rectangle or brick. This presented the consumer with a container that looked familiar and suitable, and could be displayed on store shelves.

The real growth in aseptic processing and packaging was experienced starting in the early 1980s. Following Tetra Pak’s introduction of the Brik-type package and the Scholle aseptic bag-in-box filler, other packaging
alternatives started to be introduced, as well as other manufacturers of paperboard packaging and bag-in-box aseptic filling equipment. There are now quite a number of aseptic containing alternatives, including plastic cups, coffee creamers, steel drums, form–fill–seal pouches, plastic bottles of various polymers, and even aseptic bulk storage tanks (some of these tanks holding nearly 2 million gallons of aseptically processed acid products). The market growth or driving force of each aseptic packaging alternative is different and will be reviewed in this chapter.

3.2 Aseptic metal can market

The Dole canning system was very reliable. It was based on heat for pre-sterilization and maintenance of sterilization of the filler and the metal cans and lids. Filling speeds varied from 30 cans per minute for #10 cans (see Figure 3.1) up to 450 cans per minute for 4-ounce cans.

There was considerable interest and acceptance of aseptic packaging of food into metal cans as Dole eventually supplied more than 60 canning systems, many of which are still in operation. As the learning curve for aseptic packaging using the Dole Canner increased, so did the number of different products that were aseptically filled. Products such as cheese sauces, ketchup, cream-style corn, baby food, eggnog, ice cream mix, banana puree, tomato paste, dietetic drinks, and sandwich spreads all were aseptically filled into metal cans using the Dole canning system.

The driving force for interest and the growth factor in aseptically packaging into metal cans was the improved organoleptic and nutritional

![Figure 3.1 Asceptically canned pudding. (Photograph courtesy of Real Fresh.)](image)
properties of the food being canned. The products no longer had to be overcooked for long periods of time in retorts. Instead of the food products being subjected to a temperature of 250°F from 45 minutes to sometimes 2 hours resulting in overcooking, it now could be homogeneously heated in a matter of seconds from an ambient temperature to around 275°F, held for a short period of time and then cooled very fast to a filling temperature of between 70°F and 90°F. Aseptic processing and canning resulted in dramatic quality and taste improvement in the food being processed and food processors embraced the technology.

The Dole canning system was the only aseptic packaging system that was ever developed for metal cans, other than the aseptic filling system into 55-gallon metal drums invented in the 1970s by Fran Rica for tomato products. Unfortunately for the Dole system, alternative, less expensive aseptic packaging was developed that became the choice of food processors. Aseptic plastic cups, bag-in-box, and pouches are far less expensive than the metal can, so very few other Dole canning systems have been installed in the last 20 years.

3.3 Aseptic bag-in-box

In the early 1970s, William Scholle of the Scholle Corporation, a leading manufacturer of flexible packaging of various polymers, visualized the potential for flexible packaging to replace the expensive, rigid packaging that was being used to transport food products such as tomatoes and other fruit products. Instead of using existing retorting technologies to commercially sterilize the product to be packaged in flexible packaging, he leaned toward applying a relatively new technology that was rapidly developing at the time, aseptic processing and packaging. Scholle engineered and manufactured a prototype of an aseptic filler to fill preformed, flexible bags. He tested and improved upon the initial design at Purdue University’s food processing facility in West Lafayette, Indiana.

The first Scholle aseptic filler was developed to fill bags from 1 to 5 gallons. Improvements to the original Scholle were made to the point they now can aseptically fill bags up to 330 gallons. Scholle’s prototype aseptic filler was presterilized with steam, superheated water, and chlorine. The flexible bags were and still are sealed and presterilized by gamma radiation. Aseptic bag-in-box packaging was an immediate success (Figure 3.2). Prior to the development of aseptic bag-in-box packaging, most acid food products such as tomato paste and fruits for pies, yogurt, and so forth were either hot filled into #10 cans, aseptically filled into metal drums, or frozen in 30-pound plastic pails. Number 10 cans were and still are quite expensive, troublesome to open and dispose of, and yielded loss of product due to residuals, not to mention liabilities due to workers getting cut handling these containers. Fifty-five-gallon metal drums were very
expensive and additionally sacrificed yield at the use point. Thirty-pound plastic pails were the most common way to transport fruit that was frozen at the growing area and shipped all over the United States for remanufacturing into pies, fruit for yogurt, and so forth. Not only were the pails expensive, but the cost of freezing was additionally pricey.

