

THE EFFECTS OF *AquaKLEAR*. On THM  
Internal document for training agents and distributors only  
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Chlorine

This is the most common disinfectant used by pool operators in both private and commercial pools. Alone, chlorine is a very reactive gas, which is dangerous to humans. It can affect the nose, throat and lungs if inhaled. However, as a compound it is a cheap treatment to use within swimming pools.

The most common Chlorine compound used in swimming pools is Sodium Hypo-chloride, a clear, yellowish liquid with between 12 - 15% Chloride concentration. It is similar to household bleach, only stronger. Although this is a good chemical to use, it has a very short shelf life, so much so that after only a month of storage, the concentration has deteriorated to such a low degree that it can no longer be used.

Sodium Hypo-chloride affects pH levels, increasing them to around pH9-10. This reduces the effectiveness of the Chlorine, which works best when the pool is neutral (pH7.5). In order to return the pH levels to normal, acid must be added to neutralise the water, which also costs money. After installation of *AquaKLEAR*, in the beginning less Chlorine needs to be added to the pool, as the chloramines present in the pool are broken down free chlorine is released. After the initial period minimum chloramines is reached that depends on the rate of water circulation and the rate of chloramines formation in the pool. At that point the chlorine introduced to the pool will be the amount of chlorine necessary to maintain the desired level in the pool. Less hypo-chloride means that less acid needs to be introduced. However, this is not true in every case. Some Chlorine dosing systems don't affect pH at all, and some are pH negative, meaning that they push the pH levels in the other direction.

## Releasing free Chlorine from Chloramines and Trihalomethanes

The disinfections of waters with chlorine for the control of waterborne infectious diseases can lead to the introduction of potentially carcinogenic organohalides. With advances in analytical chemistry it is now possible to monitor these compounds at much lower levels. To date most regulatory attention has focused on Trihalomethanes, THM's. The four trihalomethanes produced in water are chloroform, bromodichloromethane, dibromochloromethane and bromoform.

Trihalomethane (THM) are various derivatives  $CHX_3$  of methane (as chloroform) that have three halogen atoms per molecule and are formed especially during the chlorination of water.

Chloramines are a fixed version of Chlorine. This is the substance that produces the distinctive smell and causes sore eyes and irritation. It is formed when the Chlorine reacts with organic materials in the water, and joins with Sodium.

*AquaKLEAR* breaks down chemicals like Chloramines and THM using an electric field that is generated in the pipe under the ferrite ring that is fitted around the pipe.

The Chloramines and THM are formed due to bonding of chlorine molecules to various organic materials present in the water. THM is derives from combining chlorine and methane that is generated from the breakdown of organic materials in the filter sand and the water. The chloramines and THM molecules are carried in the water through the ferrite ring. The voltage that is created in the water strips the chlorine from the molecules. These are positively charged and will be flocculated to other particles that are negatively charged by the *AquaKLEAR*. (See Page 3 flocculants)

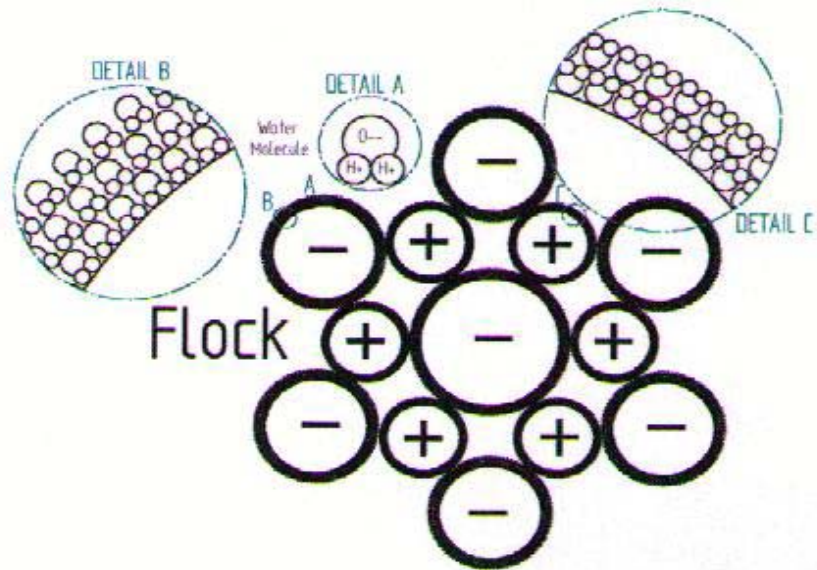
The chloramines and THM molecule will align to the electric field generated by *AquaKLEAR*. These forces stretch the molecule. The stretching force is at it's maximum when the molecule is flowing inside the ferrite ring, causing the bonds to break. Therefore, the free Chlorine is released to become usable free Chlorine once more. Some of the organic materials will recombine with the free chlorine and form chloramines and THM's the rest will be flocculated by *AquaKLEAR* to other suspended particles and will be captured in the filter.

The chloramines and THM reduction process is linked to the flocculation process generated by *AquaKLEAR*.

