THE USES OF SILICONES IN THE DAIRY AND FOOD PROCESSING INDUSTRIES

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Silicones as new synthetic materials are rapidly becoming useful for dairy and food processing and for maintenance of plants and equipment. Silicone defoamers are acceptable for food use and are effective in concentrations of 1 to 10 parts per million. Silicone release agents of various types prevent sticking of food to paper, to baking pans or to heating coils. New silicone glass container coatings, applied at the glass factory, preserve the strength of glass to reduce breakage and speed production packing. Maintenance materials include silicones for heat stable points, silicone electrical insulation for resistance to heat and humidity, silicone rubber for flexible seals and silicone grease for high temperature lubrication.

Silicones as production aids and as maintenance materials have been well accepted in the food and dairy industries. Silicone defoamers, acceptable for food processing, are effective at concentrations of 10 parts of silicone per million parts of foaming material. This small amount of silicone defoamer permits increased production capacity with present equipment, decreases processing time, upgrades the quality of production and permits the saving of material sometimes lost as foam.

Other silicone materials are widely used as release agents for sticky food products. Silicone treated paper, for example, provides clean release for candies, frozen meats, bakery goods and other foods. Silicone resin coatings baked on bread pans facilitate easy removal of bread without the use of grease. Grease-like silicone applied to processing equipment and container surfaces prevents burn-on of foods and makes such equipment more easily cleaned. Odorless and tasteless silicone rubber coated on conveyor belts provides a surface that will release either hot or cold materials without sticking.

Food processors using glass containers should have a real interest in a recently developed silicone coating being applied by some glass manufacturers. This silicone surface coating helps prevent breakage of glass containers by reducing scratching. High speed packing lines run smoothly with fewer interruptions. Profits are increased by reducing breakage in packing, shipping and handling.

Thus far we have only discussed silicones as production aids. Maintenance of a food processing plant can be materially reduced in both cost and effort by proper use of silicones. Silicone paints on ovens, boilers, exhaust stacks and steam lines withstand high temperatures and require minimum maintenance. Silicone electrical insulation provides overload protection and resistance to heat and humidity in essential electrical motors. Silicone rubber provides a heat stable, odor-free, and taste-free gasketing material for sealing cookers and other processing kettles. Silicone greases provide lubrication for bearings operating at high temperatures or in the presence of excessive moisture and heat.

Silicones are even used by the dairy farmer as a veterinary medicine to treat frothy bloat. Such medicines are available from most reliable veterinary drug houses. Silicones are also used in medical and cosmetic materials because of their chemical inertness and for the water repellent protective coating they provide the skin.

1Presented at the 42nd Annual Meeting of the International Association of Milk and Food Sanitarians, Inc. at Augusta, Georgia October 3-6, 1955.
WHAT ARE SILICONES?

Silicones are a whole new field (1) of man-made chemical polymers. By varying molecular structure, they may be produced as fluids, greases, resins, or rubber. All silicones are characterized by unique heat stability, resistance to water, and exceptional anti-stick or release properties. In addition, some have an extremely low order of toxicity and have been found suitable for use in food processing.

FOAM CONTROL WITH SILICONES

The agitation, mixing, and pumping of food and dairy products often creates severe and troublesome foam. Two commercially available silicone defoamers (2) are gaining widespread acceptance for use in controlling such foaming problems. One defoamer is a 100 per cent silicone solids material\(^2\) that may be dispersed on dry solids such as sugar, salt, powdered milk or inert powders and added to the foaming system. A mixture of 5 parts by weight of this silicone properly mixed with 95 parts by weight of salt will result in a dry, free-flowing powder. The 100 per cent silicone defoamer is also wiped on the sides of vessels above normal liquid level to control foam as it rises above the liquid. Other users suspend the defoamer in a gauze sack over systems to contact the foam as it rises. Wiped onto filling nozzles, this defoamer also helps prevent loss of fluids that foam in high-speed filling operations.

