



Technical White Paper: Ultrasound & Toxin Release

by

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A general concern heard from water utilities that are considering using ultrasonic algae control in the pre-treatment process is the potential for release of algal toxins and taste and odor compounds as the algae are killed. This is understandable because of the misconception that the cells are lysed or broken during the control process. The outer cell walls are not broken by the ultrasound, but it will be useful to understand both processes.

Virtually all of the toxins that algae can release (blue-greens being the most notorious) are created as defense mechanisms to either ward off other organisms or combat changes in water chemistry. For example, sudden changes in pH, salinity, other prolific algae populations (i.e. competition), organic wastes and other pollutants can cause a toxic response as the algae begin to produce chemicals that help them cope with the change. Ultrasound does not provoke a toxic response because the algae sense the vibration from the ultrasound as water turbulence and not a physical or chemical change.

Further, ultrasound does not break the external sheath of the algae but causes internal damage as blue-green algae gas vesicles are broken or the plasmalemma inner cell wall linings of green algae are separated from the outer sheath. The former causes the cells to sink due to loss of buoyancy and the latter interrupts the fluid transfer in and out of the cell as the plasmalemma becomes separated internally from the contractile vacuole which sits on the outer algal sheath.

Sinking blue-green algae simply prevents them from getting sufficient light, so their growth slows and they quickly stop reproducing. For green algae, their internal cell material begins to die slowly as it cannot get sufficient food nor can it get rid of waste. Once the plasmalemma is torn from the outer sheath and an internal cell pressure cannot be maintained, bacteria invade the cell and begin eating it from the inside. In both cases, algae reproduction is quickly controlled.

With about 15 years of operating experience since the emergence of this low intensity ultrasonic technology, there has never been a reported incident that algae have responded to increase toxin levels or have increased the level of taste and odor compounds.

While it is conceivably possible for this to occur with high intensity cavitation ultrasound that could be used to break the outer algal sheath, this simply does not occur with low intensity systems. In fact, you would need about 300 times more energy than the Sonic Solutions device makes to do it and even then it would only occur very near to the device.

By scanning a bandwidth of frequencies that match resonance of these algae internal cells, the device can disable them slowly and methodically without breaking them apart at the algal outer surface. Eventually as the cells decay, the outer sheath will begin to disintegrate and break down, but at that point the cell has no capacity to produce taste, odor, or toxic materials.

Summary:

Under the influence of ultrasound, algae do not sense they are under attack which means they don't produce the defense toxins or other compounds that create taste and odor issues. Ultrasound begins to reduce the algae population which is the key to preventing them from being in sufficient quantity to produce enough chemicals to cause taste, odor and toxicity problems. Further, algal outer cell walls are not broken by this technology (only inner cell walls are damaged), so toxins and other taste and odor chemicals are not released.