If the best flocculation is not achieved; then the chloramines and THM's reduction process is negatively affected.

## Flocculants

With *AquakLEAR* there is no need for flocculants as the electric field generated by the unit breaks down any chemically flocculated particles as explained above! *AquakLEAR* is able to produce continuous flocculation effect as illustrated. The signal applied to the water by *AquakLEAR* is sinusoidal and will charge any suspended particle with a charge according to the state of voltage at the time. Assuming a frequency of 100 KHz and a speed of water of 10m/s.



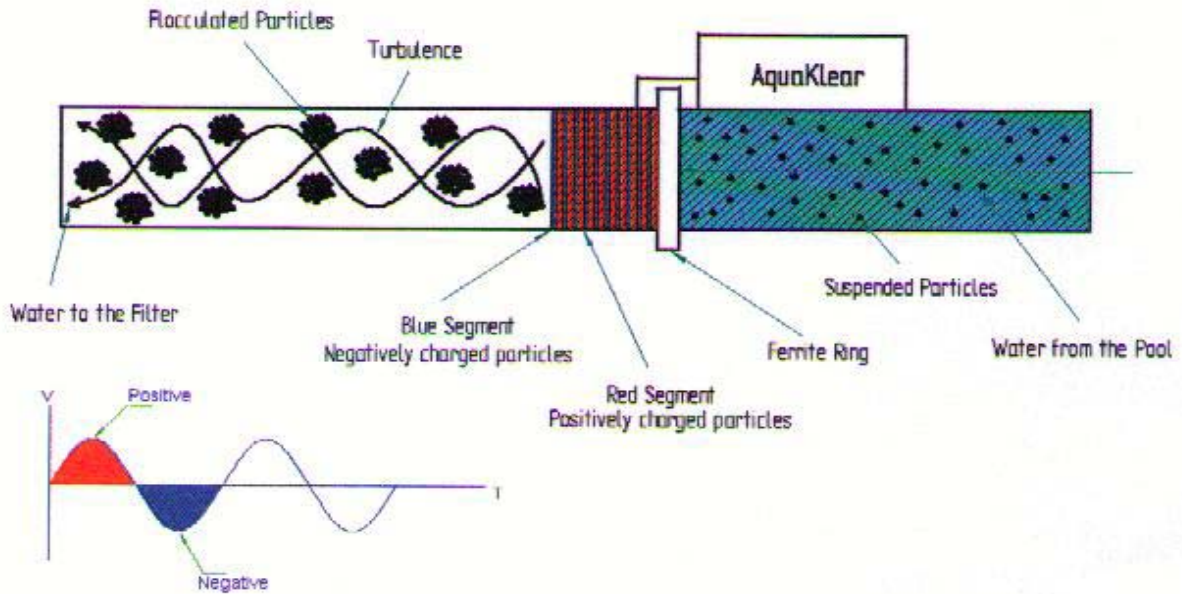
$$\text{Time} = [1/\text{Frequency}]/2 \quad (1/100,000)/2 = 0.000005 \text{ second}$$

$$\text{Distance} = \text{Speed of water} * \text{Time} \quad 10 * 0.000005 = 0.00005\text{m} = 0.05\text{mm}$$

Segments of water of .05mm that are charged alternatively. Are generated inside the ferrite ring,

Water molecules as illustrated above are bi-polar, the Hydrogen atoms have lost their electrons to the Oxygen atom thus becoming positively charged, the Oxygen has gained electrons thus becoming negatively charged. With the bond angle of  $104.31^\circ$ , the radius of the molecule is 1.38 Angstroms (Angstrom= $10^{-8}$  cm.), and the O-H distance is 0.99 Angstroms. The H atoms are so deeply embedded in the Oxygen as to make the molecule almost spherical. All charged suspended particles that are in the range of  $>1000$  Angstroms will be surrounded by water molecules as illustrated above. The charge of the suspended particle is reflected out and will attract other particles of the inverse charge. As the water molecules; as arranged are pure water, the conductivity is very low (38 billionths mho/cm at  $0^\circ$  C.), this prevents the inverse charges of the particles from being equalised. Large flock can be thus maintained. The process of flocculation generated by *AquakLEAR* is dependent on time and turbulence the same as chemical flocculants. Because *AquakLEAR* dose not add material, the filter is not blocked. As a result the time to flocculation remain unchanged. If this time is not changed the flocculation will not improve. To increase the time *AquakLEAR* will have to be moved away from the filter, before the pump, or further

on the intake pipe. If this is not practical the flow may have to be restricted by partially closing a valve or increasing turbulence by artificial means.



The backwashing of sand filters in swimming pools will not clear completely the sand filters of debris. As a result organic material is degrading in the filter creating methane. This methane will combine with chlorine to form THM's.

Because of the continues flocculation effect created by *AquaKLEAR* fine particles of organic material are flocculated and arrested in front of the filter. This eliminates the organic material from the filter and reduces any breakdown of organic material in the water.

The combine effect's of the breakdown of molecules in the AK and the elimination of organic material from the filter combine to reduce the level of THM's by up to 90%.