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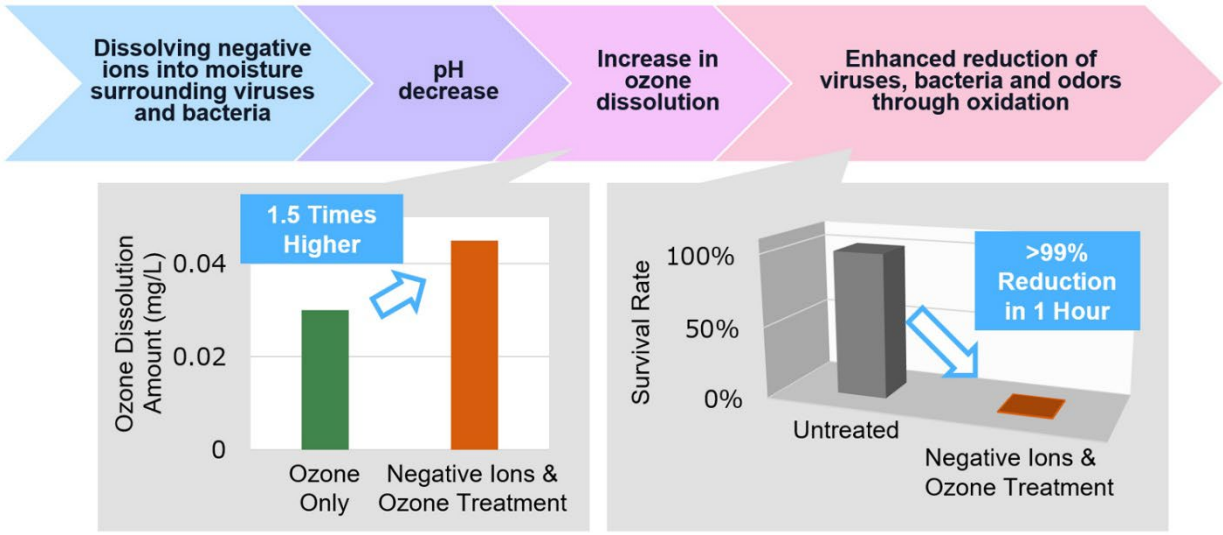
Mitsubishi Electric Achieves World's First Mechanism for Elucidating Ozone Oxidation Enhanced with Negative Ions

Reduces surface-bound viruses, bacteria and odors for safe, secure, and comfortable indoor environment



Use of negative ions to enhance ozone oxidation and reduce pink slime yeast

TOKYO, December 15, 2025 – Mitsubishi Electric Corporation (TOKYO: 6503) announced today that in collaboration with Professor Toshiaki Kamachi and colleagues from the School of Life Science and Technology at Institute of Science Tokyo (Science Tokyo) they have achieved the world's first[1] mechanism for elucidating the combined use of negative ions to enhance the oxidative action of ozone. In their joint study, they discovered that dissolving negative ions in the moisture surrounding viruses and other microorganisms lowers the pH due to nitrate-containing components derived from the negative ions, which in turn enhances the oxidative action of ozone in the moisture, enabling a strong reduction of viruses and bacteria even at low ozone concentrations. Mitsubishi Electric confirmed the reduction of bacteria and odors in low ozone concentrations of 50 parts per billion (ppb)[2] in addition to specific viruses reported previously.[3]

Buildings are becoming more airtight and better insulated, raising concerns about inadequate indoor ventilation

[1] According to Mitsubishi Electric research as of December 15, 2025.

[2] The Japan Air Cleaning Association—Air quality standards gases in the general office room: the average ozone concentration should be approximately 50ppb or less.

[3] Tests were carried out in a 23m^3 test chamber, following JEM1467 and the procedures described in the *Journal of the Society for Antibiosis and Mycology*, Vol.52, No.2 (2024), using metal coupons onto which a viral suspension had been deposited.

and unhygienic conditions. Ozone's oxidative action has traditionally been used to maintain indoor hygiene, but ozone alone has faced challenges in terms of the durability and stability of its sanitizing effects. It is also known that ozone's reduction of viruses and bacteria increases when used with negative ions and varies with pH. However, the specific chemical species of the negative ions and their pH-controlling effects had not been clarified.

