

## NCW 2002: Chemistry Keeps Us Clean

## Chemists Clean Up: A History and Exploration of the Craft of Soapmaking

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## How Soap Came to Be Common in America

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Soap is an article whose commonplace presence and obvious necessity we take for granted. It was not always so. For most of American history bath soap was a luxury product. Its eventual transformation into a ubiquitous and well-used commodity required a confluence of cultural and technological changes.

These changes can be divided into two broad and intersecting themes. First, there was a gradual filtering downward through the social scale of elite notions of personal hygiene and general cleanliness. Those below voluntarily adopted the cultural values of those above them and imparted subtle changes to them. Far more important were the efforts of upper- and middle-class reformers to impose new and more stringent standards of both societal and personal cleanliness. For these reformers, clean streets and clean bodies were of a piece.

These changes were aided by the second broad theme, the rise of an industrially-based consumer economy capable of putting more and better cleaning products into the hands of an ever-increasing percentage of the American population. In the process, soapmaking was transformed from an artisan's craft into a major industry. In part this was a larger question of fostering a culture of cleanliness through advertising and other means, encouraging consumers to use this product. Over the course of the century between 1860 and 1960, these two themes combined to produce the modern soapmaking industry.

## Cleanliness Next to Impossible

Prior to the Civil War, the majority of Americans did not consider personal cleanliness to be a priority. The elaborate codes of bodily behavior adopted by the 18th-century gentry focused more on carriage and action than on well-scrubbed hygiene, far more attainable goals given the practical realities of American life well into the 19th century. Ordinary Americans by and large ignored even these. The early 19th century was, as Juliann Sivulka remarked, the tail end of a long and grubby period in Western Civilization—"one thousand years without a bath" (1-3).

In a sense, this situation suited the art of soapmaking in America at the time. More demand simply could not have been met by the small-scale artisan soapboilers who plied their trade, let alone by the housewives who made most of the soap in early America. Soapmaking was an arduous and capricious affair that relied on good weather, trial, error, and a hefty dose of superstition. One Pennsylvania Dutch recipe, for example, advised that the soap kettle be carefully stirred



Figure 1. Soapmaking in colonial days was long, hard, and smelly work. The woman shown is stirring the raw soap mixture over a fire outdoors. (Illustration from Alice Morse Earle's "Home Life in Colonial Days" used by permission of Berkshire House Publishers.)

with a sassafras stick, in one direction only (4).

Soapmaking typically took place in the spring, when a winter's worth of fat scraps and hearth ashes were available. To make one barrel of soap took roughly six bushels of ashes, 24 pounds of fat, and a long, hot, and laborious day outdoors. Fats had to be rendered, a smoky, foul-smelling, high-temperature process that liberated the fats from the connective tissues in the raw fat. The rendered fats, typically ready before soapmaking day, would then be combined with what was called "lye," an impure solution of potassium hydroxide obtained by repeatedly pouring water through a barrel of ashes until the water was sufficiently concentrated with alkalis. This concentration was roughly three molar, versus the eight molar NaOH solution used by modern homemade soapcrafters, and it was ready when it would "bear up an Egg or a Potato so you can see a piece of the Surface as big as a Ninepence" (4).

The fat and lye solution was stirred and heated for six to eight hours over an open flame. The resulting soap was a soft, clear jelly-like substance primarily used for the monthly (or quarterly!) laundry day. Hard soaps were made by adding salt to the reaction near the end of the boiling phase, though this luxury was uncommon since salt was costly and needed for other household activities. The salt facilitated the exchange of potassium ions for sodium ions, yielding a floating soap curd that was skimmed off, pressed into

molds and then cut into bars after a few days of hardening. These methods were clearly small-scale and suited to an era that did not consider personal hygiene a priority.

### Civil War Turns the Tide

It was the legacy of two wars that would turn American culture toward cleanliness. The first was the Crimean War of 1854–1857, a bitter struggle in which the overwhelming majority of British dead perished of disease rather than combat injuries. That such deaths decreased markedly when the British nurse Florence Nightingale instituted hygienic reform in field hospitals deeply impressed many Americans, and when the American Civil War broke out four years later, there were calls to put the lesson learned in the Crimea to good use. This was done, exposing thousands of ordinary American men to the idea of regular bathing and the use of soap, practices from which they saw concrete benefits and with which they would return to their homes. It also created a dedicated corps of elite reformers, flush with wartime success and eager to bring their experience to bear on civilian life (2, 3).

