THE AIR QUALITY ISSUE

Indoor pools are increasingly experiencing problems with “bad air”. HVAC (Heating Ventilating & Air Conditioning) systems are designed to control air temperature. Some of them are designed to control humidity and air flow with fresh air mix when necessary. They are not air scrubbers, therefore the air quality is directly affected by the water quality, i.e. bad water = bad air! The “bad air” problem seems to stem from chloramines in the water: not chlorine, but chloramines. This is a chlorine compound that cannot burn off in the water. Chloramines are released during evaporation and when the water is agitated. Chloramines smell like ammonia and can cause serious respiratory problems for swimmers, staff around the pool and spectators in the stands.

Many municipal water companies are artificially adding chloramines in excess of 1.5 ppm (parts per million) to the city drinking water supply. In these instances, we highly recommend that pools look into installing an activated carbon filter for their make-up water. This will drastically reduce the amount of chloramines being added to the pool on a daily basis when fresh water is added.

Explanation: Many major municipalities and surrounding areas have switched their drinking water disinfection from chlorine to chloramine. Chloramine, a chlorine-ammonia compound, is more stable in the water system than chlorine, and breaks down slowly into chlorine and ammonia. While both methods, common nationwide, may sound ominous, there's little to worry about, except in special cases. Chloraminated water in medical dialysis, fish tanks and in certain business uses such as swimming pools will need to be specially filtered and treated. Chloraminated water can also cause rubber parts in plumbing, pumps, filters and water heaters to degrade more quickly. Chloramine-resistant replacement parts may be available.

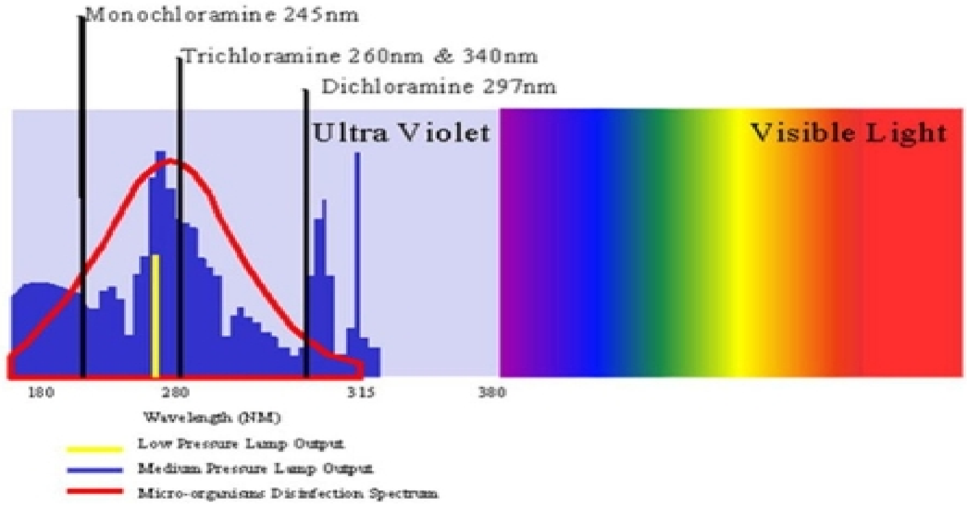
Chloramine disinfection professes to be preferable to chlorine for almost all uses: drinking, cooking, bathing, gardening and pets. The taste of the water may improve, the carcinogens called trihalomethanes formed by chlorine will be reduced, and more pathogens will be removed due to chloramines’ extra stability. As of January 1, the EPA has begun regulating chlorine, chloramines and byproduct levels in the drinking water of all communities, adding a nationwide level of oversight. Chlorine and chloramine levels are capped at 4 parts per million, but there is no cap set for ammonia. In some municipalities, chloramine and chlorine levels are capped at 2 ppm and ammonia at 0.5 ppm. Others are well above this level.

Chloramine and the small amount of ammonia produced in breakdown are neutralized in digestion, but chlorine can lead to eye and nose irritation, anemia, stomach discomfort, and damaged hair and skin. While the EPA's regulation combined with chloramines’ stability should minimize all these symptoms, there are solutions if you're still worried. Standard water filtration may not reduce and definitely will not eliminate chloramine and chlorine. While chlorine can be eliminated through boiling water or by letting it stand for a few days, neither method will eliminate chloramines. To eliminate chloramines in swimming pools, you will need a high quality granular activated carbon filter for source water (make-up water) and a dechloraminating system like medium pressure Ultra Violet.

