**What is Solar Disinfection?**

*Watch Water®* has created a proprietary innovation **solar engine** for molecular chemistry. In the water treatment industry, product discovery never stops. Rather than relying on off-the-shelf treatment, *Watch Water®* constantly seek for new treatment that could make for better results. Watch TiO₂ is used in various applications for its **PHOTOCATALYTIC** properties shown in the figure. In these applications, Watch TiO₂ in the presence of light catalyzes the degradation or other reaction of undesired chemicals or microorganisms. Watch TiO₂ is currently used as a photocatalyst.

<table>
<thead>
<tr>
<th>Titansorb</th>
<th>Adsorber for Heavy Metals</th>
<th>Granules</th>
</tr>
</thead>
<tbody>
<tr>
<td>CarbonBlock-TS</td>
<td>Removal of organics and inorganics. Self-regenerable.</td>
<td>Block</td>
</tr>
<tr>
<td>SuperOxy</td>
<td>Regeneration of Activated Carbon</td>
<td>Powder</td>
</tr>
</tbody>
</table>

Now large-scale production and use of *Watch – TiO₂* in SOLAROXY-3C with multiple products to clean water pollution from A to Z using solar energy.

**WATER POLLUTION?**

a) **Water Pollution:** is in our River’s, Reservoirs, Lakes, and Seas are drowning in Chemicals, Plastic Waste, Pharmaceuticals, Sewage, and other pollutants.

b) **Water Pollution:** occurs when harmful substances – often chemicals and microorganism contaminate a stream, river, lake, ocean, aquifer, or another body of water, degrading water quality, air quality and contribute its toxic to humans or the environment.

c) **Water Pollution:** According to the most recent surveys on water quality from the U.S. Environment Protection Agency, nearly 75% of our rivers, lakes, streams and more than half of our surface water is polluted and unfit for swimming, fishing, and drinking.

d) **Water Pollution:** This is mostly caused by sewage and industrial wastewater. Used water is wastewater it comes from our sinks, showers, and toilets (think sewage) and from commercial, industrial and agriculture activities (think metals, solvents, and toxic sludge). The term also includes stormwater runoff, which occurs when rainfall carries road salt, rubber, oil, grease chemicals, and debris from impermeable surfaces into our waterways.

e) **Water Pollution:** More than 90% of the world’s wastewater flows back into the environment without being treated or reused. Using SOLAROXY-3C by wastewater treatment facilities. Billion’s of gallon’s of wastewater can be treated easily. This low-cost Solar technology can reduce the amount of pollutant’s such as Hydrogen Sulfide, Methane, Carbon dioxide, Pathogens, Arsenic, Lead, Phosphorus and Nitrates in sewage. SOLAROXY-3C adsorbs heavy metals and toxic chemicals.

www.watchwater.de
OIL POLLUTION

Consumers account for the vast majority of oil pollution in our sea’s, including oil and gasoline that drips from million of cars and trucks every day. Moreover, nearly half of the 2 million tons of oil that makes its way into marine environments each year comes not only from tanker spills but also from land-based sources such as factories, farms, and cities. At sea, tankers spills account for about 10 percent of the oil in water around the world, while regular operations of the shipping industry – through both legal and illegal discharges contribute about one third.

All mentioned water pollutions contain complex molecules that are bio-refractory in nature. Therefore, they inhibit biological water and wastewater treatment processes and cannot be completely degraded by any of the conventional biological processes. Thus, we introduced this novel method for remediation of water and wastewater.

Catalyst and Oxidation

TiO² OXY

The Oxydes-P is a strong oxidant with high oxidation potential of $E^* = 3.7 \text{ V}$ and upon activation with solar energy and catalyst TiO₂, it starts to produce strong free sulfate radicals (SO₄²⁻), which are even stronger oxidants ($E^* = 4.2 \text{ V}$). Therefore, SOLAROXY-3C is capable to degrade almost all pollutants, even those with high toxicity and persistence. This can be applied to not only in wastewater but also in polluted Streams, Rivers, Lakes, Surface and Groundwater.

