Bar Soap Finishing – New Trends in Soap Processing Line Designs and Layouts

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ABSTRACT

Bar soap finishing lines are available in a number of configurations; depending on the nature of the product mix, either a high-speed 3- or 4-plodder system or a versatile specialty line is indicated. We describe some examples of each type, with emphasis on the use of a soap pilot-plant line to assist in the selection.

INTRODUCTION

During the past 15 years, extensive changes have occurred in the design and layout of finishing lines. Several causes for these changes exist, including (a) the need for faster and more efficient production rates, (b) development of high additive soaps and more complex shapes, and (c) introduction of marbleized soaps.

The outstanding development of the past few years has been breaking the traditional line speed barrier of 150-200 bars per minute (bpm). New high speed stamping machines have been developed which can produce up to 400 bpm of banded or bandless bars, and other equipment has reached the 300 bpm stage.

HISTORICAL

For many years continuous soap production lines have included the following operations:

1. *Amalgamation,* to add perfume, color, and other minor ingredients to soap chips or pellets, using a mixing vessel called an amalgamator.
2. *Refining,* to complete the mixing and make the soap more uniform, using either a refining plodder or one or more 3-, 4-, or 5-roll mills.
3. *Compacting and extruding,* to compact the soap and deliver a continuous log of soap to be cut, using an extruding (finishing or final) plodder.
4. *Cutting* into individual slugs of soap suitable for pressing.
5. *Pressing* into soap cakes (or bars) with an identifying logo and a desirable shape.

To one familiar with modern soap-plant practice, it is apparent that these same operations are employed today; only the design of the equipment and the line configurations have changed. The layout of modern finishing lines, their components and their rationale, is the subject of this paper.