Economics is the main driving force for the aseptic bag-in-box market. As an example, a brief comparative analysis of aseptic bag-in-box compared to product packaged into number #10 cans will be presented. Many food products destined for food service are packaged into #10 cans and delivered 6 cans per case. Food service is one of the largest markets for bag-in-box.

Case of #10 cans
- A #10 size can will normally contain approximately 96 ounces, therefore a case of #10 cans will usually be about 4.5 gallons.
- Although the price of a #10 can will vary depending upon the cost of the raw material at the time and the size of the customer based on the number of cans purchased, the average price for a #10 can at the time of this writing is $0.75 each.
- \[ 6 \times \$0.75 = \$4.50 \text{ per case (usually about 4.5 gallons)} \]

5-gallon aseptic bag-in-box
- A 5-gallon, presterilized bag will vary in price depending upon packaging materials, barriers, metallization, and so forth, but usually will cost between $0.80 and $1.20. If an average price of

**Figure 3.2** The Scholle aseptic bag-in-box filler.
$1.00 is used in the calculation, the savings would be $4.50 – $1.00 = $3.50 per case savings.

- Adding the price for the corrugated container would increase the price of the flexible bag packaging by as much as $0.20 more. If this is entered into the comparison the savings would be $3.20 for the aseptic bag-in-box compared to a case of #10 cans, but it should be noted that the bag holds approximately a half a gallon more product.

An extended economic comparison was generated for an actual food processor. This food processing facility utilizes 9 million #10 cans per year. During the fresh-fruit season it packages all the product into #10 cans. During the off-season it opens the #10 cans and reprocesses the product into alternative packaging. To elaborate on the initial comparison:

- 9,000,000 #10 cans divided by 6 cans per case = 1,500,000 cases × 4.5 gallons per case = 6,750,000 gallons of product being processed
- Cost of cans: 9,000,000 × $0.75 = $6,750,000; yearly cost of #10 cans
- Cost of bag-in-box: 6,750,000 gallons divided by 5-gallon bags = 1,350,000 bags @ $1.00 per bag = $1,350,000 yearly cost of bags
- Yearly savings to package product into bag-in-box: $6,750,000 – $1,350,000 = $5,400,000

Additionally, the processor advised the cost of reopening and disposing of the #10 cans was approximately $1,500,000 annually.

Further economic savings to be realized by aseptic bag-in-box compared to rigid metal cans are:

- Reduced space required for bags compared to empty and full metal cans
- Reduced shipping cost
- Reduced liability
- Reduced disposal cost

Based on advantages similar to those described in our comparison, economics is the main driving force for the aseptic bag-in-box market. Other manufacturers of food packaging equipment realized this and quite a few competitors to Scholle have introduced their versions of aseptic fillers for bag-in-box. There are now at least 10 different aseptic bag-in-box fillers installed in the United States alone with more than 200 aseptic bag-in-box fillers operating. There are also approximately six major suppliers of presterilized aseptic bags of various polymers and oxygen barrier materials. Improvements have been made in aseptic bag-in-box fillers to the extent that several have received U.S. Food and Drug Administration (FDA) validation for aseptically filling low-acid foods, and bag sizes have increased to the point some of the fillers can fill bags up to 300 gallons.
The market for aseptic bag-in-box is actually two distinct markets: the market for product packaged in smaller bags from 1 to 5 gallons and the market for larger bags packaged in bags from 55 to 300 gallons. The market for smaller bags is generally for product destined for the food service industry. Initially the market for the smaller bags was for acidified products, such as stabilized fruit for pies and yogurt, but this market has given way to saturation and the larger bags. The market segment for smaller bags that is experiencing growth now is for low-acid food products such as prepared sauces for restaurants, soups, chili, milk, and condiments, like ketchup, salsa, mustard, and single-strength juices. There is hardly a convenience in the United States that does not have a dispenser from Gehl’s installed to dispense warm cheddar cheese sauce and chili over nacho chips. These products are aseptically processed and packaged. It is estimated that there are more than 100 aseptic bag-in-box fillers installed filling smaller bags in the United States. This market is not mature. Most assuredly more products will be aseptically packaged into flexible bag-in-box packaging.

There are approximately 140 aseptic fillers installed to fill larger (55 to 300 gallons) bags. This market is additionally divided into two predominant markets: one for tomato paste and the other for citrus products. The total market for bulk bags in the United States is estimated at 4,500,000 units in 2008. Based on the average price for a bulk bag in 2008, this would amount to an approximate $50 million market for bags.