Physical and Chemical Properties of SOLAROXY-3C

<table>
<thead>
<tr>
<th>Physical Name</th>
<th>SOLAROXY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Form</td>
<td>Crystalline (Triclinic)</td>
</tr>
<tr>
<td>Melting Point</td>
<td>Decomposes at 10 °C</td>
</tr>
<tr>
<td>Boiling Point</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Formula</td>
<td>UV/ TiO₂/ OXYDES-P</td>
</tr>
<tr>
<td>Molecular Weight (g/mol)</td>
<td>270.3</td>
</tr>
<tr>
<td>Crystal density at 20 °C (g/cc)</td>
<td>2.48</td>
</tr>
<tr>
<td>Colour</td>
<td>White</td>
</tr>
<tr>
<td>Odor</td>
<td>None</td>
</tr>
<tr>
<td>Loose bulk density (g/cc)</td>
<td>1.40</td>
</tr>
<tr>
<td>Solubility g/100g of H₂O₂ at 25 °C in water</td>
<td>6</td>
</tr>
</tbody>
</table>

Due to SOLAROXY-3C unique properties it can be used for polluted soil, water and wastewater remediation or in other environmental applications. SOLAROXY-3C is the best available technology to oxidize non-filterable contaminants in Aquatic farms, Swimming pools and other recreational water. SOLAROXY-3C is in the area of (VAOP’s) Very Advanced Oxidation Process. AOP’s are applied as a pre-treatment or for complete mineralization at degradation of complex pollutants. SOLAROXY-3C can be defined as a process that involves the generation of both hydroxyl radicals as well as sulfate radicals as a strongest oxidant to degrade compounds that cannot be oxidized by conventional oxidants, like ineffective Aeration, Ozone, UV and Chlorine.
UV - Oxidation

UV-Oxidation treatment is getting bigger and brighter for over last 100 years – but – their electrical bill has also increased and going higher and higher. Solar treatment requires no power and is energy saving alternative. Only Solar treatment is Green Treatment for water and Waste Water. Watch-Water is introducing SOLAROXY-3C that emit ultraviolet (UV) light which could improve treatment processes for removing micropollutants in water and wastewater, including harmful pesticides and organic matter.

If the time comes when UV-Oxidation needs to be rolled out on a much larger scale across the Water supply network, the potential limitations to the process as it stands will become clear : not affordable in electricity bill. The UV lamps required are expensive to purchase at the outset and expensive to run at scale. UV lamps also do not burn out as normal bulbs do. They “SOLARIZE” which means their intensity can be reduced by up to 60% through just one year of continuous use. This is even shorten significantly if the lamp is turned on and off frequently, meaning their effectiveness and feasibility is reduced. UV lamps also contain mercury and they often break. This lead to risk of Mercury release in water and wastewater. Also their disposal must be properly managed.

UV LAMPS ARE NOT A GREEN SOLUTION

SOLAROXY-3C in water treatment processes is a real Innovation. Watch Water VAOP involves the combination of SOLAR – TiO₂ – H₂O₂. This oxidation process is very attractive for water treatment since crystalline Watch TiO₂ can be easily separated at the end of the process and reused, which makes the treatment effective and absolute chemical free.

Watch Water is focusing on implementing this (VAOP) at large scale. By Adsorbing Light, Watch TiO₂ excites an electron and the excited electron is transferred to a single oxygen atom through simple oxidation state change. The transfer of an electron in turn changes back surrounding TiO₂ structures. The crystal form of Watch TiO₂ has a decisive effect on its catalytic performance.

Oxidative – Reductive Reactions of SOLAR + WATCH TiO₂+ OXY

<table>
<thead>
<tr>
<th>Step</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Photoexcitation TiO₂⁺hv</td>
</tr>
<tr>
<td>2</td>
<td>Charge-carrier trapping of e⁻</td>
</tr>
<tr>
<td>3</td>
<td>Charge-carrier trapping of h⁺</td>
</tr>
<tr>
<td>4</td>
<td>Electron – hole recombination</td>
</tr>
<tr>
<td>5</td>
<td>Photoexcited e⁻ scavenging</td>
</tr>
<tr>
<td>6</td>
<td>Oxidation of hydroxyls</td>
</tr>
<tr>
<td>7</td>
<td>Photodegrading by OH⁺</td>
</tr>
<tr>
<td>8</td>
<td>Photodegradation by SO₄²⁻</td>
</tr>
<tr>
<td>9</td>
<td>Direct Photoholes</td>
</tr>
<tr>
<td>10</td>
<td>Protonation of Super Oxides O₂⁺+OH⁺-&gt; HOO</td>
</tr>
<tr>
<td>11</td>
<td>CO₂ Scavenging of e⁻ HOO⁺+e⁻&gt; HO₂⁻</td>
</tr>
<tr>
<td>12</td>
<td>Formation of H₂O₂ HOO⁺+H⁺-&gt; H₂O₂</td>
</tr>
</tbody>
</table>
And in the absence of this CO$_2$ in Water there will be no Carbonate Chemistry. Alkalinity found in natured waters mostly derives from ...