USA Swimming’s Facility Development Department strongly advises that you do your own research as to which UV system fits your needs.

Water in a pool, if balanced perfectly, will pass through the UV system approximately every 6 hours. That means that the water in the pool has plenty of time to develop monochloramines therefore creating the “di's and tri's” during the time in the pool with the bathers. This will happen, it’s a natural process. When this water passes through the UV, the “mono's” might be destroyed but it leaves behind the “di's and tri's” which get returned to the pool. Current best information states that the “di's and tri's” are the worst culprits causing odor, corrosion and irritation. The water in the pool will have many hours to form these compounds before ever seeing the UV system again which is why the right type and size of system is imperative.

The graph below shows the different types of chloramines and what UV wave length is required to destroy them.



The Facilities Department of USA Swimming strongly recommends that all indoor pools, both new and existing, have UV systems installed. We have also developed a 20 minute CD power point with audio called the Safe-WAY (Water Air & You). Contact *Mick Nelson* for information.

The “pool atmosphere” issue is not new. There are many “expert” opinions on water and air quality and most of them have some good points. Currently over half of the Facilities Development Department’s calls for assistance have to do with poor air quality.

Here is some information that may help you investigate and solve your specific problem.

Remember: Air Quality and Water Quality are dependent on each other.
Air quality is affected by:

- The amount of fresh air that is introduced into the building every hour. This is dependent on outdoor climate and type of building. A 90% change of air every 20-25 minutes works well in warm areas.
- The condition of the air handling equipment filters. The filters should be cleaned or changed every 3 months. There are micro-filters that filter out more air-borne contaminates than the standard fiberglass or paper filters.
- The type of air handling system. Is there a Desert-Air type system and is it regularly serviced and working properly?
- Routine maintenance. This must be done regularly and tracked on all pieces of air handling equipment. Vents and louvers must be checked and lubed at least 4 times a year to make sure they are working properly. Dust must be removed from surface of vents. Motor belts and fuses also need to be checked.

If the air smells like chlorine, something is wrong
That acrid smell we sometimes associate with chlorine is usually an ammonia type compound. The cause of this odor is “chloramines”. As mentioned earlier in this article, chloramines, or combined chlorine, occurs when free chlorine combines with ammonia and other nitrogen compounds. This combining process can be accelerated by perspiration, urine, saliva, body oils, lotions and some shampoos/soaps, fertilizers, many industrial or household cleaners, and the municipal water company adding chloramines to the city water. The odor is created when water is not properly balanced and the chloramines exceed a certain level. The odor intensifies when swimmers agitate the water, as in kicking or general warm-up swimming. The odor is worse at water level but can be extremely irritating at deck level or in the viewing area. Many times eye irritation and breathing difficulties are also experienced. Sometimes, but not always, the water may be hazy. Many times, the water will appear perfectly clear and the water test for free chlorine and pH reads normal.
This is a widespread problem in indoor pools and people with asthma are particularly susceptible. Some hospitalizations have resulted. Outdoor pools have plenty of fresh air and sunshine (ultra violet light) so they are not as susceptible to the chloramine problem.

Chloramine formation can be accelerated by:

- Swimmers not properly showering before entering pool.
- Urination in the pool.

- Swimmers doing a high level of aerobic activity and sweating in the water. (Yes, swimmers sweat in the pool during exercise.)
- Residues from ammonia based cleaning products that are used on decks or in shower rooms.
- Residues from nitrogen based fertilizers used on landscaping.
- These residue get tracked into building on shoes.
- Poor air circulation and lack of fresh air introduction into the pool building.
- Over use of “shocking” the pool for maintenance purposes.
- Improper use of chemicals not suitable for conditions specific to a geographic area.
- Chloramines added to the municipal tap water. This is a very common practice now days.

Solutions and Prevention
Short term solutions:

- Shocking the pool: If Chloramines are detected the most common solution is to “shock” the water. This means super-chlorination (break-point chlorination) which involves raising the level of chlorine in the pool to 10 parts per million. A dry chlorine powder or a liquid chlorine is used to achieve super-chlorination. Recent studies show that many times this is not as effective as Hyper-chlorination which is raising the level of chlorine to 20 parts per million. However, even more recent studies suggest any level of shocking may not be a good idea and may not help the chloramine problem. These methods may temporarily “burn out” chloramines but will also necessitate closing the pool for a few days. Extra fresh air will also have to be introduced during this process. Shocking the pool can create a whole new set of problems and is at best a very short term solution.
- Some success has been realized with a non-chlorine shock additive. Adding an oxidizer (potassium peroxy, monosulphate; brand names Oxykleer or Oxybrite) to the water can release the available chlorine to free chlorine. If this process is done in the evening, swimmers can usually be in the pool the next morning. Fresh air introduction is still important. This is not a permanent solution and unfortunately it seems to be less and less effective each time it is used in the same pool.