With approximately 90 aseptic bag-in-box fillers for bulk packaging operating, the larger of the two markets for bulk bags is for tomato products. California grows and supplies most of the tomatoes in the United States and aseptically packages paste and diced tomatoes for shipment to other parts of the country. The product is harvested, condensed, and aseptically processed and packaged in California. It is then shipped to various points around the United States to be reprocessed into ketchup, sauces, soups, and so on. JBT FoodTech is the leading manufacturer of aseptic fillers for bulk bags, although JBT FoodTech does not manufacture the packaging. The demand for aseptic bag-in-box packaging for tomato product continues to grow but at a slower pace than when the aseptic bag-in-box fillers were rapidly replacing nearly all the aseptic drum fillers. Nearly all tomatoes in California that are harvested and packaged to be reprocessed are aseptically filled into the bag-in-box.

The other major market for bulk aseptic bags is in the citrus industry. The citrus industry does not have as many aseptic bag fillers installed as the tomato industry, however, the citrus industry is afforded two crops creating an approximate season of 250 days compared to the 100-day tomato season. In the 1990s, the citrus industry embraced aseptic filling of juice into bulk bags. Almost all the operating aseptic fillers are for the larger 300 gallon bags, and although Scholle and JBT FoodTech have a few aseptic fillers installed for citrus
products, the DuPont/Liqui-Box StarAsept filler is the predominate filler being used in the citrus industry.

The market for citrus products being aseptically stored in the bag-in-box has been in steady decline for the past decade. Aseptic bags are rapidly being replaced with aseptic bulk storage tanks capable of aseptically containing millions of gallons of citrus juices. Even at that, industry sources have reported that in 2008, approximately 1.5-million bulk aseptic bags were utilized in the citrus industry (P. Brocher, personal communication, 2008).

3.4 Aseptic paperboard market

In the early 1980s, Tetra Pak returned to the United States with a new and improved package. The basic system remained the same with a web of laminated material being form, filled, and sealed in a continuous motion. What was different was that after the package was sealed and cut from the web, it was formed and folded into a rectangle or brick. This presented the consumer with a container that looked familiar and suitable to be displayed on the store shelves. The real functional feature was the straw for the smaller containers that was designed to puncture an opening at the specially scored spot. This made the container popular with many consumers who like the portability and ease of consuming whatever the package contained.

Aseptic milk and flavored milks experienced their first real introduction to the mass market in Tetra Pak’s Brik-Pak packaging. At that time the demand for Tetra Pak aseptic filling equipment for acid products such as fruit juices and flavored liquid beverages far exceeded the demand for fillers for milk. It was not until the processing of milk was significantly improved upon with the introduction of steam injection when the real growth occurred in the dairy segment.

The acceptance of juices in Tetra Pak Brik packaging was phenomenal. The consuming public embraced the new package and products with a passion as evidenced by the grocery store shelves that were lined with the many different products packaged and offered by the many beverage processors who installed Tetra Pak fillers or had the product copacked at various locations (Figure 3.3).

The market for new Tetra Pak fillers for acid products is somewhat static at the time of this writing due to the many fillers that are already installed and operating. However, as the learning curve in aseptic processing and packaging improved, so has the scope of new products that are being aseptically packaged into paperboard-laminated containers. It appears that new products are being aseptically packaged every day. Products such as soups, broths, nutritional drinks, and many sauces like the ones pictured in Figure 3.4 are all being aseptically packaged into paperboard-type containers.
Figure 3.3 Aseptic product in Tetra packaging. (Photograph courtesy of Tetra Pak.)

Figure 3.4 Low-acid aseptic product in Tetra packaging. (Photographs from sales literature.)
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It appears that the real growth in the paperboard laminate packages is in specialty food and beverages other than juices and fruit flavored beverages. Tetra Pak now has approximately 200 aseptic fillers installed and operating in the United States. Almost half of these fillers are now for low-acid beverages and other foods. This trend will continue.