Using Mitsubishi Electric's established technologies to evaluate the reduction of viruses, bacteria and odors, together with Science Tokyo's analytical and identification capabilities for discharge-generated reactive species,[4] the two organizations clarified how negative ions control pH in aqueous films. They also elucidated the mechanism by which the combined use of negative ions enhances ozone's oxidative action, and additionally confirmed that adherence of Escherichia coli and pink slime yeast to test specimens in wet areas was reduced by 99% within one hour, and that sweat and damp-clothing odors were reduced by at least one unit of odor intensity within one hour.[5]

Details will be presented at the Pacifichem[6] 2025 international conference in Honolulu, Hawaii from December 15 to 20.

Going forward, Mitsubishi Electric will continue to develop innovative technologies for safer and more enjoyable indoor environments.

Features

1) Elucidation of mechanism for combining negative ions to enhance ozone's oxidative action

Ozone dissolved in water decomposes more rapidly under high pH (basic) conditions and is suppressed under low pH (acidic) conditions. To enable low-concentration ozone to act on viruses and bacteria, it is important to suppress its decomposition in water near those organisms, meaning that an acidic (low-pH) environment is preferable. Through multifaceted examinations of discharge-generated reactive species—including ion chromatography, electron spin resonance (ESR[7]) measurements to identify radical species, and fluorescence analyses of highly reactive molecules—Mitsubishi Electric and Science Tokyo identified nitrate-containing ions in water exposed to negative ions and ozone. They also clarified that these ions induce the observed pH change.

In addition, pH measurements of water exposed to negative ions and ozone for one hour confirmed a decrease from neutral pH7 to mildly acidic pH5. Mitsubishi Electric also confirmed that the dissolved ozone concentration increased approximately 1.5-fold compared to the absence of negative ions.

The company clarified the reduction mechanism whereby an increase in dissolved ozone concentration in water enhances the opportunity for ozone to come into contact with target viruses and bacteria, thereby improving its oxidative action.

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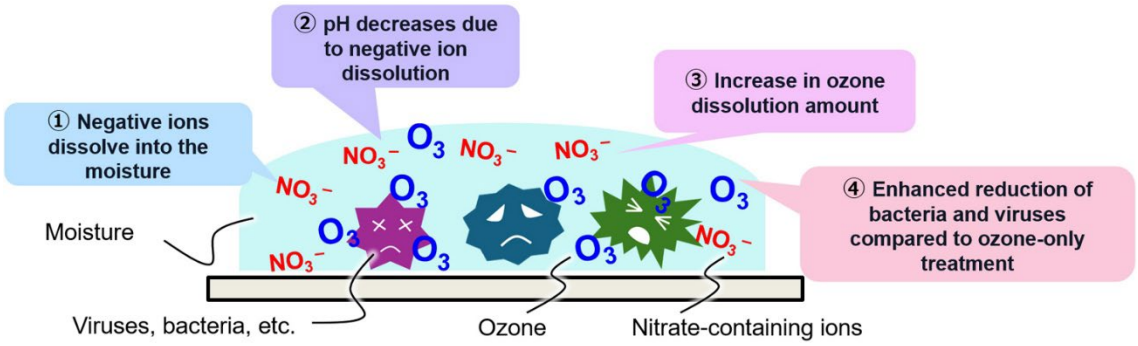
[4] Reactive species generated by discharge (including electrons, ions, radicals and excited-state molecules)

[5] Evaluated on a six-point scale of odor intensity, with a one-unit decrease corresponding to a 90% reduction in perceived odor.

[6] One of the world's largest international conferences in the field of chemistry, held every five years https://pacifichem.org

[7] A technique for detecting compounds that have unpaired electrons and for evaluating reactive oxygen species and other active species present among discharge-generated reactive species.