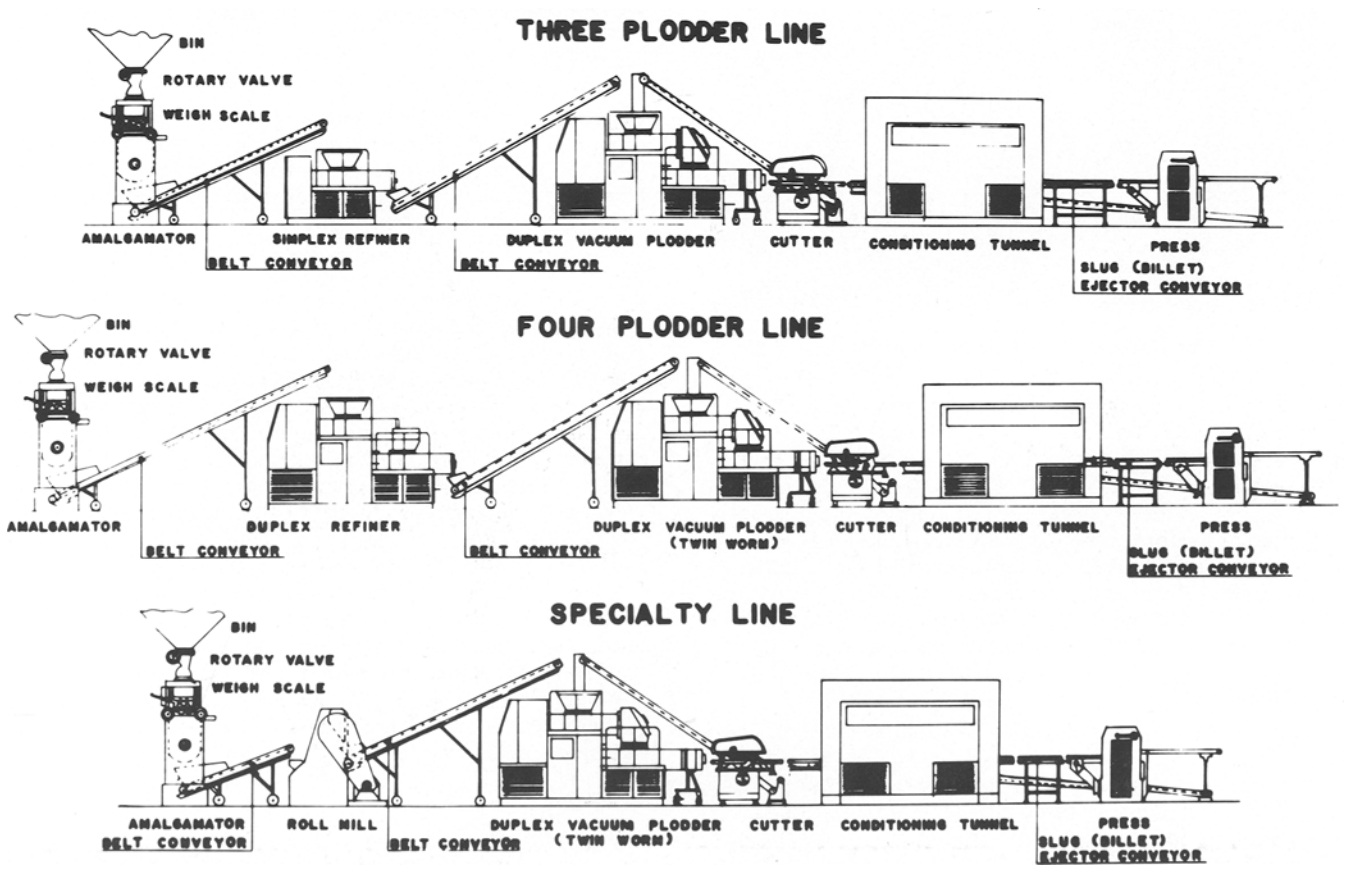

FIG. 1. Modern soap finishing line configurations.

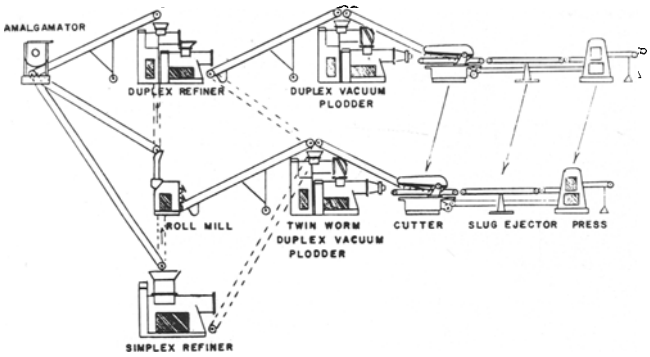

FIG. 2. Flexible pilot line schematic.

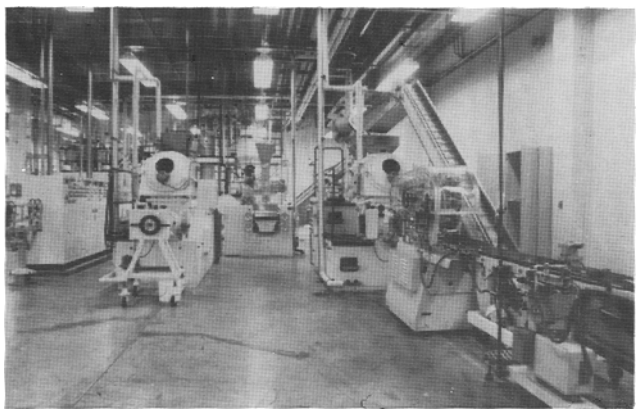

FIG. 3. Pilot plant photo.

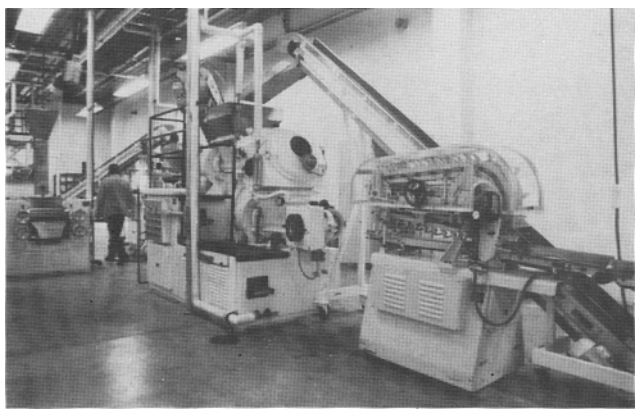

FIG. 4. Duplex vacuum plodder and cutter.