The other supplier of aseptic filling equipment for products into paperboard-laminated packages is SIG Combibloc. Unlike the Tetra Pak form–fill–seal principle of producing sterile packages, the Combibloc filler uses preformed packages that are supplied to the filler, folded flat. The filler then automatically opens, forms, sterilizes, fills, and seals the packages. The packages with the Combibloc filler are sterilized with hydrogen peroxide and hot air. Both the Tetra Pak and Combibloc fillers are FDA validated for aseptically filling low-acid foods, but the Combibloc filler was the first filler used in a commercial aseptic processing system containing a low-acid food with particulates. The installation is located at a Campbell Soup facility in Canada aseptically filling soups with small particulates like the one pictured in Figure 3.5.

Tetra Pak is by far the leading supplier in the world for the supply of aseptic fillers and packaging material. Aseptic packaging at Tetra Pak is dynamic. They now have many different types of fillers designed to aseptically fill into many different packaging configurations, the most recently being a form–fill–seal gable top design. One thing can be counted on with Tetra Pak and that is innovation.

Figure 3.5 Low-acid aseptic product containing particulates.
3.5 **Aseptic plastic cup market**

The market for food products aseptically filled into plastic cups enjoyed tremendous growth starting in the early 1980s. Robert Bosch Company installed the first aseptic filler in the United States for filling food products into plastic cups. This installation was followed by a number of other manufacturers such as Hassia, Metal Box, ERCA, Benco, Gasti, and Hamba. The Gasti and Hamba fillers never received FDA validation for aseptically filling low-acid foods but were used as extended shelf-life (ESL) fillers for refrigerated products.

The introduction of these aseptic fillers for filling into plastic cups all but took away the market for the Dole canning system due to high speeds and economics of packaging materials. In all, 26 aseptic fillers and 12 more extended shelf-life fillers were installed starting in the 1980s. Due to excellent engineering, high production speeds, lack of chemical sterilants, and aggressive marketing, Hassia, now OYSTAR Hassia, has become the dominant supplier of aseptic cup fillers in the United States (Figure 3.6). The latest OYSTAR Hassia aseptic cup filler can fill almost 1700 cups per minute (C. Ravalli, personal communication, 2010).

![Figure 3.6 Some products aseptically filled using an OYSTAR Hassia filler.](image-url)
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The first products to be aseptically filled into plastic cups were puddings. The interest in aseptic filling into plastic cups was driven not only by the economics of higher production and less expensive packaging, but also by the much improved organoleptic quality of the aseptically processed pudding. Over the years the scope of products expanded to include cheese and other sauces, condiments, soup, baby food, and flavored gels. Of late, however, the market for aseptic fillers for cups has softened considerably and not many new aseptic cup fillers have been installed. Manufacturing sources have advised that this is most likely due to the capital-intensive cost of aseptic processing and packaging and saturation.

3.6 Aseptic pouch market
The aseptic pouch market is believed to be in its infancy. This is an underdeveloped market that is expected to explode with activity mainly due to the economic savings in packaging, but also due to

− Improved nutritional and organoleptic quality of the food product compared to retorting or hot filling
− Convenience compared to #10 cans
− Less disposal cost
− Less space required
− Less manpower requirement at the end use point

The economic savings are exceptional and are the main driving force. The predominate market for product to be supplied in pouches is the institutional or food service market for replacing product in #10 cans. Cans are not only costly but take up considerable space, can be difficult to open and dispose of, and incur liability cases from users cutting themselves handling them. Aseptic filling equipment and packaging material suppliers in addition to food processors have advised that #10 cans generally cost about $0.75 per can. They additionally have advised that a comparable pouch costs approximately $0.27. That is an overwhelming difference in cost. For each million cans a food processor uses it would save approximately $480,000 in packaging cost alone.

Another major savings is in floor space. The photograph in Figure 3.7 taken (with permission) at a trade show demonstrates the space required for 832 #10 metal cans compared to the space requirement for 832 pouches in the roll on the bottom left or in one corrugated box on the bottom right of the photograph (B. Pritchard, personal communication, 2010).

Robert Bosch was the first company to develop an aseptic filler for flexible pouches. Bosch supplied a number of aseptic pouch fillers to replace fillers that were using the Dole canning system filling puddings and cheese sauces in #10 cans. The market for cheese sauce exploded with
activity, and today there is hardly a convenience store that does not have a dispenser for aseptic cheese sauces for chips.

Inpaco, DuPont/Liqui-Box, Fres-co, OYSTAR Hassia, and Cryovac all have developed aseptic fillers for pouches that operate at varying filling capacities, size of pouches, handling of different particulate size and technology, such as fitment attachment offered by Fres-co.

