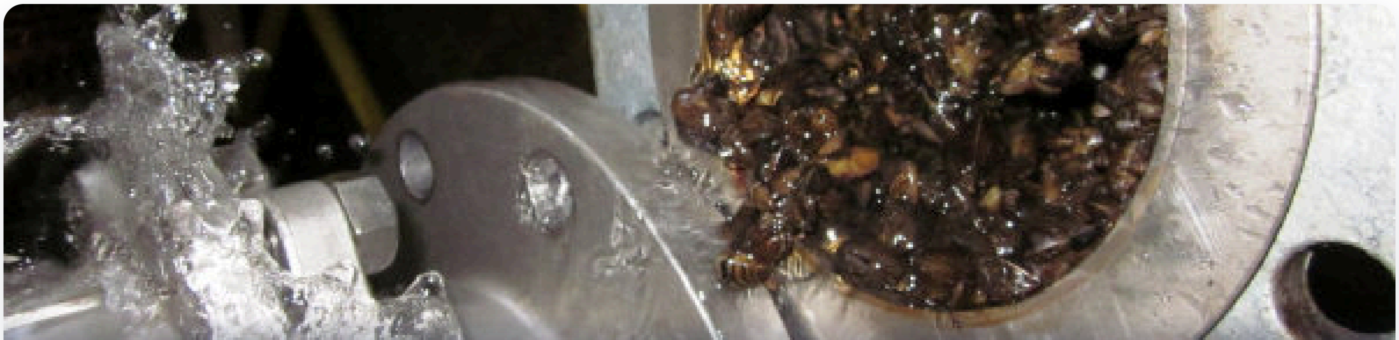
APPLICATION REPORT • INVASIVE SPECIES CONTROL

Zebra & Quagga Mussel Control with JC 9465

A liquid mineral-oxychloride reactive-oxygen-species (ROS) reagent that clears biofilm and mussels from raw-water intakes, pipes, screens, and cooling systems — delivering ozone-class oxidation with a lasting residual ORP.

~+650 mV TARGET ORP CONTROL SETPOINT	**100%** ADULT & VELIGER MORTALITY	**6.60 log** MICROBIAL REDUCTION AT 10 PPM



Before treatment — an intake flange packed with zebra mussels and biofilm, throttling flow through the line.

The Biofouling Problem

First found in Lake St. Clair in 1988 — and believed to have arrived in ballast water from the Black and Caspian seas around 1985 — the zebra mussel (*Dreissena polymorpha*) spread rapidly across the Great Lakes and down the Ohio, Cumberland, Arkansas, Tennessee, and Mississippi rivers to New Orleans. The closely related quagga mussel (*D. bugensis*) and the Asiatic clam (*Corbicula fluminea*) followed the same path. These mollusks invade water utilities, clogging transmission lines, valves, screens, and meters, damaging centrifugal pumps, and causing taste-and-odor problems.

Adult mussels (6–45 mm) anchor by byssal threads and are far more resistant to oxidants than their free-floating veliger larvae. Conventional control leans on free chlorine — but at the doses and contact times mussels demand, chlorine forms excessive trihalomethanes (THMs), is highly toxic to non-target fish and invertebrates, and requires dechlorination before discharge.

Ozone-Class Oxidation — With a Residual

Chlorine dioxide and ozone prove that reactive oxygen species handle both organic loading and target pests far better than chlorine — but neither is cost-effective, and ozone dissipates so fast it leaves no residual to protect downstream piping.

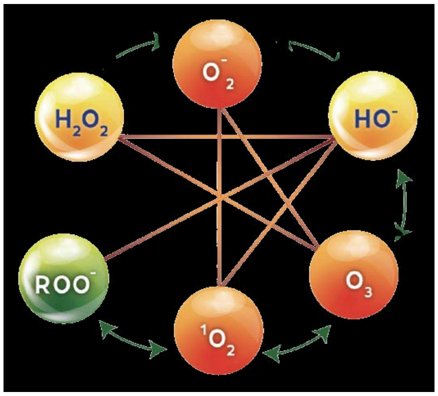
JC 9465 delivers a family of ROS in a stable liquid, providing oxidation potential almost equal to ozone with the added benefit of **residual oxidation energy**. Chemically it is a chelation of minerals with oxygen (mineral oxychloride, MOxC), purposely weakly bound so that on contact with inorganics, microbes, and organic matter it readily gives off ROS — hydroxyl radical, singlet oxygen, superoxide, and peroxide — that aggressively oxidize contaminants.

