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Silicone vs. EPDM Rubber Tubing: Does it Make a Difference in Milk Processing Applications?

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Today's dairy farmers need to be highly understanding of all the critical aspects of raw milk production, including the processing equipment and materials the milk contacts. Processors and farmers alike are well aware of the negative effects poor equipment sanitation can have on product quality, hygiene and production efficiency in milking applications.

Proper equipment is a large part of maintaining both a high-quality milk product (i.e., safety/hygiene), as well as compliance. As a component in milk processing (and storage) equipment, tubing plays a vital role in maintaining/upholding and transferring product safety, hygiene and quality.

To ensure proper sanitary conditions, the inner surfaces of milking equipment and pipelines, or tubing, should be cleaned daily. Regular product sampling and testing are also necessary throughout various stages of the milk collection and transfer process to ensure product quality.

Most dairy farm and processing equipment is made of stainless steel, where alkaline and acid-based detergents and sanitizers are run through the system components to flush them clean of bacteria and other particles or debris. If not properly sanitized, the unwanted buildup of protein and organic material — or milk fouling (proteins, mineral deposits, and fats) — can occur.

This build up, which can occur on rubber tubing, can lead to microbial contamination if not cleaned properly. Contaminated tubing can create multiple negative effects including a breach in regulatory compliance, textural and taste issues, and reduced efficiency for processors.

In many cases, deposits that are produced from fouling may be dislodged by flowing milk, causing contamination. Milk fouling can occur during both the collection and processing stages, which can negatively impact quality and hygiene in the finished dairy product — along with milk-brand quality and integrity.

Tubing Considerations: Silicone vs. EPDM Rubber (hereafter stated as rubber)

Chemicals in Rubber Tubing May Leach into Milk

Chemicals leaching from the tubing composition into milk can have a negative effect on the product's organoleptic properties, but an even more damaging impact on processors' ability to achieve compliance with regulatory standards that govern the health and safety of foods and beverages for consumer consumption.

Over time, rubber tubing can lead to a buildup of an unsanitary colored residue/extractables, potentially including carbon black, which is a chemical material used in rubber and plastic products, among others.

The issue with carbon black and other such chemicals is that if they leach into milk, they could cause taste and odor issues and/or regulatory and health concerns.

For example, next are a series of images representing a comparison of a 72-hour chemical soak of EPDM and Silicone Tubing. The tubing was soak tested using: 0.5% (v/v) nitric acid and isopropyl alcohol (IPA, 99.8%) at room temperature, both of which are known cleaning chemicals for dairy tubing.

Image 1: Silicone Tubing (on left) and EPDM Tubing (on right) in 0.5% nitric acid – day one (initial).

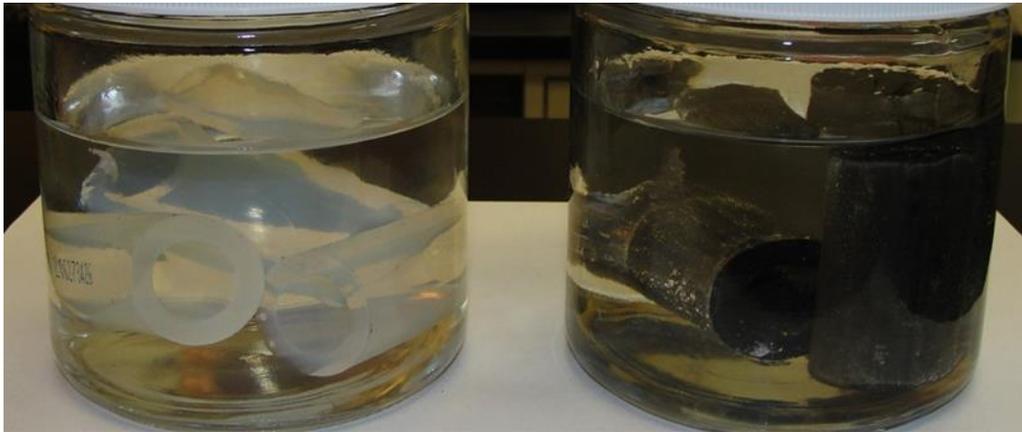


Image 2: Silicone Tubing (on left) and EPDM Tubing (on right) in 0.5% nitric acid – 72 hours.