As the technology to aseptically process and receive FDA validation for food products containing particulate matter develops, so will the market for aseptic pouch fillers and packaging material. The food service industry will embrace these food products as a wonderful alternative to not only metal cans but also consistent and organoleptically more palatable foods compared to over- or undercooking foods due to human judgment by restaurant cooking staffs.
3.7 Aseptic plastic bottle market

Besides Tetra Pak’s paperboard laminate fillers, the market with the most activity in recent years has been the introduction and installation of aseptic fillers for plastic bottles of polypropylene (PP), high-density polyethylene (HDPE), and polyethylene terephthalate (PET). The beverage industry has embraced the plastic bottle. The first aseptic plastic bottle filler installed in the United States and validated for the filling of low-acid foods was manufactured and installed by Bosch for nutritional beverages. Since then many aseptic bottle fillers have been installed to fill high-acid beverages, whereas others are using their aseptic fillers to fill extended shelf-life, refrigerated dairy products. Many fillers being used in an ESL mode are not FDA validated and therefore cannot be used to fill shelf-stable low-acid beverages.

In all there are nine manufacturers of aseptic filling equipment with installations in the United States; six manufacturers have received FDA validation. In all, there are approximately 75 installations, aseptically filling high- and low-acid beverages including extended shelf-life products. These suppliers include:

<table>
<thead>
<tr>
<th>Bottle Filler Manufacturer</th>
<th>FDA Validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robert Bosch</td>
<td>Yes</td>
</tr>
<tr>
<td>OYSTAR Hamba</td>
<td>No</td>
</tr>
<tr>
<td>KHS</td>
<td>Yes</td>
</tr>
<tr>
<td>Krones</td>
<td>No</td>
</tr>
<tr>
<td>Procomac</td>
<td>Yes</td>
</tr>
<tr>
<td>Serac</td>
<td>No</td>
</tr>
<tr>
<td>Shibuya</td>
<td>Yes</td>
</tr>
<tr>
<td>Sidel–Rotary</td>
<td>No</td>
</tr>
<tr>
<td>Sidel–Linear (Tetra Pak)</td>
<td>Yes</td>
</tr>
<tr>
<td>Stork</td>
<td>Yes</td>
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</tbody>
</table>

Consumer acceptance of the plastic bottle is outstanding and is chipping away at the market for beverages that were previously supplied in paperboard or Brik-type packages. The primary reasons for this acceptance are, but not limited to:

- With plastic bottles, the consumer can see the product
- The bottles fit easier into the cup holders in automobiles
- Bottles are easier to open and easier to reclose
- Bottles can come in many sizes and shapes
- They are easier to recycle
The market for beverages is interesting and very dynamic. It is also quite segmented between high- and low-acid beverages. Initially, beverage processors could justify the capital-intensive aseptic processing and filling system based on the reduced cost of resin compared to a heat-set bottle for hot filling. Initially, this cost difference could be as much as 20% more than a lighter weight bottle used on the aseptic fillers. Over the years the blow molders have improved upon the technology and have reduced the cost of the heat-set bottles to the point that it is now economically more attractive to hot fill high-acid beverages. In a detailed economic comparative analysis of hot fill versus aseptic including, but not limited to, capital cost for processing and filling equipment, bottle cost, utility costs, and operating costs it was calculated that the overall difference between the cost to hot fill versus aseptically filling was less than 1 cent. It is no wonder beverage processors are now returning to hot filling high-acid beverages.

The market for low-acid beverages is quite different. It is almost impossible to hot fill low-acid beverages for shelf stability, therefore aseptic processing of mostly dairy products and some other high-acid beverages is divided between aseptic shelf-stable beverages and extended shelf-life beverages. Although there are a number of aseptic fillers producing shelf-stable dairy products, this is not a growing market. U.S. and Canadian consumers are accustomed to drinking their dairy products refrigerated and prefer them that way. The market growth for low-acid beverages in plastic bottles is in extended shelf-life products. Extended shelf-life products in most cases are processed the same way as aseptic products with the general exception of two differences: first, with extended shelf-life products, the end product must be distributed refrigerated, therefore the filling temperature is approximately 40°F or less; second, the products are normally not filled using an FDA-validated filler. This does not mean the filler is not clean and sterile. It only means the filler more than likely did not go through the validation process. In both cases, the processing system and filler are both presterilized prior to production. With extended shelf-life dairy products processors can generally expect a 90- to 110-day refrigerated shelf life.