Prevention:
Usually more than one thing needs to be changed to alleviate the problem. The most common methods are:

- Change the air circulation system to include more fresh air introduction and better turnover or more efficient closed system circulation and dehumidification.
- Evaluate the type and brands of chemicals being used to treat the pool water for both chlorine and pH control.
- Evaluate the pool filtration system to see if a filter that filters down to a more effective micron rating (like DE at 4 microns) would help.
- Check the labels on all cleaning products to make sure they do not contain ammonia or are not nitrogen enriched.
- Have the staff get the users of the pool to take showers before entering. This is usually required by state health codes but many pool users resist the practice.
- Consider installing an Ultra Violet (UV) water treatment system that cuts down on the amount of chlorine used and also “breaks down” all three chlormine types: mono and di and tri chloramines.
- Install an activated carbon filter to remove chloramines from the city water that is used to fill or add water to the pool.

When does the pool water need to be changed?
The frequency of changing pool water depends on:

- The size of the pool
- The water temperature
- The bather load
- The type and brand of chemicals used
- The type of filter and the turnover rate

In general, the smaller the pool the more frequently the water has to be changed. Hot tubs in the 300 to 600 gallon range need to be drained and refilled at least monthly. A monthly change is required by many state Departments of Public Health.

Many specialty pools, such as lessons pools or therapy pools in the 1,500 to 5,000 gallon range need to be drained every 3 to 4 months. The warmer the water and the higher the bather load, the more frequently the water needs to be changed.

Larger pools, such as lap pools and competitive pools can actually go years before needing to be drained. Because of the large surface area that is exposed to evaporation, new water is constantly being added. In effect the water is always in a state of renewal. We have seen pools with perfect water that have not been drained for four years or more. Some things that can shorten the life of the pool water and necessitate early draining:

- Improper chemicals with non-soluble buffers or binders and poorly designed “inert ingredients”
- Poor quality filtration
- Continually “shocking” the pool to break up chloramines
- Users not taking showers before entering the pool

Problems cannot be ignored. Serious health and safety issues are involved. Everyone who works in an aquatic facility needs to be made aware of the importance of a clean and healthy environment.

“UV or not to be” that is the question…

Water treatment is almost always the problem when the air is “bad”. According to research from several sources, improperly balanced chlorinated pools can actually cause asthma. These findings may explain why swimmers are more prone to exercise induced asthma than athletes in other sports. "Results show that nitrogen trichloride (produced by high levels of available Chlorine) is a cause of occupational asthma in swimming pool workers like lifeguards and swim instructors," says Dr. K. Thickett of the Occupational Lung Diseases Unit at the Birmingham Heartlands Hospital. In Dr. Thickett's study, each of the subjects either stopped taking inhaled corticosteroids altogether, or their asthma symptoms resolved significantly once they were placed in other environments away from the swimming pools. Dr. Thickett's study was backed up by research from other European and Australian sources.

The problem isn't the chlorine, but what chlorine turns into when combined with organics. As mentioned earlier, the organics are contributed by bathers in the pool in the form of sweat, dander, urine and other organics. The chlorine reacts with the organics and produces nitrogen trichloride, aldehydes, halogenated hydrocarbons, chloroform, trihalomethanes and chloramines. In addition, as mentioned previously, many municipalities are now chloraminating the source water.

Dr. John Marshall, of the Pure Water Association, an American consumer group campaigning for safer drinking water, states: "It shows we should be paying more attention to the chemicals we put in our water and we should be looking for other alternatives to high levels of chlorination.” There are options that are safe, and non-toxic, such as treating water with ultra violet light.

When compared to chlorine “feeder systems, Ultra Violet systems involve a higher initial capital cost. However, over the life of the pool Ultraviolet technologies reduce the on-going operating and maintenance costs. This can be significant. Chlorine is famous for destroying pool infrastructures, rusting out ventilation systems and destroying pool liners and coatings. UV poses no such problems. The UV/chlorine pool will be much cleaner, which means dirt, grease, oils, organics and other materials will wind up in the filter system much faster than with highly chlorinated systems.