Image 3: Silicone Tubing (on left) and EPDM Tubing (on right) in IPA – day one (initial).

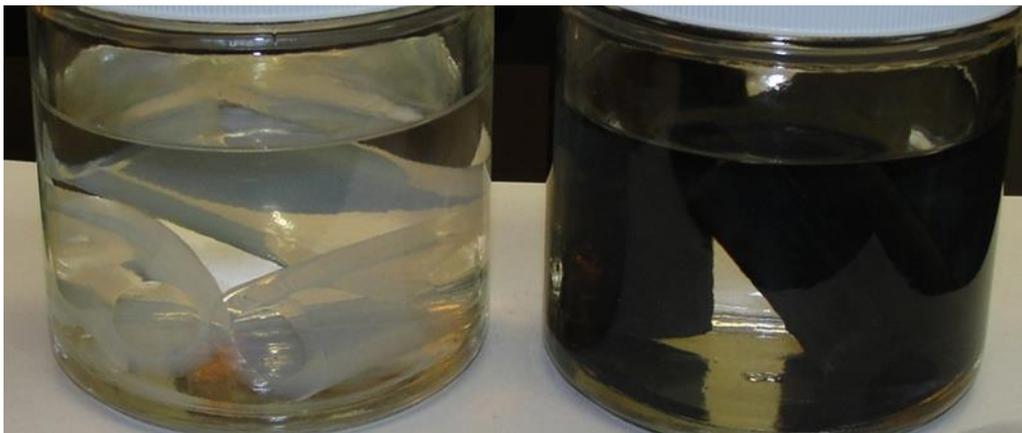


Image 4: Silicone Tubing (on left) and EPDM Tubing (on right) in IPA – 72 hours.



Tubing Tests: Rubber and Silicone

The Saint-Gobain Northboro Research & Development Center — the second largest multi-disciplinary R&D center for the Saint-Gobain Group located in the United States — tested tubing samples, including rubber tubing and Saint-Gobain Tygon® II silicone tubing.

The goal was to relatively compare the amount of organic semi-volatile and non-volatile extractables between silicone and rubber tubing after soaking it in DI water (representing the aqueous nature of the milk) and 0.5% nitric acid solution (representing the cleaning chemicals used to clean the tubing). Following are the key gas chromatography (with mass spectrometer detector) results from the testing, taken from an April 2017 analytical report:

Figure 1: GCMS chromatogram with liquid injection of Tygon II tubing extracted 72hr in DI water at room temperature, DI water was vacuum oven dried 100°C-72hr, any residue was dissolved using methanol and this methanol solution was analyzed:

