The different effects tubing materials can have on raw milk collection

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 comes into contact with.

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.

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Proper equipment is a large part of maintaining both a high quality milk product (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 sanitisers are run through the system components to flush them clean of bacteria and other particles or debris. If not properly sanitised, the unwanted build up 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 processers.

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

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 build up of an unsanitary coloured 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 odour issues and/or regulatory and health concerns.

For example, Figs. 1 to 4 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.

Tubing test

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

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Fig. 1. Silicone tubing (on left) and EPDM tubing (on right) in 0.5% nitric acid – day one (initial).

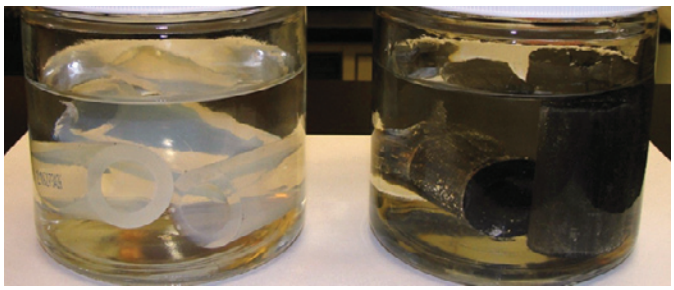

Fig. 2. Silicone tubing (on left) and EPDM tubing (on right) in 0.5% nitric acid – 72 hours.

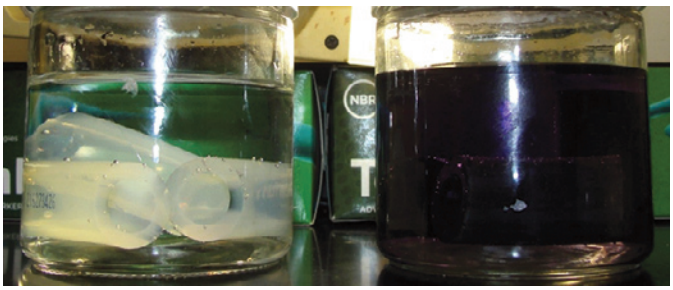

Fig. 3. Silicone tubing (on left) and EPDM tubing (on right) in IPA – day one (initial).

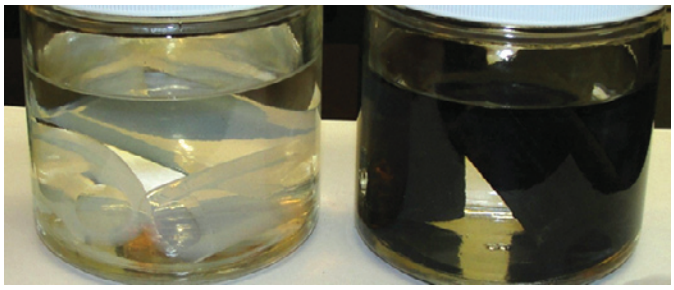

Fig. 4. Silicone tubing (on left) and EPDM tubing (on right) in IPA – 72 hours.

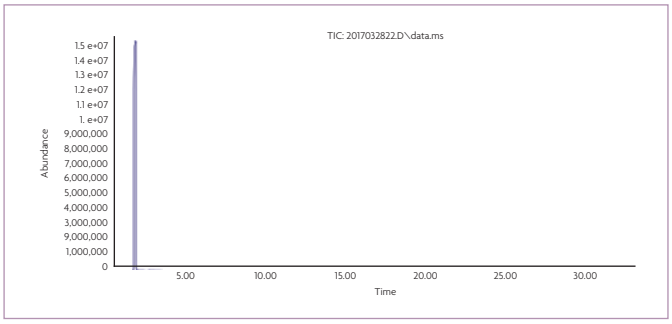

Fig. 5. GCMS chromatogram with liquid injection of Tygon II tubing extracted 72 hours in DI water at room temperature. DI water was vacuum oven dried 100°C-72 hours. Any residue was dissolved using methanol and this methanol solution was analysed.

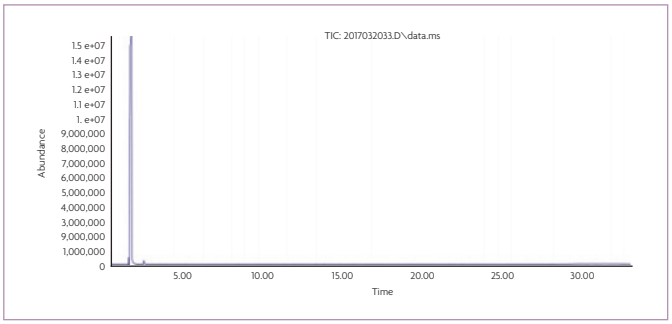

Fig. 6. GCMS chromatogram with liquid injection of Tygon II tubing extracted 72 hours in 0.5% HNO3 at room temperature. HNO3 was vacuum oven dried 100°C-72 hours. Any residue was dissolved using methanol and this methanol solution was analysed.

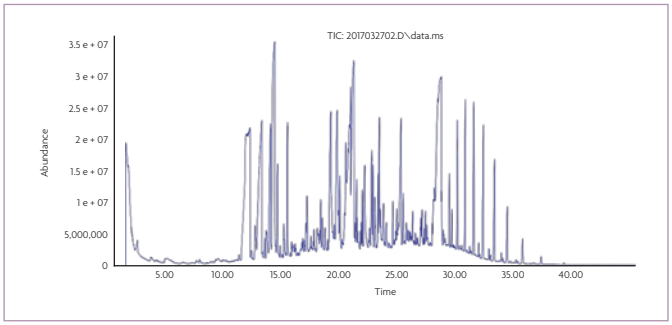

Fig. 7. GCMS chromatogram with head space of unbranded black rubber tubing extracted 72 hours in 0.5% HNO3 at room temperature. HNO3 was vacuum oven dried 100°C-72 hours.

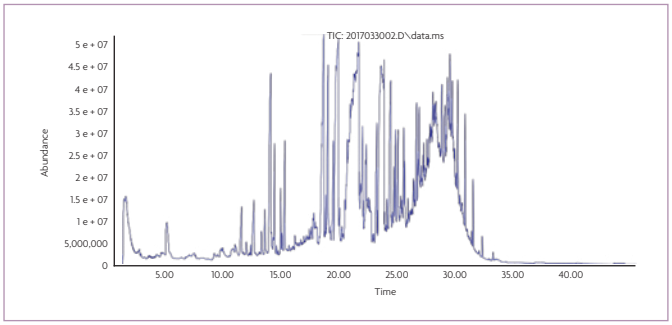

Fig. 8. GCMS chromatogram with head space of unbranded black rubber tubing extracted 72 hours in DI water at room temperature. DI water was vacuum oven dried 100°C-72 hours.

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nature of the milk) and 0.5% nitric acid solution (representing the cleaning chemicals used to clean the tubing).

Figs. 5 to 8 show the key gas chromatography (with mass spectrometer detector) results from the testing, taken from an April 2017 analytical report.

As observed in the figures, 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 selection

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.

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.

This long lasting tubing is also extremely flexible, installs quickly and easily fits milk handling equipment. It is specially formulated to reduce the risks that can occur with the use of rubber tubing, such as cracking, ageing and improper hygiene. ■

References are available from the authors on request:

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