A water shell around each metal-oxy-complex conserves its energy, delivering a measurable, lasting ORP rather than a single spent dose. The reaction is effectively catalytic: it lowers the activation energy for oxidizing organic material, then the minerals return to ground state. The mineral-oxide by-products are themselves mildly biocidal — guarding against bacterial recontamination — and fall well below FDA maximum contaminant levels.

OXIDATION POTENTIAL OF COMMON OXIDANTS

REAGENT	FORMULA	VOLTS
Fluorine	F_2	3.06
Mineral Oxychloride	**$M_xO_{ə}Cl_t$**	**2.8–2.9**
Hydroxyl Radical	OH•	2.80
Oxygen Ion	O^-	2.42
Ozone	O_3	2.07
Hydrogen Peroxide	H_2O_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

THE JC 9465 ROS FAMILY



REACTIVITY OF JC 9465 — DOSE RATIOS

TARGET	EFFECTIVE CONCENTRATION
Inorganics	< 1.0 mg/L per 1.0 mg/L inorganic
Pathogens	1.0 mg/L per 1,000–10,000 mg/L pathogen
Organics	1.0–8.0 mg/L per 1.0 mg/L organic
Residual	Mineral-oxide by-products resist recontamination

Unlike chlorine, mineral oxychloride releases single oxygen atoms embedded within the molecular structure of organics and pathogens — killing microbes rather than poisoning them, so more is accomplished with less.

How JC 9465 Compares

Field and laboratory studies show the dose and contact time required to kill these mollusks are extremely high for conventional oxidants. Measured as LT_{50} — the time to 50% mortality — JC 9465 matches ozone's best performance while holding a controllable ~+650 mV ORP setpoint at neutral pH.

OXIDANT	RESIDUAL (MG/L)	ORP (MV)	TEMP (°C)	PH	STAGE	LT_{50} (DAYS)
Free chlorine	0.5	NA	23	8.0	A	8.7
	4.8		21	7.9	A	5.9
	4.7		16	7.8	J	4.8
Potassium permanganate	1.1	NA	17	7.6	J	7.9
	4.8		17	7.6	J	8.6
Monochloramine	2.6	NA	28	7.9	J	0.6
	10.7		17	7.9	J	0.5
Chlorine dioxide	1.2	NA	24	6.9	J	0.7
	4.7		22	6.6	J	0.6
Ozone	0.5	NA	17	7.0	A	4
	0.5		17	7.0	J	0.2
JC 9465	**0.5**	**~+650**	**17**	**7.0**	**A**	**4**
	0.5	**~+650**	**17**	**7.0**	**J**	**0.2**

A = adult, J = juvenile. Compiled after Cameron et al. (1989); ozone extrapolated from EPA data. JC 9465 dosed to an ORP setpoint rather than a fixed residual.

Application & Effect Ranges

TREATMENT	APPLICATION	EFFECT
Chlorination (adults)	0.5 ppm for 7 days	75% kill
Chlorination (adults)	2 ppm, continuous flow	> 95% kill
Chlorine dioxide	0.5 ppm for 24 hr	90% kill
Chloramine	1.2 ppm for 24 hr	100% veliger kill
Ozone	0.5 ppm for 5 hr / 7–12 days	100% veliger kill
JC 9465	**~+650 mV for 5 hr / 7–12 days**	**100% veliger & 100% adult kill**

Proven Microbial Kill

As a preamble to EPA registration, an independent microbe-specialty laboratory ran kill assays against *Salmonella enterica* (10708). At just **10 ppm**, JC 9465 drove a 6.60-log reduction in 30 minutes — outperforming sodium hypochlorite dosed ten times higher, at 100 ppm.

SOLUTION	PPM	CFU/ML, TIME ZERO	CFU/ML, 30 MIN	LOG REDUCTION
Hypochlorite	10	2.00×10^{7}	1.89×10^{5}	2.02
Hypochlorite	100	1.58×10^{7}	< 5	6.49
JC 9465	**10**	**2.00×10^{7}**	**< 5**	**6.60**

Salmonella enterica 10708 assay conducted as a preamble to EPA registration.

RESULT

More kill, less product. JC 9465 achieved a full veliger and adult mussel kill and a 6.60-log microbial reduction at one-tenth the dose of chlorine — with mineral-oxide residues that resist recontamination and fall well below FDA maximum contaminant levels.

After JC 9465 treatment — the same class of line cleared of biofilm and mussels, flow fully restored.

Ozone-Class Oxidation | Residual ORP Protection | Residues Below FDA MCL | EPA Registration — In Testing

For application engineering, dosing trials, and ORP-controlled feed design, contact Jenfitch, Inc. — charles@jenfitch.com • www.jenfitch.com