\[ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \] (Carbonic Acid)

\[ \text{HCO}_3 \rightarrow \text{Bicarbonate} \]

\[ \text{CO}_3 \rightarrow \text{Carbonate} \]

Alkalinity is a measurement of the capability for water to accept protons (H$^+$-ions), without a measurable change in pH level. This is the parameter of Drinking water which works to retain the pH level in the range of 6.5 to 9.5 pH units. In human health criteria table, Alkalinity is simply listed as a Non-Priority-Pollutant (NP) and no recommended value is given. Alkalinity is most often expressed as CaCO$_3$, same as Water Hardness.

An important precursor to these set of reactions is the absolute necessity of molecules, without which, hydroxyl radicals could not be created. The formation of not only hydroxyl radicals and sulfate radicals but also the superoxide anions (O$_2^-$) which contributes to the formation of Hydrogen Peroxide. The combination of these three very strong oxidants generates (VAOP’s) and series of mineralization reaction’s geared toward the destruction of all organic contaminants.

Titanium dioxide became a photocatalysis when Watch Water started manufacturing crystalline TiO$_2$. Watch Water discovered the photochemical reaction of Watch TiO$_2$, exhibited when combined with the power of Oxydes-P and solar light. This resulting reaction was the splitting of water molecule to generate a Hydroxyl radical

\[ \text{TiO}_2 (h^+) \text{H}_2\text{O} \rightarrow \text{TiO}_2 + \text{HO}^- + h^+ \]

The photocatalytic properties of watch TiO$_2$ combined with Oxydes-P can degrade 99% of all water pollutants when treated with sunlight and SOLAROXY-3C.

This piqued the interest to introduce it to the entire world to clean and disinfect contaminated Air-Soil-Water using the free solar energy of the sun. Oxidative and Reductive reactions from unique Watch TiO$_2$ are due to its crystalline characteristic of processing a sole electron in its outer orbital. The reaction process begins when sunlight energy photoexcites that lone electron, which creates an empty outer valence band.
The organic compounds are mineralized to carbon dioxide and water by given enough irradiation time. A basic visual representation of the Photocatalytic mechanism can be seen in the figure above which demonstrates the process that occurs when light energy irradiates Watch TiO2 crystalline particles. The illumination ejects electrons from Valence band resulting in a positively charges area with "HOLEs" (h+).

These holes primarily react with water molecules to generate hydroxyl radicals, thus creating the dominant destructive component of the photocatalytic process. The free electrons e- jump to the conduction band where they can react with oxygen molecules in the water to generate Superoxide radical anion’s.

**USING SOLAROXY-3C**

The generation of mixed radicals OH* as well as SR (Sulfate radicals) in the photocatalytic process of SOLAROXY-3C makes it possible to decompose any organic as inorganic compounds. These contaminants can be removed without adding any other flocculants or oxidants like Chlorine, Ozone, UV, Hydrogen peroxide and etc. SOLAROXY-3C can even be used to treat Landfill leachate. 30 to 40 grams of dosage is optimal to remove 100% of COD & BOD including the Colour removal.

SOLAROXY-3C can be used to treat highly concentrated effluent with a continuously stirred batch reactor. To accelerate the Hydroxyl and Sulfate radicals production, Oxydes-P can be added with SOLAROXY-3C.

The SOLAROXY-3C outperform the slow and all conventional technologies by removing nearly all contaminants from the water and wastewater within 30 minutes.