Part of the problem in adopting UV is that many engineers, architects, pool builders and designers are not familiar with the technology. Engineering, architectural and other technical training has all been geared to chlorine. It takes significant re-education to now apply UV and many in the industry are reluctant. However, once pool owners add UV, they realize that they no longer have to put up with red eyes, rashes, “bad” air and the health consequences of over chlorinated pools. This will increase the demand for UV technology. Expect to see more expertise at the local pool builder or pool maintenance companies. However, be aware that many of these companies rely on repeat sales of chemicals. These companies may be highly resistant to UV systems as revenue for chemicals will drop. For pool maintenance companies that are paid to keep pools clean, UV is great. They spend less time maintaining pools and the pools will be cleaner.

UV does not replace chlorine. It allows you to maintain a lower residual chlorine reading and allows the chlorine to be used for disinfesting. Each state Department of Public Health will have a copy of the state’s regulations and limitations for using UV in commercial pool applications. Each state may have different codes and getting them to lower their required minimum chlorine levels can be very challenging.

What is ultraviolet or UV?
Ultraviolet light is part of the light spectrum, which is classified into three wave length ranges:

- UV-C, from 100 nanometers (nm) to 280 nm
- UV-B, from 280 nm to 315 nm
- UV-A, from 315 nm to 400 nm.

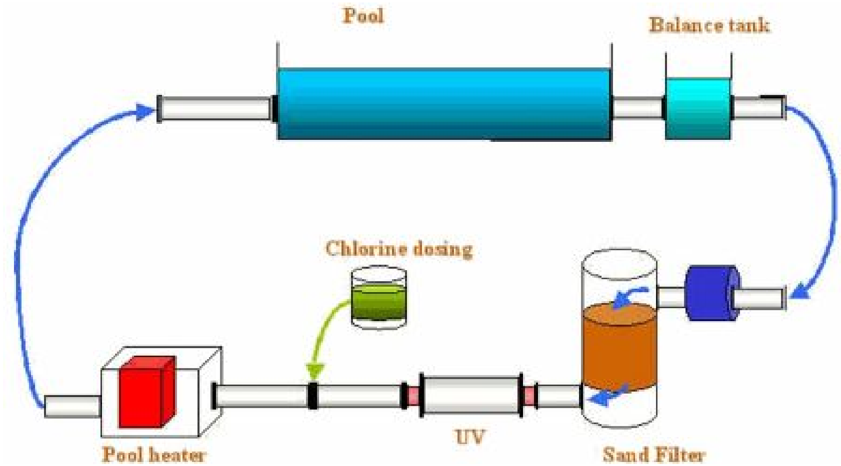
UV-C light is germicidal, which means that it deactivates the DNA of bacteria, viruses and other pathogens and thus destroys their ability to multiply and cause disease. Certain wave lengths also break down chloramines that develop in indoor swimming pool water.

Specifically, UV-C light causes damage to the nucleic acid of microorganisms by forming covalent bonds between certain adjacent bases in the DNA. The formation of such bonds prevents the DNA from being unzipped for replication, and the organism is unable to reproduce. In fact, when the organism tries to replicate, it dies.

Ultraviolet technology is a non-chemical approach to assist disinfection. In this method of disinfection, nothing is added to the pool water except chlorine and pH control chemicals. This makes this process simple, inexpensive and requires very low maintenance. Ultraviolet purifiers utilize germicidal lamps that are designed and calculated to produce a certain dosage of ultraviolet (usually at least 16,000 microwatt seconds per square centimeter but many units actually have a much higher dosage.) The principle of design is based on a product of time and intensity: they must have a certain amount of both for a successful design.

How do ultraviolet purifiers work?
Short wave pressure mercury vapor tubes that produce ultraviolet wavelengths are installed in a water tight chamber. The UV system is installed after the pool filter and the return water to the pool is circulated 100% through the tube. Approximately 95% of the ultraviolet energy emitted is at the mercury resonance line of 254 nanometers. This wavelength is in the region of maximum germicidal effectiveness and is highly lethal to virus, bacteria and mold spores. Therefore, the water or air that passes through the chamber is exposed to the germicidal UV light and the genetic material of the micro-organism is deactivated, which prevents them from reproducing. Other wave lengths can successfully break down chloramines so make sure to check the difference between low pressure and medium pressure UV.

Typical UV Unit Shown below


Pool
Balance tank
Chlorine dosing
Pool heater
UV
Sand Filter