



TwinOxide[®]

Superior Water Disinfection Power

Application Document

How to implement *TwinOxide*[®] in swimming pools & whirl pools

TwinOxide[®] Application Document

Status:	Final
Publication Date:	11 May 2007
Document Origination:	April/May 2007
Audience:	Chemist/Engineer
Document Status:	Final
Publication Status:	Published
Update Monitoring:	Quarterly
Document name:	Application Document - Swimming Pools - 2007.05.11 .doc
Photos:	Courtesy of J+L

1/9

© 2007 TwinOxide International B.V. – All Rights Reserved

Disclaimer: This information relates to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. Such information is to the best of our knowledge and belief, accurate and reliable as of the date compiled. However, no representation, warranty or guarantee is made as to its accuracy, reliability or completeness. **NO WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED, IS MADE CONCERNING THE INFORMATION HERIN PROVIDED.** It is the user's responsibility to satisfy himself as to the suitability and completeness of such information for his own particular use. We do not accept liability for any loss or damage that may occur from the use of this information nor do we offer warranty against patent infringement.

TwinOxide[®] and the TwinOxide[®] Logo are registered trademarks of TwinOxide International B.V.



Disinfection of swimming pools with TwinOxide®

The most widespread used disinfectant for swimming pools is chlorine. The use of chlorine implies numerous general acknowledged disadvantages and hazards. The hazards of chlorine involve both safety and health related risks and effects that can only be avoided by ending the use of chlorine and applying a disinfectant with completely different characteristics.

TwinOxide® is a superior disinfection concept that has been acknowledged in numerous countries and that re-defines the minimum characteristics of a 21st century disinfectant.

The swimming pool industry has been looking for alternatives to replace the use of chlorine for a long time. Many chemical and mechanical concepts have been tested and evaluated but with only limited results or new problems to be tackled.

TwinOxide®, an advanced delivery system to generate 99.9x% pure chlorine dioxide in an aqueous 0.3% solution allows a full replacement of chlorine with sublime disinfection results satisfying the requirements and needs of the swimming pool industry and swimmers!

When TwinOxide® is applied in a swimming pool many of the undesired limitations of classical disinfectants are absent, e.g.:

- TwinOxide® provides more microbiological security as the full spectrum disinfection capacity of TwinOxide® kills all in water common micro-organisms, viruses and pathogens (including Legionella control);
- TwinOxide® removes the biofilm and inhibits the reformation of this dangerous biofilm;
- TwinOxide® does not cause allergic reactions (no skin irritation or ruptures, no activation of the mucous glances, no eye irritation) and does not generate the typical pool smell and therefore improves the swimming experience;
- TwinOxide® does not generate TriHaloMethanes (THM's) or other carcinogenic by-products;
- TwinOxide® is not corrosive and erroneous dosing (overdosing) does not cause an immediate risk for swimmers;
- TwinOxide® enables you to provide swimming comfort without the use of chlorine and does not generate chlorite, chlorate or free chlorine;
- TwinOxide® is not explosive and a chemical substance with only a limited hazard class;
- TwinOxide is applied with standard equipment commonly used in the swimming pool industry;
- TwinOxide® provides its superior disinfection power in a broad pH-level bandwidth (pH-level 4 to 10);
- The number of back flush procedures may decrease (cost saving);
- Less chemical use to optimize microbiological control in a pool;
- Only limited use of pH-level adjustment chemicals;
- No use of chlorine!

Before applying TwinOxide® in a swimming pool the following steps should be followed:

1. Stop the dosing of chlorine for at least 1 day and maximum 3 days;
2. Perform a stand disinfection of 6-8 hours on the (sand) filters with 10ppm TwinOxide® (based on the volume of the sand filter) and back flush the filter(s) afterwards;
3. Add a primary dosage of at least 0.6ppm and maximum 1.0ppm TwinOxide® to the swimming pool (based on the total volume of water in the swimming pool system) in the evening so that overnight contact is optimized without additional swimmers load on the swimming pool;
4. After the initial dosage of TwinOxide® keep the level of TwinOxide® in the pool at a level of at least 0.2ppm;
5. A monthly stand disinfection of the filters is recommended.

To calculate the required volume of TwinOxide® for a given dosage rate and pool water volume, the following formula is used:

$$\frac{\text{Water volume to be disinfected} \times \text{dosage rate in ppm}}{3000} = \text{Liters TwinOxide® 0.3\% solution}$$

TwinOxide® calculation formula

Step 1. Stop the dosing of chlorine

Before adding TwinOxide® to the swimming pool the level of chlorine needs to decrease. Therefore at least 1 day and up to maximum 3 days before adding TwinOxide® the dosing of chlorine to the pool should be stopped. (In hot climate conditions or high level of UV radiation conditions, this dosing of chlorine should stop maximum 1 day before applying TwinOxide®).