These Civil War reformers and their late-19th- and early-20th-century heirs introduced a new culture of cleanliness to America, both on societal and personal levels. On a broad scale these reformers aimed at no less than the cleansing of American life, including water systems, streets, and even entire slums. These efforts, coupled with the broader experience of the Civil War soldier with soap and

hygiene, led to a greater cultural emphasis on personal cleanliness as well. Indoor bathrooms and the bedroom washstand became more popular during this period, and soon bathing, and the concomitant need for hard soap, became a fixture in American life (2, 3).

### Scaling Up

A great deal of effort went into convincing the mass of Americans that they should be cleaner than they were. Reformers preached the gospel of personal hygiene and soap use in places as diverse as settlement houses, schools, and factories (2, 3). More important than these efforts, however, was the soapmaking industry's pioneering use of advertising.

Soapmakers were among the first to realize the potential of ideas such as branding, packaging, and focused advertising. In an era when most consumer products were sold in bulk, they began to produce individually labeled bars and to seek brand recognition. By 1904, Procter & Gamble (P&G) was spending more than \$400,000 per year in advertising, a staggering sum at the time. Soap advertising, and advertising in general, reached new heights in the 1920s when corporations began to view overproduction as a form of underconsumption. By the end of that decade, advertising had vastly increased the market for soaps, and soapmakers had had to increase their production to match (3).

Soapmakers had been hard at work modernizing their industry to keep pace with demand since the 19th century. For most of the period under examination here, this simply

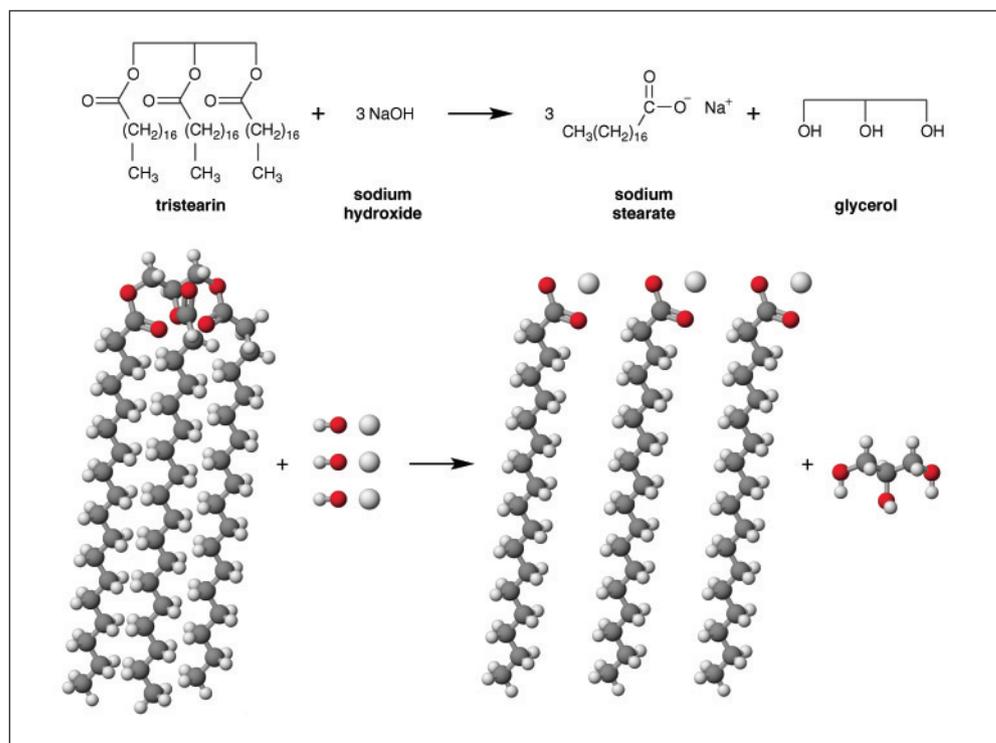


Figure 2. In the classic soapmaking reaction, tristearin, a saturated fat, reacts with three equivalents of sodium hydroxide to produce three sodium stearate "soaps" plus glycerol.