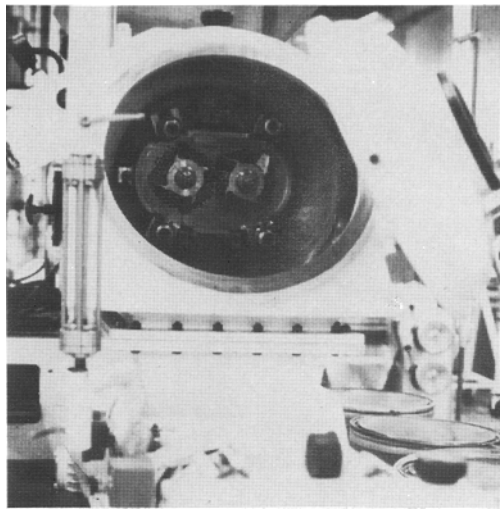

FIG. 5. Twin worm plodder.

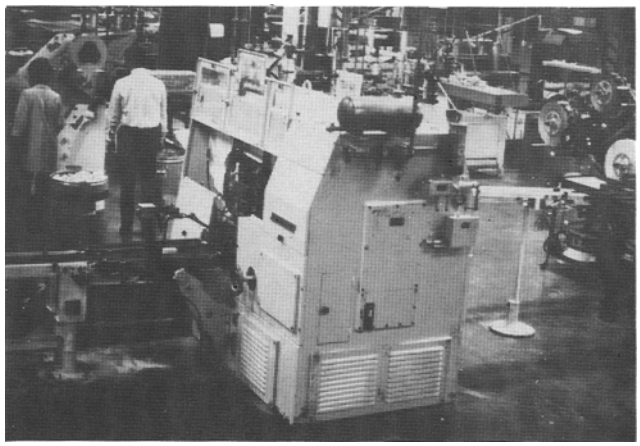

FIG. 6. High-speed press.

MODERN LINE TYPES

The types of line most often employed in the modern soap plant fall into two categories:

1. High-speed lines for production of relatively simple or uniform type bar soap formulas.
2. Specialty lines for production of very high quality toilet soap and for more complex formulations (synthetic detergent bars, soap-synthetic bars, translucent soaps, and highly superfatted soaps).

High-Speed Lines

First let us review optimum configurations for high-speed production.

Three-plodder system: For soap bars produced at a rate of 150-200 bpm, a three-plodder configuration is frequently used. In this discussion, plodders are emphasized because they have the primary influence on production rate and product quality. Plodders are available to perform three functions: pelletizing, refining, and extruding. On the three-plodder line, two plodders will be fitted with fine screens (50 U.S. Mesh or 55 European, with openings of 0.3 mm diameter) through which the soap is forced; these are called refining plodders. A third plodder compacts the soap into a uniform plastic mass and extrudes it as a continuous log of soap to be cut and pressed; this plodder is the extruder. In the actual 3-plodder high-speed line shown in Figure 1, a simplex refiner is followed by a duplex vacuum plodder.

Four-plodder configuration: Soap bars produced in the 200-300 bpm range are usually processed through a 4-plodder configuration (although not exclusively), with the first three plodders serving as refiners and the last as an extruder (Fig. 1). Again, the actual configuration shown is a duplex refiner followed by a duplex vacuum plodder.

To achieve high production rates, very large plodders (4000-5000 kg/hr) are required. The plodders use worm diameters of 300-400 mm and are available in either single- or twin-worm designs. Dual extrusion systems are frequently employed to lower linear exit speeds and to eliminate the need for press diverters.

