



## Mixed Oxidants versus On-Site Hypochlorite

Chlorine (in the form of hypochlorous acid and hypochlorite ion) is the only measurable component in both mixed oxidants and sodium hypochlorite produced on site. However, there is ample evidence for the presence of other chlor-oxygen species in the mixed-oxidant solution, as noted by operational improvements reported both in the laboratory and in the field.

Mixed oxidants *behave* like chlorine dioxide or ozone while offering a residual chlorine disinfectant to comply with EPA requirements. Moreover, based on third-party studies that demonstrate that the other chlor-oxygen species in mixed oxidants do not include chlorine dioxide and ozone, the EPA does not require mixed-oxidant users to monitor for any disinfection by-products other than TTHMs and HAA5, just as with other forms of chlorine. Mixed-oxidant customers can enjoy the benefits of a superior disinfection technology as summarized below, while still maintaining a chlorine residual, all in a single technology.

	Mixed Oxidants	On-Site Hypochlorite
<b>Safety</b>	<ul style="list-style-type: none"> <li>Eliminates hazardous disinfection chemicals – only salt, water, and power are required for oxidant production.</li> <li>Eliminates storage and handling of chlorine gas or bulk hypo, reducing liability exposure.</li> <li>No Risk Management Plan (RMP) required.</li> <li>No HAZMAT training, SCBA gear, or DOT shipping requirements.</li> <li>Uniform Fire Code for chlorine gas scrubber does not apply.</li> <li>Dilute concentration (&lt; 0.5%) prevents equipment corrosion.</li> <li>Safer water – fewer DBPs and harmful microorganisms.</li> </ul>	<ul style="list-style-type: none"> <li>Eliminates hazardous disinfection chemicals -- only salt, water, and power are required for hypochlorite production.</li> <li>Eliminates storage and handling of chlorine gas or bulk hypo, reducing liability exposure.</li> <li>No Risk Management Plan (RMP) required.</li> <li>No HAZMAT training, SCBA gear, or DOT shipping requirements.</li> <li>Uniform Fire Code for chlorine gas scrubber does not apply.</li> <li>Dilute concentration (&lt; 1%) prevents equipment corrosion.</li> </ul>
<b>Chlorine Residual</b>	<ul style="list-style-type: none"> <li>Oxidant demand is decreased. i.e., a lower dose (typically 33% less) will achieve the same or higher residual.</li> <li>Lower required dose results in lower operating costs and DBP production.</li> <li>Chlorine residual lasts much further in distribution (&gt; 25 miles) and has a much longer detention time (15 days in remote tank rather than 5 days).</li> <li>Chlorine booster stations or ammonia (chloramines) can often be eliminated, offering additional operating cost savings.</li> </ul>	<ul style="list-style-type: none"> <li>No change in oxidant demand when compared to traditional chlorination.</li> <li>Operating costs will not be affected by reduced dosages.</li> <li>Chlorine residual is equivalent to that from traditional chlorination; will not carry any further or last any longer.</li> <li>For long detention times in distribution, may require boosting or combination with ammonia (chloramination).</li> </ul>

	Mixed Oxidants	On-Site Hypochlorite
<b>DBP Formation</b>	<ul style="list-style-type: none"> <li>Reduces TTHM and HAA5 production by 30% to 50%.</li> <li>Does not form chlorite or bromate.</li> <li>Produces low levels of chlorate and perchlorate (not regulated).</li> </ul>	<ul style="list-style-type: none"> <li>No reduction in TTHMs or HAA5.</li> <li>Does not form chlorite or bromate.</li> <li>Produces minimal levels of chlorate and perchlorate (not regulated).</li> </ul>
<b>Effectiveness</b>	<ul style="list-style-type: none"> <li>2-10 times more effective than chlorine.</li> <li>Broader inactivation range. Can kill <i>Giardia</i> at practical doses; more effective against <i>Cryptosporidium</i> than hypochlorite.</li> <li>More rapid disinfection.</li> <li>Lower dose required.</li> <li>Evidence that Ct values are actually lower (but not approved by U.S. EPA) than for traditional chlorination.</li> </ul>	<ul style="list-style-type: none"> <li>Effective kill on certain microorganisms.</li> <li>Higher Ct value (more time &amp; dose required) than mixed oxidants.</li> <li>Behave more like conventional bulk bleach which is ineffective against <i>Cryptosporidium</i> and other resistant pathogenic microorganisms.</li> </ul>
<b>Biofilm &amp; Algae Removal</b>	<ul style="list-style-type: none"> <li>Removes existing biofilm from storage tanks and distribution.</li> <li>Prevents regrowth.</li> <li>Counteracts taste and odor effects of algae blooms.</li> <li>Eliminates organic material that contributes to DBP formation and ensures that residual will endure.</li> </ul>	<ul style="list-style-type: none"> <li>Less effective against biofilm.</li> <li>Regrowth occurs when burn-out (cleaning) doses are brought back to normal operating doses.</li> <li>More organic material in the lines means higher DBP formation.</li> <li>Biogrowth will consume chlorine residual, increasing oxidant demand.</li> </ul>
<b>Pretreatment</b>	<ul style="list-style-type: none"> <li>Can be used to enhance microflocculation, decreasing alum doses by up to 40%.</li> <li>Pin floc forms much more quickly, even at cold temperatures.</li> <li>Can reduce fluoride doses and sludge handling requirements.</li> <li>Improves filter runs.</li> <li>Lowers settled turbidity and thereby reduces filter backflushing requirements.</li> <li>Use in pretreatment typically removes organic precursors, reducing final DBP levels by up to 50%.</li> </ul>	<ul style="list-style-type: none"> <li>Use in pretreatment offers no advantages.</li> <li>Typically increases DBP levels above the limit.</li> </ul>