Step 2. Stand disinfection of the filters

Filters contain high concentrations of organic substances that cause a microbiological risk to the pool. To minimize this risk a stand disinfection of the filters is required. Numerous countries oblige filter stand disinfection by law (e.g. in some countries filters must be disinfected individually at least once a month).

Swimming pools most commonly use sand filters either in combination with active coal filters. As TwinOxide® does not generate THM's the absorption function of active coal is not necessary. Removal of the active coal filter may therefore be considered.

Filter disinfection procedure:

- Based on the volume of the filter(s) add 10ppm of TwinOxide® to the filter
- Allow a contact time of at least 6-8 hours.
- After the stand disinfection thoroughly back flush the filters.
- Execute an optical inspection. If the filters are highly contaminated repeat the stand disinfection procedure.

Step 3. Add a primary dosage of 0.6ppm (maximum 1ppm) TwinOxide® to the swimming pool

After the filter stand disinfection TwinOxide® is added to the swimming pool.

- The initial dosage level of TwinOxide® is higher as it readily reacts with all organic compounds (e.g. bacteria, biofilm, dissolved organics etc).
- After adding this initial dosing level the minimum required level of TwinOxide® in the swimming pool must be 0.2ppm. Add this initial dosing in the evening when the pool is no longer used.
- As TwinOxide® removes (gradually) the biofilm (that chlorine cannot remove) special attention is required as strings of biofilm may release and enter into the pool system. Possible temporary increase of bacteria count may be anticipated when the biofilm is releasing. Regularly the filters and grids need to be inspected and back flushed when necessary. Extra filtering may be required.

It may take between 5 to 12 days before the biofilm release actually starts.

Depending on the amount of biofilm in the system it may take up to six weeks before the total biofilm is removed from the pool system. Biofilm removal is unpredictable and should always be monitored (it may take even several months before sticky biofilm particles are removed by TwinOxide®).



Biofilm release by using TwinOxide®

Step 4. Keep the level of TwinOxide® in the pool at 0.2ppm

In order to maintain the level of TwinOxide® at a minimum of at least 0.2ppm at all times dosing and measuring equipment need to be used to provide permanent disinfection capacity to the swimming pool.

A typical permanent and automatic *system for continuous dosing* of TwinOxide® contains various equipment components that need to be installed. The technical equipment to apply TwinOxide® into a swimming pool is standard available in the market. The level of sophistication of the dosing systems may depend on customer requirements. Very often the dosing equipment of chlorine can be used to apply TwinOxide®. (Ask your equipment supplier).

A typical dosing system for TwinOxide® features:

- A dosing pump (acid resistant);
- A black PE-HD storage vessel + one spare storage vessel;
- A Redox sensor;
- An injection point (placed behind the filter and behind the flow pump)
- A simple or sophisticated control unit to manage the dosing pump and sensor (if necessary linked to the integral building management control system)

The level of TwinOxide® in the swimming pool can be measured on line and manually.

Manual Measuring:

The manual measuring of TwinOxide® is executed with a photometer/spectro photometer with DPD1 (the photometer should have a ClO₂ setting in the menu). Consult the manual of the photometer for this feature).

Online Measuring:

TwinOxide® is measured online with a redox sensor. The sensors should be calibrated according to the manufacturer's directions. (The typical redox value for a swimming pool is 740 mvA (minimum 720mvA)).



TwinOxide® dosing System



Redox sensor to measure the level of TwinOxide®

Step 5. Monthly stand disinfection of the filters

The execution of a periodical **stand disinfection** of the filters is highly recommended as the accumulation of organic compounds may contribute to the level of micro biological contamination. See Step 2 in this document for the stand disinfection procedure.

If the filters are small (e.g. a whirlpool) a contact vessel with cover may ease the filter disinfection procedure.



Vessel with cover for stand disinfection of small filters

© 2007 TwinOxide International B.V. – All Rights Reserved

Disclaimer: This information relates to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. Such information is to the best of our knowledge and belief, accurate and reliable as of the date compiled. However, no representation, warranty or guarantee is made as to its accuracy, reliability or completeness. **NO WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED, IS MADE CONCERNING THE INFORMATION HERIN PROVIDED.** It is the user's responsibility to satisfy himself as to the suitability and completeness of such information for his own particular use. We do not accept liability for any loss or damage that may occur from the use of this information nor do we offer warranty against patent infringement.

TwinOxide® and the TwinOxide® Logo are registered trademarks of TwinOxide International B.V.