The 100 per cent Antifoam Compound has been used in the cooking of jams, jellies and preserves; defoaming maple, cane and corn syrup; processing and fermenting of cattle food, processing grain for vitamin production; and dry mixed with instant coffee powder to prevent foaming when re-constituted.

The second and perhaps more versatile silicone defoamer is a water emulsion containing 30 per cent silicone solids emulsified with acceptable food grade emulsifiers.\(^3\) This defoamer can be diluted with equal parts of water and added to foaming systems from a drip-feed system or can be added to the ingredients with each batch.

The silicone emulsion is particularly useful in defoaming such frozen dairy confections as are molded on stick handles. One user reports the addition of 34 parts of this defoamer per million parts of mix produces less foam in the mix and higher production of uniformly molded bars on the stick. He adds the defoaming emulsion with the ingredients of each batch. In producing dry skim milk, evaporation has been aided by using this silicone defoamer. In evaporating whey from cottage cheese or in pumping whey into storage or drain tanks, this silicone emulsion has been effectively used to control foam.

Professor S. R. Skaggs, head of the Dairy Department of the New Mexico College of Agriculture and Mechanic Arts, reports that he successfully uses the silicone emulsion to defoam detergents used to clean milk equipment and milk pipeline. In this application, 1 part of the emulsion is diluted with 2 to 3 parts of water and placed in a small force-feed oil can. As the detergent solution for cleaning is mixed, 1 to 2 squirts from the oil can are added as needed to prevent excessive foaming. Professor Skaggs believes this would be a satisfactory method for applying the defoaming emulsion in dairy plants or on farms.

The 30 per cent silicone emulsion is also used to defoam cooling brine in re-circulating brine systems. Users report that the addition of 2 to 10 parts by weight of the emulsion per million parts of the brine provides efficient defoaming for several months.

Other defoaming applications in the food industry include the use of the emulsion in yeast production, processing tomato sauce, producing flavor concentrates, cooking pickles, processing sauerkraut, defoaming starch extracted from processing green peas, and as an ingredient of ice cream cones.

Both silicone defoamers, the 100 per cent solids and the 30 per cent emulsion, have been used in dairy and food processing for several years. Pre-

\(^2\)Dow Corning Antifoam A
\(^3\)Dow Corning Antifoam AF Emulsion
liminary toxicological studies completed in 1948 (8) indicated that the defoamer was non-toxic. Extensive feeding tests were then run to substantiate this finding. Two-year feeding tests on rats (9) indicate that concentrations 300 times greater than 10 parts per million have no adverse effect. Dr. A. J. Lehman (6) reports, "A methyl polysilicone, also called Dow Corning Antifoam A, is a chemically inert material and, as the name implies, is an antifoaming agent. The toxicological data which have been submitted appear to show that the material is relatively non-toxic by oral administration. We have seen no reason to object to its use to suppress foaming when the quantity employed does not exceed 10 parts per million.” This figure of 10 parts per million represents less than 12 ounces in a standard 8,000-gallon railroad tank car.

PREVENTING BURN-ON OR STICKING OF FOOD PARTICLES WITH SILICONES

Silicones are excellent release agents. Several different physical forms have been developed that are particularly useful in food and dairy processing. Silicone treated parchment or paper, treated at the paper mill, provides a clean, low cost, disposable release surface (7). Properly processed silicone treated paper is such a good release surface that even plastic tape will not stick to it. This silicone release paper is widely used as a disposable surface for candy making, for wrapping sticky candy, as a separator for frozen meats, as a baking surface for bakery sweet rolls, and in many other packaging and wrapping operations.

A silicone resin coating has been widely used on bread pans in commercial bakeries (4, 7). This resin prevents the sticking of bread in the pan during baking. Its use eliminates or reduces the need for pan grease and thus helps to keep bakeries cleaner. The resin is sprayed from a solvent solution onto the clean, dry pan and baked in a high temperature oven. Application of the resin may be done by the pan manufacturer, by the baker, or by companies that specialize in applying such coatings. Properly applied, the resin coating will last for two-hundred bakings before it must be reapplied.