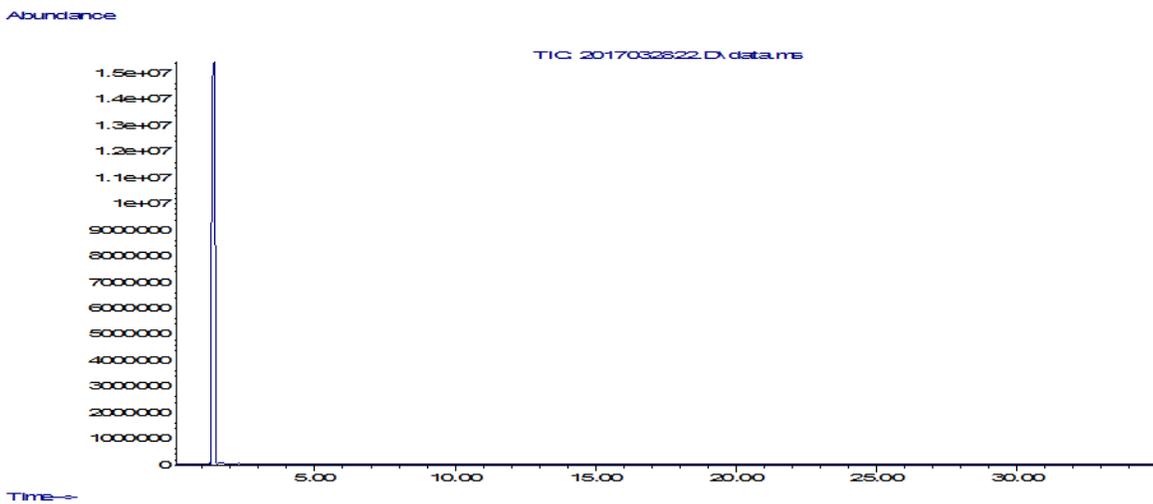


Figure 2: GCMS chromatogram with liquid injection of Tygon II tubing extracted 72hr in 0.5% HNO₃ at room temperature, HNO₃ was vacuum oven dried 100°C-72hr, any residue was dissolved using methanol and this methanol solution was analyzed:

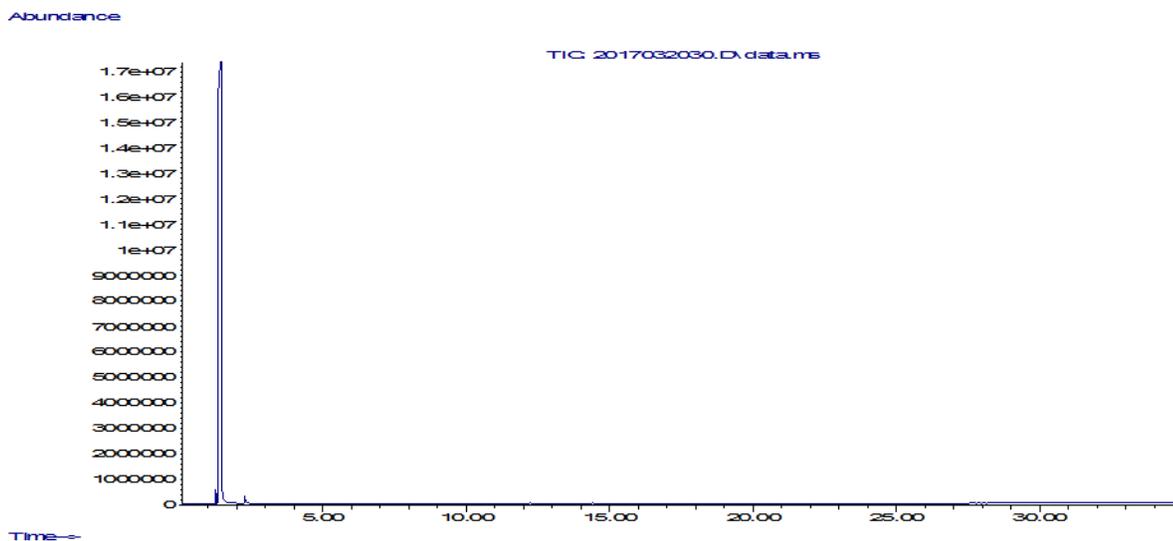


Figure 3: GCMS chromatogram with head space of unbranded black rubber tubing extracted 72hr in 0.5% HNO₃ at room temperature, HNO₃ was vacuum oven dried 100°C-72hr:

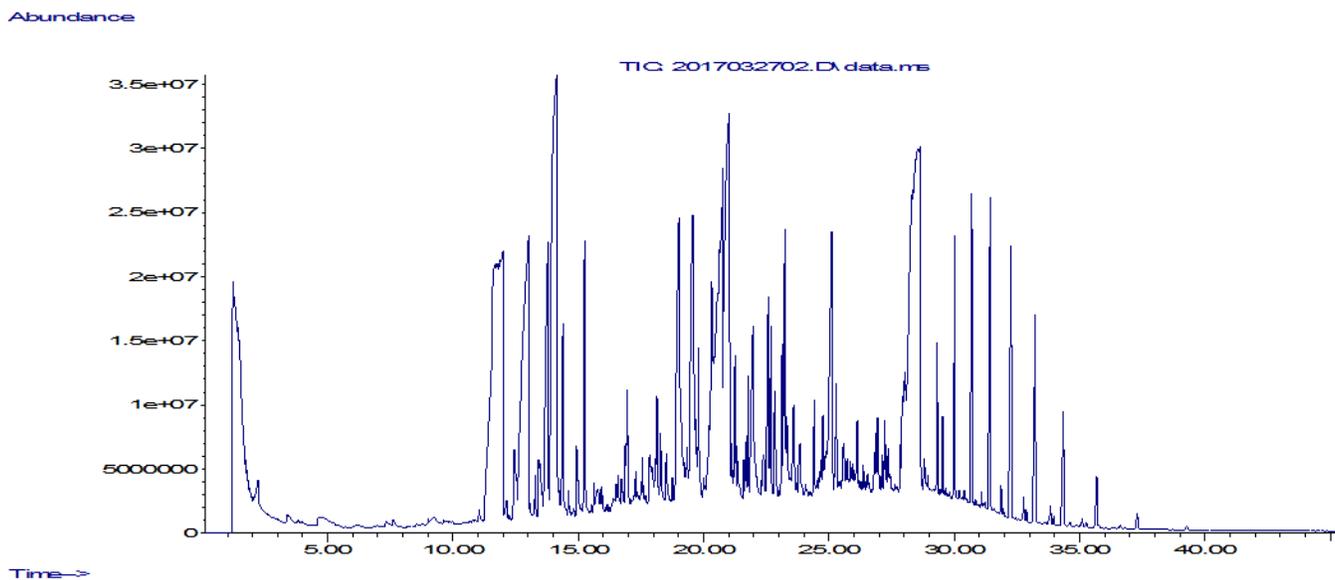
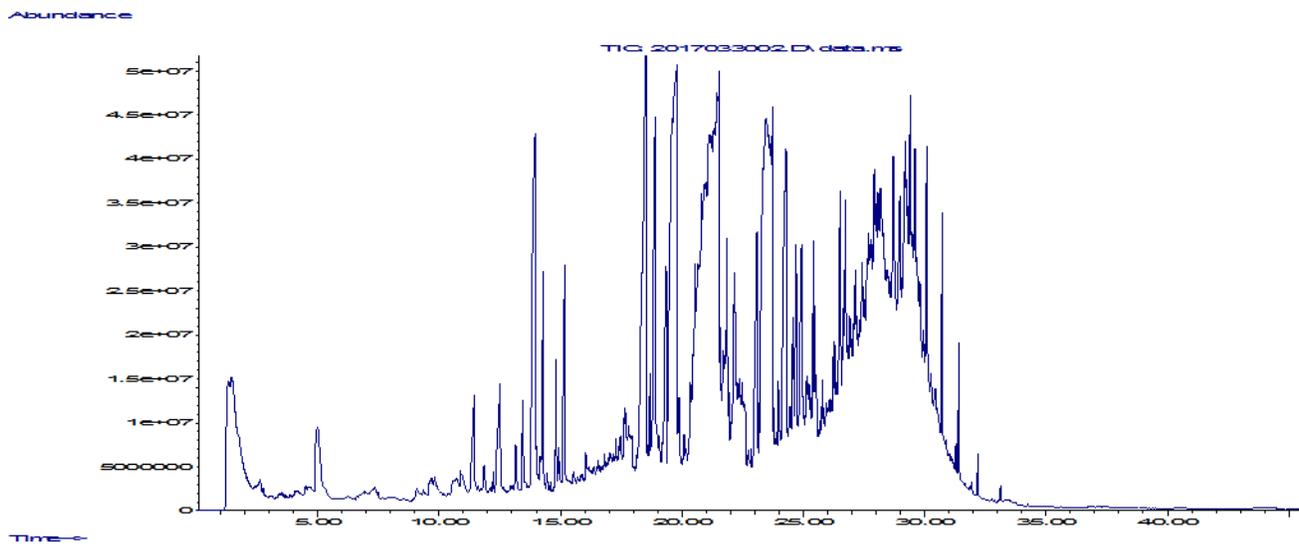


Figure 4: GCMS chromatogram with head space of unbranded black rubber tubing extracted 72hr in DI water at room temperature, DI water was vacuum oven dried 100°C-72hr:



As observed in the Figures above, the GCMS analysis for Tygon II silicone tubing shows one silicone-related peak with each solvent; the rubber tubing extracted at least 24 distinct chemical compounds. These findings clearly demonstrate that silicone is a much cleaner tubing material vs. rubber under these testing conditions.