	<b>Mixed Oxidants</b>	<b>On-Site Hypochlorite</b>
<b>Taste &amp; Odor</b>	<ul style="list-style-type: none"> <li>• Virtually eliminates taste and odor complaints</li> <li>• Effective against taste problems caused by algae blooms; seems to remove geosmin and MIB.</li> <li>• Rapidly oxidizes hydrogen sulfide.</li> <li>• Minimizes formation of chlorinous taste and odor due to di- and tri-chloramines.</li> <li>• Chlorine taste usually not apparent, even at residuals &gt;5 ppm.</li> </ul>	<ul style="list-style-type: none"> <li>• No change in taste and odor from traditional chlorination.</li> <li>• Not effective against musty tastes caused by algae blooms.</li> <li>• Slower reaction to oxidize H<sub>2</sub>S.</li> <li>• When combined with ammonia, breakpoint is more difficult to achieve, allowing di- and trichloramines to persist.</li> </ul>
<b>Oxidation of Other Compounds</b>	<ul style="list-style-type: none"> <li>• Will more rapidly oxidize iron and manganese, preventing precipitation in the pipelines.</li> <li>• May eliminate use of KMnO<sub>4</sub>.</li> <li>• Achieves breakpoint at lower chlorine to ammonia dose ratios (i.e., practical experience shows breakpoint achieved at as much as half the dose required with bleach).</li> </ul>	<ul style="list-style-type: none"> <li>• Slower reaction to oxidize iron or manganese.</li> <li>• Dose required for breakpoint can be twice as high as with mixed oxidants.</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>• Cell replaced every 7-10 years following recommended maintenance.</li> <li>• Cell replacement can take as little as 15 minutes.</li> <li>• Oxidant created on demand, eliminating product deterioration.</li> <li>• No mixing or diluting solution.</li> <li>• No ionic membranes, gas exchange venturis, or complex changing and cleaning process.</li> <li>• No safety equipment necessary.</li> </ul>	<ul style="list-style-type: none"> <li>• MIOX is an expert in OSG manufacture and operation. Maintenance requirements are the same.</li> </ul>

	<b>Mixed Oxidants</b>	<b>On-Site Hypochlorite</b>
<b>Economics</b>	<ul style="list-style-type: none"> <li>• Higher capital cost offset by lower operating costs, resulting in lower lifecycle cost.</li> <li>• Reduced oxidant demand typically means operating costs will be 30% less than estimated, offsetting slightly higher salt and power conversion efficiencies.</li> <li>• Positive effect on other plant processes can save thousands of dollars monthly in operations.</li> <li>• Use of bulk brine silo further reduces labor costs.</li> <li>• No liability costs or expenses for safety training or equipment.</li> </ul>	<ul style="list-style-type: none"> <li>• Higher capital cost offset by lower operating costs, resulting in lower lifecycle cost.</li> <li>• Slightly more efficient salt and power conversion rates than for mixed oxidants – however, unlike mixed oxidants, hypo will not reduce oxidant demand or other chemical requirements in the plant.</li> <li>• Use of bulk brine silo further reduces labor costs.</li> <li>• No liability costs or expenses for safety training or equipment.</li> </ul>