Topics to be considered:

- If the circuit contains pumps with rubber sleeves, these sleeves may contain a high deposit of organics, e.g. biofilm and algae as organic substances have a tendency to deposit on rubber.
- It is important to understand that an outside pool endures more influence from temperature, direct sunlight and UV radiation. These three factors may influence the consumption of TwinOxide®. Therefore covering a pool when not in use is advised;
- The standard level of TwinOxide® in a swimming pool or whirlpool is 0.3ppm. The standard level may deviate depending on local laws and regulations.
- Extra monitoring and extra addition of TwinOxide® may be required after thunder/lightning weather conditions as these have the same effect on TwinOxide® as they have on chlorine. (Oxidizers may completely disappear during thunder/lightning weather conditions, even when a pool is covered).
- TwinOxide® can be used in combination with possible present Ozone or UV equipment. It is strongly advisable to dosage TwinOxide® after the Ozone or UV equipment.
- TwinOxide® provides full spectrum disinfection at pH-level 4 to 10. This means that the pH-level does not require monitoring for disinfection effectiveness (like with chlorine!). As pool water inclines to increase in pH-level the water becomes more alkaline. This may be noticed by a dried skin of swimmers.
Intermittent addition of an acid to the pool will decrease the pH-level and optimizes the level of comfort and swimming experience
- Always respect the local law and regulations (e.g. in some countries it is *not* allowed to manually add a disinfectant to a public swimming pool, in some countries a special permit is required when chlorine is not used). In most countries manual dosing of a disinfectant is allowed in private pools.

Example: A swimming pool with 320,000 Liter of water:

Add an initial dosage rate of 0.6ppm of TwinOxide® to the swimming pool water volume based on the following formula:

$$\frac{\text{Water volume to be disinfected} \times \text{dosage rate in ppm}}{3000} = \text{Liters TwinOxide}^{\circ} \text{ 0.3\% solution}$$

TwinOxide® calculation formula

Example:

Volume of pool:	300,000 Liter
Total volume of water in the pool system	320,000 Liter
Primary Dosage:	0.6ppm

$$\frac{320,000 \times 0.6}{3000} = 64 \text{ Liter TwinOxide}^{\circ} \text{ 0.3\% solution}$$

The initial dosage volume of 64 Liter in our example must be added to the pool in a short time frame (maximum 2 hours) after closure time in the evening. This can be poured into the pool manually while respecting safety measures from the MSDS and avoid inhalation at all times. Or set the dosage pump to rapidly add this initial dosage volume of TwinOxide® into the pool system.

Use of TwinOxide® in private indoor swimming pool without automatic dosing/measuring system:

1. Stop the dosing of chlorine for at least 1 day and for maximum 3 days;
2. Perform a stand disinfection of 6-8 hours on the (sand) filters with 10ppm TwinOxide® (based on the volume of the sand filter) and back flush the filter(s) afterwards;
3. Add a primary dosage of 0.6ppm TwinOxide® to the swimming pool (based on the volume of water in the swimming pool) in the evening so that overnight contact is optimized without additional swimmers load on the swimming pool;
4. Add at least each once a week a dosage of 0.2ppm TwinOxide® to the swimming pool water volume in the evening (= 6,67liter TwinOxide® per 100,000 liter swimming water). This ensures that overnight contact is optimized without additional swimmers load on the swimming pool;
5. When there are outstanding weather conditions(hot and sunny) and when the swimming pool is very intensively used, add a dosage of 0.2ppm TwinOxide® two times per week;
6. A monthly stand disinfection of the filters is recommended;
7. Watch out for lightning weather conditions as lightning has the same effect on TwinOxide® as they have on chlorine. (Oxidizers disappear with lightning even when a pool is covered);
8. It is strongly advised that the indoor pool is covered over night and when not in use (equal to chlorine).

Use of TwinOxide® in private outdoor swimming pool without automatic dosing/measuring system:

1. Stop the dosing of chlorine for at least 1 day and for maximum 3 days;
2. Perform a stand disinfection of 6-8 hours on the (sand) filters with 10ppm TwinOxide® (based on the volume of the sand filter) and back flush the filter(s) afterwards;
3. Add a primary dosage of 0.6ppm TwinOxide® to the swimming pool (based on the volume of water in the swimming pool) in the evening so that overnight contact is optimized without additional swimmers load on the swimming pool;
4. During summer time: Add two times per week a dosage of 0.2ppm TwinOxide® to the swimming pool in the evening (= 6,67liter TwinOxide® per 100,000 liter swimming water). This ensures that overnight contact is optimized without additional swimmers load on the swimming pool;
5. When there are outstanding weather conditions(hot and sunny) and when the swimming pool is very intensively used, add a dosage of 0.3ppm TwinOxide® two times per week to the swimming pool in the evening;
6. A monthly stand disinfection of the filters is recommended;
7. Watch out for lightning weather conditions as lightning has the same effect on TwinOxide® as they have on chlorine. (Oxidizers disappear with lightning even when a pool is covered).
8. It is strongly advised that the indoor pool is covered over night and when not in use (equal to chlorine).