This description of two types of high-speed lines (3-plodder and 4-plodder) is by no means intended to be all-inclusive. Many manufacturers still employ roll mills on high-speed lines as an alternative to refining plodders.

Specialty Lines (Fig. 1)

The purpose of a specialty line is to provide flexible processing capability so that a variety of toilet bar formulations can be produced at reasonable speeds. Typically,

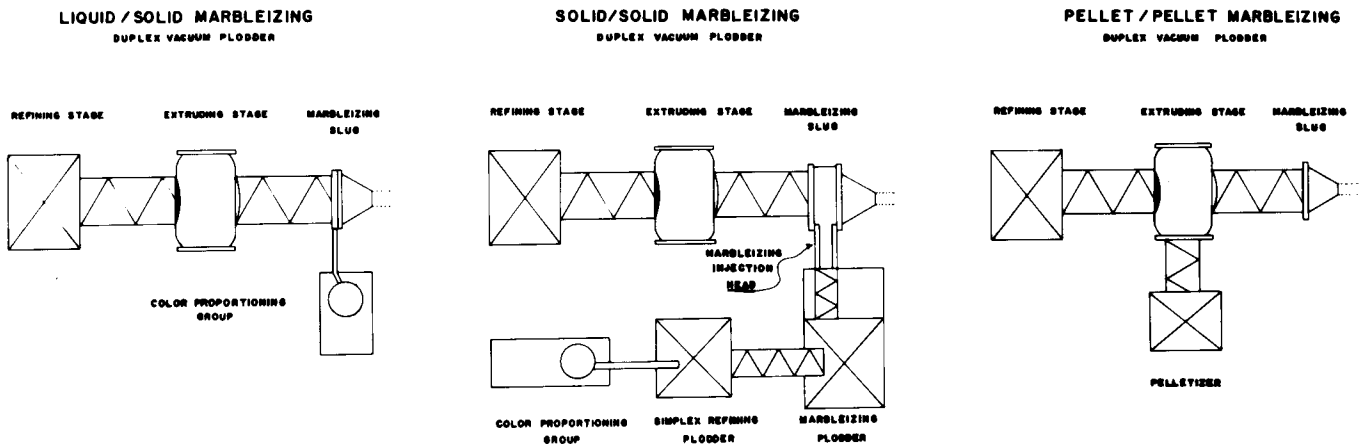

FIG. 7. Marbleization process diagrams.

specialty lines contain more refining stages than high-speed lines, either in the form of roll mills or refining plodders. The line shown is a mill line, with one 5-roll mill added to a duplex vacuum plodder system. Specialty lines also may contain twin-worm plodders to process synthetic detergent bars or other sticky compositions.

An idealized specialty line would have optional equipment in position for use when required. An example of a fully flexible specialty soap line in somewhat diminished scale is the Armour-Dial soap pilot plant (Fig. 2) which is designed to study many types of finishing line configurations. This line contains an amalgamator, duplex refining and duplex vacuum plodders (200 mm diameter), a cutter, and a press. Connected to this line by movable conveyors are a 3-roll mill, a simplex refiner, and a twin-worm duplex vacuum plodder for compositions which are hard to process. A view of this line is shown in Figure 3. Thus we can operate in the following modes: (a) four-plodder line, (b) three-plodder line, (c) mill line, (d) any of the first three using the twin-worm duplex vacuum plodder.

Obviously, other operating modes are possible with the variety of equipment available, but few are used in actual soap plant practice.

Should the question arise as to what type of line configuration to install in a new soap plant, the following factors must be considered: (a) What product mix will be produced? (b) What production rate is needed? (c) What quality is expected?

FACTORS IN SELECTING A CONFIGURATION

Product Mix

If more than one type of soap is to be produced such as soap-synthetic bars, superfatted soap, translucent soap, etc., then flexibility in the form of optional added refining capacity should certainly be included in the finishing line. If a single product type is required, then a much simpler line configuration is better.

Production Rate

Rate is essentially determined by the size of the plodder and the capacity of the stamping press employed, so correct plodder sizing is important. Production plodders with diameters from 200-400 mm and lines rated at 100, 200, and 300 bpm are available. Market demand and labor costs are also major considerations in deciding what production rate to incorporate.