Another silicone release agent has the consistency of a soft paste. This soft grease can be applied to heating surfaces of food processing equipment to prevent foods sticking to the container. For best results, the grease should be rubbed in or buffed onto the surface with a soft buffing wheel. Such a coating makes heating surfaces, steam coils, kettles, and cooking vessels easy to clean and easier to keep clean. It also reduces the amount of material lost on the sides of the kettle. This easy-to-use release agent should be in every plant or factory. This silicone material is also an excellent rubber lubricant for installing tubes or hose on a metal pipe. It is a good valve lubricant for high temperature operation and is also useful for release of hot irons for heat sealing plastic film.

Conveyor belts coated with silicone rubber provide a surface for releasing either hot or cold foods without sticking. The silicone rubber can be used over a temperature range of -70°C to 250°C without failure. Another advantage of the silicone rubber coating is that it is also odorless and tasteless and will give the food no odor or off-flavor.

NEW SILICONE COATING FOR GLASS

The newest silicone for food processors is a sili-

\[5\text{Dow Corning Pan Glaze}\]
\[6\text{Slipicone}\]
\[4\text{Kalamazoo Vegetable Parchment, Kalamazoo, Michigan; Minerva Waxed Paper Company, Minerva, Ohio; Riegel Paper Corporation, Milford, New Jersey.}\]
Aerosol bottles were dropped 4 feet onto a concrete floor. The silicone treated bottle withstood 5 to 6 more drops onto the concrete than the untreated containers. On pendulum impact tests, the treated bottles withstood 15 per cent more impact than untreated bottles.

In production line tests, 75,000 sulphured beverage bottles were compared to 75,000 silicone treated bottles. The breakage for the sulphured bottles was 0.5 per cent as compared to 0.04 per cent for silicone treated bottles, or 12 times as great.

Glass packing production lines using silicone treated bottles can be run with greater efficiency, less down time and reduced cost from breakage.

**Silicones for Maintenance**

Silicone paints stand out from ordinary protective finishes for their resistance to heat and to moisture. (5) They have been used as maintenance paints on ovens, boilers, and steam lines. Silicone aluminum paints, for example, have given excellent service at temperatures up to 535°C. (1000°F.). Pigmented silicone paints have slightly lower heat stability. Best adhesion is obtained by sandblasting the surface to bright metal, applying a silicone primer and then

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*Figure 3. Addition of silicone antifoam agent in the preparation of a frozen skim milk confection reduces foam and assists in uniform filling of the freezing molds.

*Figure 4. Silicone treated glass bottles reduces scratching of the glass and increases life of bottles. (Courtesy of Brockway Glass Company)*

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<table>
<thead>
<tr>
<th>Bottle type</th>
<th>Plain</th>
<th>Silicone treated</th>
<th>Per cent improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 oz. Aerosol</td>
<td>456</td>
<td>480</td>
<td>9</td>
</tr>
<tr>
<td>24 oz. Juice</td>
<td>185</td>
<td>237</td>
<td>28</td>
</tr>
<tr>
<td>12 oz. Beer CB</td>
<td>294</td>
<td>560</td>
<td>87</td>
</tr>
<tr>
<td>12 oz. Beer NB</td>
<td>224</td>
<td>278</td>
<td>24</td>
</tr>
<tr>
<td>12 oz. Beer Ex</td>
<td>349</td>
<td>429</td>
<td>23</td>
</tr>
<tr>
<td>14 oz. Ketchup</td>
<td>308</td>
<td>474</td>
<td>54</td>
</tr>
</tbody>
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Dow Corning EF-4010 — Dow Corning Z-4141
the silicone finish. The finish can normally be baked by operation of the equipment.

Air-drying modified silicone finishes are also being investigated. Such finishes sacrifice some of their heat stability in the modification. Modified silicone finishes are useful at temperatures up to 225°C.

