

PUBLIC HEALTH • WATER SAFETY

Breaking the Chain of Legionellosis

A potentially fatal disease is spreading through the water systems around us. DZ 9966 mineral oxychloride chemistry cuts the causative chain at its weakest link—destroying the biofilm where *Legionella* hides.

**450%**RISE IN U.S. LEGIONNAIRES' CASES
SINCE 2000**~90%**OF *LEGIONELLA* LIVE INSIDE
BIOFILM, NOT THE WATER STREAM**6-log**REDUCTION IN UNDER 10 SECONDS
AT ORP > +700 mV

— What Is Legionellosis?

Legionellosis is the family of infections caused by *Legionella* bacteria. It ranges from Pontiac Fever—a mild, flu-like illness—to Legionnaires' disease, a potentially fatal pneumonia that frequently requires hospitalization.

The disease first drew public attention in 1976, when 221 attendees of an American Legion convention in Philadelphia fell ill and 34 died. The CDC identified the responsible bacterium in 1977 and named it *Legionella*. Nearly all human infections are caused by *L. pneumophila*. According to the World Health Organization, the overall fatality rate in Europe is about 12 percent—yet U.S. cases have grown nearly 450 percent since 2000.

The most common route of exposure is inhaling contaminated, aerosolized water droplets smaller than five microns. Showerheads and faucets, hot tubs, cooling towers, HVAC systems, and fountains all generate these aerosols. Those most at risk are people over 50, current or former smokers, and anyone with existing lung disease or a compromised immune system.



Cooling towers, HVAC and building plumbing generate warm, aerosolized water—the conditions *Legionella* thrives in.

— Where the Risk Lives

Legionella is common throughout the environment in water and moist soil, but in nature it rarely reaches infectious levels. The danger begins when small amounts enter the complex water systems of large buildings, then multiply. It prefers warm, stagnant water—above 20°C (68°F) and below 50°C (122°F), with an optimum of 37°C (98.6°F), the temperature of the human body and of most hot tubs. Facilities with intermittent flow—hotels, hospitals, cruise ships, schools and campsites—are especially susceptible.

— Why Biofilm Is the Weak Link

Microorganisms adhere to natural and man-made surfaces and colonize them as **biofilm**—a complex ecosystem of bacteria, algae and grazing protozoa that shields its inhabitants from temperature extremes and biocides. Areas of slow flow and stagnation encourage it to form, and about **90 percent of the *Legionella* in a water system lives within the biofilm** rather than in the water stream.

Legionella grown in biofilm is markedly more resistant than that grown in the liquid phase. Research at a university biofilm research center has found that as biofilms collect sediment and scale they become brittle and break off in fragments; when inhaled, these fragments are harder for the body to clear than single bacteria.

Biofilm also harbors amoebae. *Legionella* can infect an amoeba, feeding on its internal materials while gaining protection, then replicate until the host cell bursts and spreads the infection further. As a 2013 article in *Virulence* notes, amoebae can form protective cysts under unfavorable conditions, and bacteria grown inside them show changes in “biochemistry, physiology, and virulence potential,” including greater antibiotic and chemical resistance.

THE WEAKEST LINK

Because roughly 90% of *Legionella*—and its most resistant, amoeba-hardened forms—lives inside biofilm, controlling biofilm formation breaks the causative chain of Legionellosis.



— The Breakthrough: DZ 9966

To cause infection, *Legionella* must first multiply to sufficient numbers. That multiplication is controlled with **DZ 9966**, a mineral oxychloride chemistry that mimics nature's ability to generate a very high concentration of reactive oxygen species (ROS)—hydroxyl radical ions and singlet oxygen ions.

The strength of an oxidizing biocide is measured by its electrochemical potential. Ozone measures about 2.07 volts and sodium hypochlorite just 0.94 volts, while DZ 9966 reaches **2.7–2.8 volts**—more energy, and therefore faster disinfection. Its ROS react faster with microorganisms than chlorine can, succeeding in applications where chlorine alone has failed.

Oxidation-reduction potential (ORP) is used to control biological growth. A study by an independent pathogen laboratory confirmed that holding ORP above **+700 mV** achieves a 6-log reduction of *Legionella* in under 10 seconds—eliminating legionellosis in most systems in less than four hours.

OXIDATION POTENTIAL OF COMMON OXIDANTS		
REAGENT	FORMULA	VOLTS
Fluorine	F ₂	3.06
Mineral Oxychloride	M _x O _y Cl _z	2.8–2.9
Hydroxyl Radical	OH•	2.80
Oxygen Ion	O ^{•−}	2.42
Ozone	O ₃	2.07
Hydrogen Peroxide	H ₂ O ₂	1.78
Perhydroxyl Radical	HO ₂	1.70
Chlorine Dioxide	ClO ₂	1.57
Hypochlorous Acid	HOCl	1.49
Chlorine Gas	Cl ₂	1.36
Oxygen (Molecule)	O ₂	1.23
Hypochlorite Ion	OCl [−]	0.94
Sodium Hypochlorite	NaOCl	0.94
Hydroperoxide Anion	HO ₂ [−]	−0.88
Superoxide Radical	O ₂ ^{•−}	−2.40

— Higher ORP, Fewer Survivors

In laboratory testing, raising the oxidation-reduction potential of the water steadily collapses the surviving bacterial population—until, above the disinfection threshold, no colony-forming units remain.

ORP LEVEL (mV)	CFU PER 100 mL OF WATER
+200	300
+300	36
+400	3
+600	0 — water disinfection
+800	0 — water sterilization

Independent pathogen laboratory: holding ORP above +700 mV achieved a 6-log reduction of Legionella in under 10 seconds.



From cooling water and plumbing to food, utilities and oil & gas—one microbial-control program, many systems.

— One Solution, Many Systems

Biofilm prevention and removal belong in every general microbial-control program. Stopping the multiplication of *Legionella* does the same for other waterborne pathogens—reducing risks from organisms such as *Naegleria fowleri*, the “brain-eating amoeba,” and *Salmonella*, which causes some 1.2 million gastrointestinal illnesses in the U.S. each year.

DZ 9966 has been proven highly effective as a single oxidant in applications where chlorine alone has failed—including biofilm control, cooling water, pulp and paper, food and beverage, utilities, and oil and gas.

D&Z Worldwide is a marketing and distribution firm that specializes in water treatment chemicals. Our team brings more than 40 years of combined experience in water treatment and a deep understanding of the complex, dynamic systems where *Legionella* grows.

THE BOTTOM LINE

By holding ORP above +700 mV, DZ 9966 destroys biofilm and inactivates *Legionella*—a 6-log kill in under 10 seconds, clearing most systems in under four hours and breaking the causative chain of Legionellosis.

NSF/ANSI 60 Certified

EPA FIFRA Registered Biocide

USDA Organic Certified

Effective Where Chlorine Failed

— Talk to Us

For more on this technology, contact D&Z Worldwide — deepak@dz-worldwide.com • www.dz-worldwide.com.