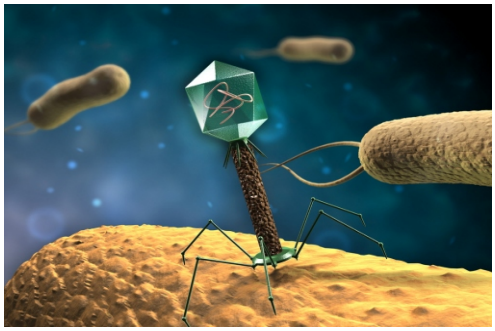


## KES Science & Technology - Using Airocide Air Sanitation Against Bacteriophage

Bacteriophage are present in all dairy processing environments and their action can result in increased production processing times and reduced product quality, and in the worst case complete loss of the production batch.

Bacteriophage is airborne virus particles which can attack the lactic acid bacteria used in the dairy, by adhering to the cell surface and injecting their DNA into the cell. With this mechanism bacteriophage take over the cell's metabolism, altering it to replicate new bacteriophage which are then released into the dairy environment.

Bacteriophage replicate quickly on growing cells and one phage can increase in number to 10 million phages in 5 hours under cheese making conditions.

The word “bacteriophage” originates from the Greek meaning “eat”, the literal translation “bacteria eater” or “virus, which can infect bacteria”.

With a size in the range of 0.10.2 ìm phage are considerably smaller than bacteria. Therefore they can be transferred through air and can thus be present in all production areas.

A bacteriophage, or phage for short, is a virus consisting of a protein head that contains nucleic acids ( DNA or RNA ). For reproduction bacteriophage will need to penetrate a growing bacterium as they do not have their own metabolic system and therefore cannot reproduce by themselves (characteristics of all viruses.

Bacteriophage is still the most common cause of failure in acidification during cheese production. The only method to secure totally phage-free environment is to sterilize equipment, milk and air.

Since bacteriophage are often airborne and can easily spread via water and aerosols it is crucial to ensure a proper design of production facilities. This will involve circulating the air away from the cheese production and in a direction following the cheese as it moves towards pressing, molding, salting and ripening areas.

Several methods for detecting phage and their levels are available. The two most commonly used are the inhibition test and the plaque assay (spot test).

Industry experts tell us starter disruption by bacteriophage can penalize dairy manufacturers with additional processing costs of up to 5 times the cost / kg of final product.

Microbial starters play an essential role in the manufacture of yogurt, cheese and other cultured dairy products. They produce lactic acid and other metabolic by-products that influence important quality characteristics such as flavor, aroma, and texture, and aid micro-flora control.

Bacteriophage is a group of viruses that attack the starter organism hosts, such as lacto cocci. Specific phage-host interactions can lead to the complete lysis of the starter cells preventing them from contributing to the production of the dairy products.

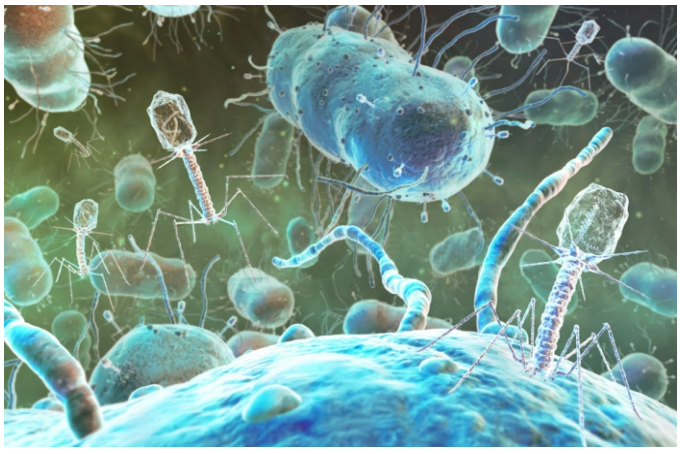
Infection with bacteriophage is the major single cause of fermentation failure or slow-acid production problems in fermentation processes. “Dead” vats in cheese-making are a persistent challenge. Any phage contaminating the bulk starter milk or cheese milk can then inhibit activity of the starters responsible for acidification, or kill strains with other essential functions such as aroma production. These will have serious and detrimental effects on the quality of the final product.

Bacteriophages are ubiquitous in the dairy plant, found in varying concentrations, from low levels in clean rooms, to high levels, as measured for example in the aerosols produced by separators. They are also identified in the outdoor environment, where air is often sourced for the compressed air network.

Since the development of basic principles of phage control in the early 1940s, and despite considerable effort in the industry devoted to prevention (dairy plant design, aseptic techniques, clean rooms, strain rotations ), the dairy environment remains a constant reservoir for bacteriophage. Most of these phages are not completely inactivated by standard processing conditions or equipment sanitation regimes. Some estimates for cottage cheese production losses are as high as $6000 for a 5000 gallon tank. This loss potential considered across the Cottage Cheese Curd Production in the US for 2012 of 423,683,000 pounds would equate to a potential loss of almost $500 million dollars of product loss risk.

The cost consequences of phage can be summarized including:

- Product loss
- Downtime processing costs
- Incremental costs for stringent cleaning and sanitation
- In some cases, reduced value of final product



## Case Study

A cheese plant using open vats for production of cheddar style cheeses was routinely monitored for presence of phage against their starter cultures. High levels were regularly detected in the cheese and milk samples. It was determined that this was the likely cause of slow acidification in some cheese batches. An audit was carried out to determine the source and to identify control options.

Environmental monitoring was carried out using two techniques:

1. Detection of airborne phage in the plant environment using exposure plates for 30 Minutes
2. Detection of airborne phage using a Sartorius Air Sampler with gelatin filters.

Phage levels throughout the plant ranged from 0 to 3.2 pfu/sample with the highest level being in the highest risk area on the vat deck. As infection in the fluid cheese milk has the highest risk potential in the cheese make, this area was identified for implementation of control systems.

Full sanitation of the production area floors was carried out. The vats were inspected, repaired and sanitized. And two Airocide ACS 100 Food Grade systems were installed, positioned adjacent to the vats on the vat deck, to treat the air flowing over the open vats.

Production was then carried out for 10 days and the environmental audit repeated. No phage were detected in any of the environmental samples collected throughout the plant. The cumulative actions of sanitation, equipment repairs and air handling improvement have effectively reduced the phage problems in production.
Continued monitoring for phage in the cheese vats over 3 months show occasional phage hits, but infrequent evidence of cross contamination between vats, i.e. airborne transfer between the open vats.