Structures rendered by Randall J. Wildman, using CACHE 4.0.0 software.

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meant scaling up the old methods. For example, when William Procter and James Gamble of Cincinnati began business in 1837, they made “twelve frames [of soap] a week—each frame weighing 1000 pounds”, which they cut into two-pound bars. By the 1870s, however, production had increased almost a hundred-fold. By 1930, P&G made soap in boilers three stories tall, each large enough to make enough soap to fill seven boxcars (5, 6).

There were several factors that made this growth possible, notably the increased availability of purer alkalis and saponifiable fats. In the mid-19th century most soaps were made with soda ( $\text{Na}_2\text{CO}_3$ ), potash (crude  $\text{K}_2\text{CO}_3$ ), or pearlash (purified  $\text{K}_2\text{CO}_3$ ) obtained either through the old method of leaching ashes or through the LeBlanc Process, which produced soda from brine and sulfuric acid. The  $\text{Na}_2\text{CO}_3$  was “causticized” by the action of  $\text{Ca}(\text{OH})_2$  (slaked lime) to produce  $\text{CaCO}_3$  and  $\text{NaOH}$  (caustic soda). For commercial purposes the LeBlanc Process was superseded by the Solvay Process after 1865. The Solvay Process requires several steps involving the conversion of  $\text{NaCl}$ , ammonia, and carbon dioxide into  $\text{NH}_3(\text{aq})$  and  $\text{Na}_2\text{CO}_3$ . From the chief manufactory located on the shores of Onondaga Lake near Syracuse, NY, came a ready, pure, and inexpensive source of  $\text{NaOH}$ , allowing freedom from dependence on foreign imports and offering a boost to the American soap industry of the 1880s (6–8).

At about the same time, the supply of fats broadened as world markets opened up and the modern oleochemicals industry was born. Beginning in the 1860s coconut, palm, and whale oils were imported in large quantities into the United States, with cottonseed oil becoming a player in the 1890s and early 1900s. Cottonseed oil became even more important when P&G’s research laboratories began to work on the catalytic hydrogenation of fats in 1908 (a process whose European patents had been granted five years earlier). This led to the development of commodity-quantities of solid, hydrogenated cottonseed and other oils useful for soapmaking, not to mention Crisco, a popular shortening launched in 1912 (6).

Throughout this period, soapmakers introduced new products designed to capture the expanding market for cleanliness. Colgate introduced Cashmere Bouquet, the first American perfumed toilet soap, in 1872 (9), and seven years later Procter & Gamble introduced Ivory Soap, the product of a happy accident in which overstirring a batch of soap made it float in water (5). Demand for soap flakes and powders for faster laundry washing also encouraged new soap products, and pushed the industry to develop hollow soap granule technology.

### An Industry Revolutionized

These improvements were simply larger and more efficient variations of the same old methods, however. In the 1930s two developments changed soapmaking on a more fundamental level. The first was the discovery of synthetic

detergents. Detergents solved many heavy-duty cleaning problems, had superior wetting properties, and worked particularly well in hard water, which soap did not do. DuPont and P&G launched the American detergent industry in 1932. Dreft, the first commercially available detergent, appeared a year later, and the following year Drene, the first detergent-based shampoo, made its debut (6).

The second development was the factory-scale hydrolyzer, which P&G patented in 1939. The process itself had been understood since the 1820s (10), but it had taken more than a century for chemical and engineering teams to be able to hydrolyze fatty acids from the glycerol backbone of the fat molecule on an industrial scale.

In stainless steel towers 65 feet high, a hot mixture of fats and oils, selected according to a given soap formula and containing a catalyst, was pumped in near the bottom of the tower. Scalding water dropped from the top in a counter-current flow against the rising fats, which split as they rose. The fatty acid was carried off in a continuous stream, while the water washed the glycerin out (6).

