

TECHNICAL BRIEF • MUNICIPAL & INDUSTRIAL WASTEWATER

Removing Dissolved Copper in Wastewater Treatment

How do you meet a dissolved-copper discharge limit of 1.6, 3.1, or 6.1 ppb — cost-effectively? A look at reverse osmosis, deionization, and chemical precipitation.

Three technologies can reach low dissolved-copper levels: reverse osmosis (RO), deionization (DI), and chemical precipitation. Each differs sharply in removal, complexity, and operating cost.

— Comparing the three approaches

METHOD	MECHANISM	REMOVAL	KEY TRADE-OFFS
Reverse Osmosis	Membrane filtration	~90% of all ions	High-pressure pumps, up to 20% reject, high capital/energy/maintenance (\$0.03–0.05/gal)
Deionization	Ion exchange (H ⁺ swap)	Cu to ~0.1 ppb	High capital, frequent regeneration, spent-acid disposal, costly resin replacement
Chemical Precipitation DZ 9830 + DZ 1687	Metal-sulfide precipitation	Cu < 0.5 ppb	Broad pH range, dense easy-to-dewater sludge, economical

RO and DI are effective but capital- and operating-cost intensive. Chemical precipitation with metal sulfides reaches the lowest effluent levels most economically.

— Reverse Osmosis (RO)

RO membranes remove dissolved copper effectively, generating ~90% removal of everything. The trade-offs are significant: expensive high-pressure pumps, a rejection rate up to 20%, ongoing maintenance and replacement cost, treatment cost of \$0.03–0.05/gal, energy cost, and disposal of spent cleaning solutions. Operational parameters (NTU, TSS, solids loading, silt density index) must all be managed.

— Deionization (DI)

DI removes dissolved copper to as low as 0.1 ppb by ion exchange: copper-laden water passes through cationic and anionic resins, exchanging copper for hydrogen ions until the resin is exhausted, then regenerated with sulfuric acid. The trade-offs are high capital investment, disposal of spent cleaning solutions, frequent regeneration, and high resin-replacement cost.

— Chemical precipitation — the DZ 9830 + DZ 1687 approach

Dissolved-metal removal is driven by solution pH or by metal precipitants. The traditional route raises pH with caustic soda, lime, or soda ash to form an insoluble metal hydroxide — but hydroxide is amphoteric (increasingly soluble at both low and high pH) and produces excessive, hard-to-dewater sludge. The optimum pH for copper removal is 8.1.

The metal precipitant DZ 9830 forms a copper-sulfide ion that precipitates over a broad pH range. Metal sulfides are not amphoteric, form a dense easy-to-dewater sludge, and have lower solubility than hydroxides — enabling higher copper removal. Paired with DZ 1687, a cationic organic/inorganic coagulant that builds a dense, fast-settling particle, the program has produced effluent below 0.5 ppb in full-scale trials, economically. It also works where naturally occurring chelating agents block normal hydroxide precipitation.

94%DISSOLVED COPPER
REMOVED**70%**DISSOLVED ZINC
REMOVED**<0.5 ppb**EFFLUENT COPPER
(OTHER TRIALS)

— Full-scale, one-year plant results — DZ 9830 (10 mg/L) + DZ 1687 (10 mg/L)

DATE	INFLUENT Cu	EFFLUENT Cu	Cu REMOVAL	INFLUENT Zn	EFFLUENT Zn	Zn REMOVAL
Mar 11	35 ppb	2.0 ppb	94.3%	87 ppb	27 ppb	68.9%
Mar 15	28 ppb	1.6 ppb	94.3%	109 ppb	22 ppb	79.8%
Mar 30	58 ppb	1.4 ppb	97.6%	100 ppb	24 ppb	76.0%
Aug 16	46 ppb	3.8 ppb	91.7%	96 ppb	42 ppb	56.3%

Values in parts per billion (ppb); effluent sampled at the secondary clarifier prior to filtration. In other studies, the same program achieved non-detect levels for dissolved copper.

LOOKING FOR ALTERNATIVES?

If you need to remove dissolved copper or zinc, contact us at deepak@dz-worldwide.com for a copy of the aquatic-toxicity reports.