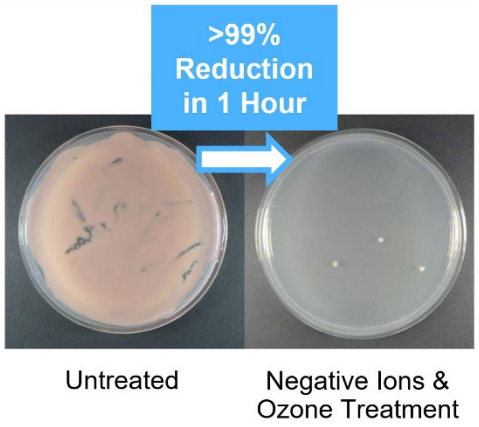


Mechanism for reducing viruses and bacteria through the combined use of negative ions and ozone

*2) **Reduced adherence of indoor viruses, bacteria and odors confirmed in low ozone concentrations***

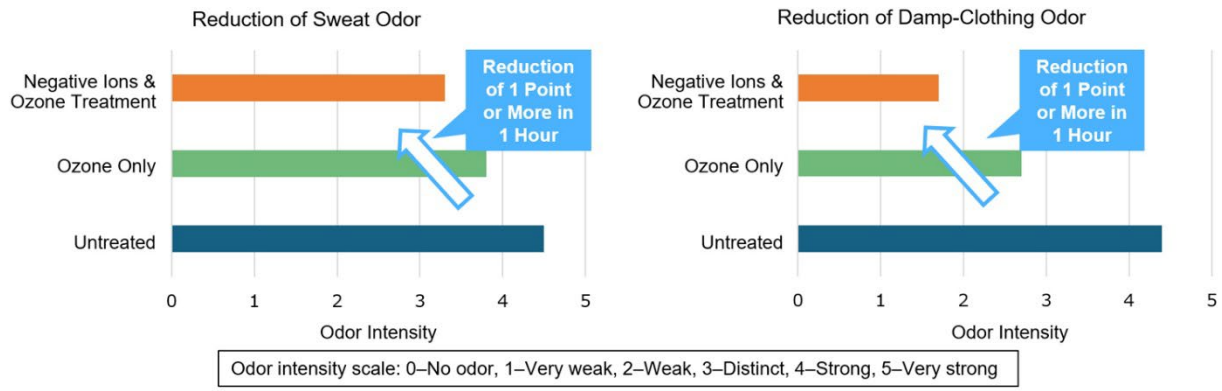
This technology enhances oxidative action efficiently even with low-concentration ozone by controlling the pH of moisture through negative ions. As a result, it is highly effective in reducing viruses, bacteria and odors even in ozone concentrations of 50ppb or lower.

Using this technology, a one-hour treatment in ozone concentrations of 50ppb or below reduced viruses' adherence to test samples by 99%, as previously reported, and confirmed that Escherichia coli on test pieces and pink slime yeast in wet areas[8] were reduced by 99%. In addition, Mitsubishi Electric confirmed that on a six-point scale of odor intensity, a decrease of at least one point was confirmed for sweat and damp-clothing odors adhering to test fabrics.[9] All of these effects were greater than the results achieved with ozone treatment alone.



Reduction of pink slime yeast

[8] Test inside an approximately 12-L sealed chamber using resin coupons onto which a bacterial suspension had been deposited.
[9] Test inside an approximately 4.6 m³ chamber using fabric samples with adhered odor components.



Reduction of sweat and damp-clothing odors

Roles and Tasks

Mitsubishi Electric	Device design and control, and evaluation of virus, bacteria and odor reduction
Science Tokyo	Analysis and identification of reactive species generated by electrical discharge

Feature Development

Mitsubishi Electric will pursue the development of a small, highly efficient device that can suppress the generation of viruses, bacteria and odors not only in crowded public places (schools, hospitals, offices, etc.) and homes (living rooms, kitchens, bathrooms, etc.) but also in mobile environments such as cars, trains, airplanes and shared mobility. The company also plans to accelerate its development of technologies tailored to the characteristics of specific environments to deliver optimal disinfection and deodorization solutions, contributing to an increasingly safer, secure, and comfortable society.

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About Mitsubishi Electric Corporation

With more than 100 years of experience in providing reliable, high-quality products, Mitsubishi Electric Corporation (TOKYO: 6503) is a recognized world leader in the manufacture, marketing and sales of electrical and electronic equipment used in information processing and communications, space development and satellite communications, consumer electronics, industrial technology, energy, transportation and building equipment. Mitsubishi Electric enriches society with technology in the spirit of its "Changes for the Better." The company recorded a revenue of 5,521.7 billion yen (U.S.$ 36.8 billion*) in the fiscal year ended March 31, 2025. For more information, please visit www.MitsubishiElectric.com

*U.S. dollar amounts are translated from yen at the rate of ¥150=U.S.$1, the approximate rate on the Tokyo Foreign Exchange Market on March 31, 2025