Silicone electrical insulation (10) is being more widely used in food and dairy production plants. Silicone insulated motors can be obtained from several motor manufacturers or standard motors can be rewound with silicone insulation. Silicone insulated motors have a capacity up to 50 per cent higher than the same size motor with standard Class A insulation. Silicone insulated motors are more resistant to heat and moisture than motors insulated with any other class of electrical insulation.

A large baby food manufacturer, insisting on absolute cleanliness, washes off all machines, electrical motors and equipment twice daily. On 3 to 30 horsepower Class A open frame motors they had motor failure in 6 to 8 weeks. These motors were rewound with silicone Class H insulation in 1952. Such excellent results were reported that eleven more motors were rewound with silicone insulation. All of these silicone motors are still in service, resisting the combination of heat and moisture.

Silicone lubricants offer many advantages to food processors. Silicone grease is used in the bearings of food carts or trucks that are exposed to temperatures up to 125°C, in steam autoclaves (3). Reports show that only one to two greasings per season is required to provide good lubrication and to prevent corrosion of the wheel bearings. Because of its high temperature stability and usefulness to 250°C, this silicone grease is also used in slow speed conveyor bearings operating near ovens or in other hot spots.

Silicone rubber is now being widely used for oven door gaskets. This heat stable rubber withstands temperatures up to 250°C for long periods of time. This silicone does not soften at high temperatures. It is being used for gasketing steam kettles and sterilizers. Silicone rubber bottle nipples for baby feeding have been well accepted. In hospital tests where sterilization is rigidly controlled, the silicone nipples lasted more than 5 times longer than the best organic rubber nipple. In this period the silicone nipple did not lose its shape or become discolored from sterilization. There is a good possibility that silicone rubber would be a cost saving replacement for rubber parts of automatic milking machines that must be sterilized.

For exterior of masonry buildings, clear silicone water repellents are a worthwhile maintenance material. The clear solution is sprayed or flooded onto the clean, dry brick or cement surface. The silicone penetrates the masonry from ⅜ inch to ⅜ inch to provide an invisible water repellent surface. Such a treatment minimizes white staining from leached salts in the mortar. It also protects the masonry from freeze-thaw cracking and helps prevent water seepage through above grade masonry walls. The use of this silicone in milk houses, in dairy plants and in food plants helps to keep above grade walls clean and dry.

Silicones are also used as a water repellent treatment for leather(10). This silicone treatment is applied to leather at the tannery to produce shoes that are durably water repellent yet permit the leather to breath. Another silicone leather water repellent(11) is supplied for home application to shoes. Either of these treatments helps keep the leather dry and preserve shoes at the same time. The silicone water repellent for leather will not take the place of rubber boots worn while hosing a plant but will insure more foot comfort after the boots are removed and when walking through puddles or rain.

Silicone water repellents for fabrics(12) are also available. A silicone treatment makes textiles soft, resistant to staining and is the most durable water repellent on the market.

Silicones in protective hand creams help protect the hands from water born irritants. Wider use of silicones in cosmetics and protective hand creams

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9Dow Corning 41 Grease
8Silastic (TM)
10Sylflex
11Shoe saver
12Sylmer
may help combat problems of skin irritation in the food industry.

**Silicones for Bloat**

Silicones as a veterinary bloat treatment (11) help farmers save hundreds of thousands of dollars every year by saving bloated cattle. The silicone medicine is for the treatment of frothy bloat. Normally, the medicine is injected directly into the rumen of the bloated animal; however, it may also be administered by syringe or by drench. Several silicone treatments for bloat are now available from well known veterinary supply houses.

**Conclusions**

The silicones are now widely used in the food and dairy industry. Their main usefulness is in controlling unwanted foam, preventing adhesion in processing or packaging, and as heat stable, moisture resistant paints, grease, electrical insulation and rubber. A new application for silicones is as a scratch resistant coating for glassware. The low toxicity of the specific silicones recommended for food use and their unusual properties of heat stability, water repellency and release makes them ideal materials for production aids in food and dairy processing.

**References**