Quality

Finished bar quality is closely related to the number of refining stages employed using either refining plodders or mills. High quality soap requires a larger than normal number of refining steps, as do formulations which tend to be sticky. In general, three or more refining steps give highest quality in the finished bar. Conditioning tunnels or refrigerated stamping dies are often employed to improve stamping and to assure excellent appearance in the finished bar.

FINISHING UNITS AND THEIR FUNCTION

Amalgamator

Of the required finishing line equipment, the amalgamator (generally a horizontal helical-blade mixer) is of some interest. In a fully automated soap plant, the amalgamator is the only batch operation, although even the batching steps can be automated. Soap is weighed into the amalgamator intermittently, dosed with controlled amounts of perfume and with "minor" ingredients (color, antioxidant, opacifier, germicides, etc.), frequently in the form of a slurry, mixed to roughly distribute these ingredients in the soap, and discharged on the belt feeding the first-stage plodder.

Auxiliary equipment feeding the amalgamator can range from rotary valves over a closed amalgamator to a weigh-belt feeding an open amalgamator, and from automatic gravimetric or volumetric dosing systems to manual dosing of powders and liquids.

Plodders

To obtain good continuous production, the soap plodder, of course, is a necessity. Basic plodder design (a motor-driven, hopper-fed, screw extruder) has been in use for many years, but modern versions are available to perform the functions of refining, pelletizing, and extruding. A modern duplex refiner is shown in Figure 4. A duplex is simply a tandem arrangement of two simplex refiners. To have a properly compacted bar, a duplex vacuum plodder is required. Plodders are available in twin-worm designs in addition to the usual single-worm arrangement, and a view of a twin-worm plodder is shown in Figure 5.

Cutters

The soap cutter is designed to divide the continuously extruded log of soap into individual "slugs" of an appropriate size to fit the press. Two types of continuous cutters are available, with either manual or automatic chain adjustment.

Presses and Stamping Dies

Two types of stamping presses have been available for some time. They are: (a) vertical motion pin die presses capable of pressing pillow-shaped bars at 100 bpm, and (b)

horizontal motion presses rated at 200 bpm of brick-shaped bars. New highly sophisticated and adaptable horizontal motion, modern presses are available (such as the Mazzoni Model STUF Quater, Fig. 6), which can produce side-banded bars at 400 bpm and unusual shapes with or without side bands at 200 bpm. Unfortunately, end packaging equipment does not yet match the 400 bpm rate unless used in tandem. Conversion between bar types of these modern presses is accomplished simply by changing die sets and supports. Again, a highly flexible press should be used on specialty soap lines producing several types of bars, while simpler machines are available for use with finishing lines devoted to processing a single bar type.

The use of refrigerated stamping dies operating at -20 C has become standard in the industry. They serve to improve product appearance, to lessen die-fouling, and to improve production rates. Their use has minimized the need for conditioning tunnels.

Conditioning Tunnels

Conditioning tunnels are available in both refrigerated and nonrefrigerated types and are designed to cool the external surface of the soap by passing a stream of air over it to facilitate pressing. This is particularly useful with "sticky" bar formulations (soap-synthetics, highly superfatted bars, etc.).

MARBLEIZING TECHNIQUES

We define marbleizing as any process which creates a nonuniform bar color. Essentially, equipment to marbleize soap can be categorized as liquid injection or solid injection equipment. Marbleizing is usually accomplished via auxiliary equipment attached to the final finishing plodder.

The type of marbleizing desired determines whether liquid or solid injection is chosen. If streaks of dark color on a light-colored (not white!) base are desired, use liquid injection. Figure 7 shows schematic representations of marbleization processes. If strong, wide parallel stripes of dark color and white are desired, solid injection into the compression cone by a commercially available unit is indicated. If nonuniform narrow bands of dark color on white soap are desired, then a system using pellet injection into the vacuum hopper of the final stage is best.