Biofilm release considerations

In most cases a pool has been treated with chlorine, prior to the use of TwinOxide®. The use of chlorine almost guarantees the presence of biofilm in the total pool system. Biofilm can be noticed on the ceramic tiles in the pool (slimy sediment), but it is very difficult to determine the intensity of the volume of biofilm sediment present in the pipelines. Further it is very difficult to predict how sticky a biofilm layer is.

After the initial dosage of 1ppm TwinOxide® to the pool the scavenging and removal process of the biofilm starts and will continue until the biofilm is completely removed from the system. This removal process may some time (in most cases within 6 weeks but in some cases the last biofilm particles were removed after a some months of continuous use of TwinOxide®).

Within 2-3 days some biofilm sediments may be detected optically in the pool. This is the soft part of the biofilm that readily reacts with TwinOxide®. By extra filtration and appropriate measures this soft part of the biofilm can simply be removed from the swimming pool. During this stage some more turbidity may be noticed in the swimming pool. This effect cannot be avoided but TwinOxide® already proofs its superior characteristics of oxidation and disinfection that were not available when using chlorine!

After removal of the soft part of the biofilm, TwinOxide® will start with the removal of the though part of the biofilm. This is the layer that has been build up during time and that chlorine could never remove. This biofilm contains high levels of organics and contains and hides colonies of bacteria.

In general after 10-14 days the biofilm starts to release from the pipelines and this mostly happens as a combination of large strings and small chips of biofilm with a brown color. During this time the bacteria count in the water may increase as colonies of bacteria are released together with the biofilm.

Extra attention to filtration is required and pool operators should regularly inspect the pool and (obviously) the safety of swimmers should be considered at all time.

This biofilm presence implies that during the first weeks of using TwinOxide® in a swimming pool the consumption of TwinOxide® may be higher as not only the normal disinfection takes place. The biofilm and bacteria colonies in the biofilm are under continuous exposure of TwinOxide® and the oxidation and disinfection power contributes to the consumption of TwinOxide® present in the pool water.

It is difficult to predict how long this biofilm removal process takes as the identification of the volume of biofilm is very difficult and factors like the age of the pool system play an important role too. (A new pool obviously contains less biofilm than a pool facility built 25 years ago!).

Bear in mind that in addition to disinfection TwinOxide® cleans up the mess that chlorine has left behind!

The biofilm removal process is very unpredictable and should always be monitored. In some cases it may take even several months before the last sticky biofilm particles are totally removed by TwinOxide®.

The swimming pool water gets a temporarily green type of color after applying TwinOxide®

In some cases where pools converted from chlorine to TwinOxide® situations have been reported where the pool water discolored with a green shade color.

First of all: The green color does NOT come from TwinOxide®! Although the TwinOxide® 0.3% solution has a yellow/greenish color, TwinOxide® cannot discolor water into a green color.

- The dosage rate levels of TwinOxide® are low and cannot contribute to discoloring the water;
- TwinOxide® with superb oxidation capacities actually improves the water color (and is in some applications used as a bleaching agent of e.g. paper or textile).

The green color is not caused by the color of TwinOxide® 0.3% solution but a result from the addition of TwinOxide® to the water and the immediate reaction with (soluble) iron and/or (soluble) manganese. In the situation that the pool water and make-up water are completely free from (soluble) iron and/or (soluble) manganese, these sediments may be present in the biofilm.

The total set of iron and/or manganese in the biofilm/water, with the release of the biofilm (containing high level of organics) causes the water to turn slightly green.

This is a harmless color effect and in the majority of cases the color disappears after 1 day. When dosing at levels of 1ppm or more, the slight green colorization may occur a little more often but disappears too. While the swimming pool has this green shade the pool can be used as normal.

Please bear in mind that TwinOxide® oxidizes the iron and manganese and increases the pool water quality. The temporary slightly green color shade is a harmless effect from the presence of these substances and disappears in time. The temporary green color shade may be noticed too when adding make-up water.

Painted in pools

Some swimming pools are painted. Paint very often contains a high level of organics and thus reacts with TwinOxide®. This means that the paint may cause some extra consumption of TwinOxide®. Paint that contains organics is an ideal place for bacteria and algae to adhere and thus causes more activity from TwinOxide®.

When algae are detected in a private swimming pool

In the event that algae are detected in a (private) swimming pool a shock dosage of TwinOxide® can be applied. A shock dosage of 3ppm-5ppm will kill the algae and by increasing the water turn around optimized filtration is established to remove the algae from the swimming water. After a shock treatment with TwinOxide® the swimming pool should not be used for at least 2 hours to ensure maximum disinfection power for algae removal.

Dosing and measuring equipment

For additional information on dosing and measuring equipment you may contact your TwinOxide® reseller.

TwinOxide® is available in various packaging sizes that fit to customer requirements.