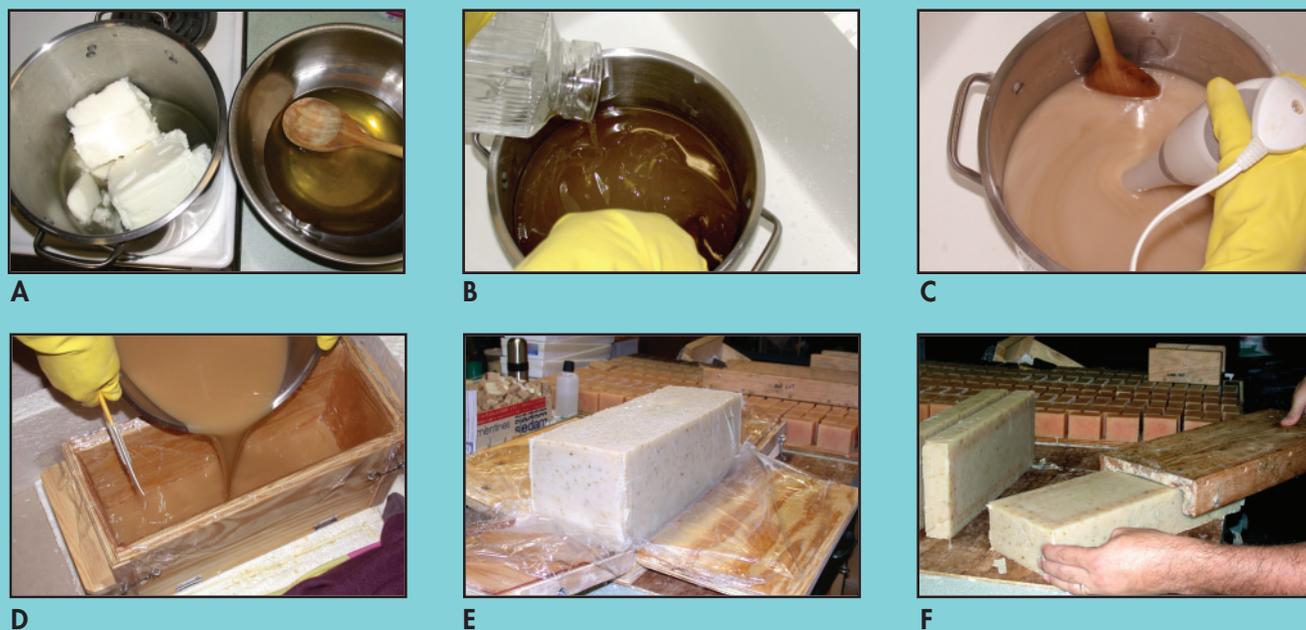
The next step was the neutralization of the fatty acid with carefully titrated amounts of sodium hydroxide to form neat (raw) soap almost instantaneously. The neat soap would then travel to the crutcher, a kind of specialized mixer, to be mixed with builders, fragrances, and other ingredients suiting the particular kind of soap. This continuous process cut the time needed to make a batch of soap from two weeks to 24 hours. Additional gains were made in purity, waste reduction, scientific process control, and space requirements (6). Since this breakthrough, the soapmaking industry has not changed significantly in how soap is made, but has focused mainly on novel ways to process the neat soap, or in customized blends of fatty acids, alkalis, and additives for uses in new products such as liquid and antibacterial soaps.

### Handcrafted Soap

In recent years, though, there has been an upsurge in a new, or rather an old, form of soapmaking: homemade cold-process soap. Cold-process soap is made without boiling, generating its own heat from the saponification reaction, and it tends to be made in small batches. If you would like to try cold-process soapmaking on a small scale, this *Journal* has published a Classroom Activity on cold-process soapmaking adapted for the teaching laboratory (11). It marks an odd return to its beginnings for the soapmaking industry. As the proprietors of our own small soap company, we heartily applaud this trend, even as we enjoy knowing our place in the long history of soapmaking in America.

### Supplemental Material

A glossary of historic terms for the chemistry of soap is available in this issue of *JCE Online*.



photos by K. L. Kostka

Figure 3. A series of photos showing cold-process soapmaking. A: Solid soybean shortening and coconut oil (left) will be melted, then combined with olive oil (right) in a stainless steel vessel. B: An 8 molar lye solution is slowly stirred into the melted oils when the temperatures of oils and lye solution are about 38 °C. C: After the lye is mixed with the melted oils, a handheld blender is used to improve mixing and reaction rate. D: When the raw soap is the consistency of a loose pudding, it is poured into a mold where it will be covered with blankets for about 48 hours. E: Once the cold-process soap is freed from its mold, it is the consistency of cold cream cheese and is ready to cut. F: Cutting a block of soap into smaller pieces with a wire cutter.

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