Protection Through Appropriate Tubing Selection

Tubing Selection and Solutions

One effective course of action dairy farmers and processors can take to ensure product quality, safety and regulatory compliance in milking applications is to evaluate and specify appropriate tubing solutions.

It is critical in specifying proper equipment to ensure organoleptic properties are unaffected (or have limited effect) from dispensing tubing materials.

From initial collection to transfer, processing and more, tubing is a key component in nearly every part of the milking process. This means that there are several touchpoints or opportunities for milk to become contaminated if proper tubing is not specified.

Plus, unclean milking systems foster bacteria growth, which can lead to hygiene issues and milk products with limited shelf life — not to mention potentially harmful implications for consumers.

A key consideration in the selection process should include tubing that exhibits performance properties that meet the milking equipment industry's specific needs, such as flexibility in hot and cold temperatures (for proper fitting installation and retention), resistance to kinking, hardening, fat absorption and durability (to ensure long and reliable service life), among others.

Additionally, it is important to ensure the milk tubing has been rigorously tested and proven to perform under the various conditions that can be encountered in a milking application.

Tested Tubing Products That Perform

[Saint-Gobain's Tygon II](#) is a high-performing silicone tubing engineered with a smooth surface and inner bore that resists sticking, encrustation and bacteria growth, while reducing the potential for particle entrapment. Also, Tygon II does not contain the level of additives and by-products as compared to EPDM rubber that could leach into milk and alter the quality of the milk.

Tygon II silicone tubing also provides flexibility for hot and cold temperatures, along with durability for long and reliable service; it also offers resistance to kinking and tearing.

Additional products that Saint-Gobain offers to this market include [Tygon S3™ M-34-R milk tubing](#) which is entirely clear, allowing for immediate visual inspection and verification of cleanliness. Its smooth, non-porous inner surface also reduces the occurrence of buildup from butterfat, milkstones and milksoil and can help to eliminate the possibility of bacteria growth within the milk transport line.

Long-lasting Tygon S3 M-34-R tubing is also extremely flexible and installs quickly and easily fits milk handling equipment. Tygon S3 M-34-R is specially formulated to reduce the risks that can occur with the use of rubber tubing, such as cracking, aging and improper hygiene.

For more information on how to protect food and beverage quality and safety with high-performance tubing solutions, visit www.processsystems.saint-gobain.com.

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About Saint-Gobain

Saint-Gobain designs, manufactures and distributes materials and solutions which are key ingredients in the wellbeing of each of us and the future of all. They can be found everywhere in our living places and our daily life: in buildings, transportation, infrastructure and in many industrial applications. They provide comfort, performance and safety while addressing the challenges of sustainable construction, resource efficiency and climate change. With 2016 sales of more than \$43 billion, Saint-Gobain operates in 67 countries and has more than 172,000 employees.

Saint-Gobain's Performance Plastics business is headquartered in Solon, Ohio, and employs 6,000 people in 22 countries. It is a world leader in high-performance plastics, including flexible tubing, seals, coated fabrics, foams, window film, barrier/release films, tapes, medical components, fluid handling systems and bearings.

Saint-Gobain's Process Systems business unit helps customers achieve safety, performance and brand assurance through a broad range of capabilities that rely on superior engineering and customer support. Our product applications include those in the food, beverage, habitat, aerospace, chemical and electronics sectors. We've helped customers in all of these industries achieve goals in innovation, efficiency, sustainability and product integrity through customized solutions such as flexible tubing, gaskets, seals, hoses, fittings, pumps, valves and manifolds.