**SOLAROXY-3C** is the best available (VAOP) to mineralize all toxins produced by cyanobacteria using falling or spraying doser over the Lakes, Streams, Rivers, Sewage, Wastewater system, clarifiers, Landfill- leachate. Ammonia in all water’s can be reduced to 100%. Only SOLAROXY-3C can degrade Ammonia from wastewaters. The SOLAROXY-3C process can be used to provide the energy necessary for the conversion of Ammonia to hydrogen and nitrogen gases.

\[
2\text{NH}_3 (g) \rightarrow 3\text{H}_2(g) + \text{N}_2 (g)
\]

The above equation shows that 2 moles of Ammonia can be converted to 3 moles of Hydrogen gas and 1 mole of Nitrogen gas. Formation of H₂ from photocatalytic destruction of NH₃ photocatalytic degradation on Ammonia in Manure can be removed up to 100% is possible. SOLAROXY-3C can remove odor from all human and animal manure. Watch TiO₂ Photocatalytic Oxidation or SOLAROXY-3C can be used to Deactivate pathogen indicators such as Escherichia coli (E. coli). Using 1 g/L SOLAROXY-3C will inactivate E.coli completely in just 10 minutes. Inactivate E.coli to levels below detectable limits.

**SUMMARY**

The use of SOLAROXY-3C can be employed for the removal of Organics, Nitrogen based contaminants, Antibiotics, Pharmaceuticals, microplastics, Oder and even Pathogens. Removal of COD and BOD is the best job for SOLAROXY-3C. Regarding removal of heavy metals and metallic oxynions SOLAROXY-3C photocatalysis is the Best Available Technology (BAT). Watch TiO₂ is a Crystalline Metal Oxide with a high sorption capacity. It can adsorb heavy metals like Lead, Chromium, Arsenic, Copper, Selenium, Uranium.
Wide range of applications

- Drinking Water
- Ground Water
- Surface Water
- Grey Water
- Effluent Water
- Sewage Water
- Rainwater Drains
- Ponds
- Lakes
- Rivers
- Aquatic Ponds
- Swimming Pools
- Municipal Sludge
- Landfill Leachate
- Blackwater
- Infected Surfaces
- Cooling Water
- Algae Growth inhibitor
- Usage of SOLAROXY-3C as – Algaecide, -fungicide

In Disinfection

- Sterilizing of Surfaces
- Disinfectant for all surfaces
- Disinfection of Ion exchange Resins
- Disinfection of Membranes
- Disinfection of Activated Carbons
- Strong Disinfection for treatment of water systems

In Wastewater

- Simulated Wastewater
- Lagoon Wastewater
- Municipal Wastewater
- Industrial Wastewater
- Pharmaceutical Wastewater
- Hospital Wastewater
- Commercial Wastewater
- Oil & Petrochemical Wastewater
- Food & beverage wastewater
- Paper mill Wastewater
- Industrial Wastewater Sludge
- Municipal Wastewater sludge

Pollutant’s to Remove

- Ammonium ion’s
- Creatinine
- Chlorinated Creatine
- Arginine
- Escherichia Coli (E.coli) 99.99%
- Enterococcus faecium
- Urea & Uric acid
- Amino acids
- Micropollutants
- Phenol, 2, 4 – dichlorophenol
- Atrazine
- Naphthalene
- Microcystin – LR
- Dyes including congored
- Volatile Organic Compounds(VOC’s)
- Endocrine disruptors
- Pharmaceuticals and their Metabolites
- Cyanotoxins
- Per-fluorinated Compounds
- Lindane (Chlorinated pesticide)
- Carbamezepine
- Bisphenol (BPA)
- Porcine Circovirus
- Chloramphenicol Antibiotic
- ALL Organic Pollutants (100%)
- Hormones
- Herbicides incl. tembotrione
- N,N Diethyl – P-Phenylenediamine (DPD)
- Ethylenediamine tetraacetic acid EDTA
- Microorganisms including viruses and bacteria
- Diseases – Associated Prion Protein (100 %)
- Methyl Blue Degradation
- 2-phenyl-5-Sulfobenzimidazole
- Rapid degradation of Axodye
- Rapid degradation of PFQA&PFOS
- Degradation of Caffeine in water
- All anionic dyes
- Oxidation of Lignin
- 100% Algae removal
- Nitrobenzene Wastewater
- “Penta” congeners
- Di (2-ethylhexyl) Phthalates (DEHP)
- Steroids: Estrone (E1), 17 α – estradiol (E2), 17 β – ethinylestradiol (EE2)
A novel oxidation material has been developed by Watch Water® Germany, which uses a catalyst for the degradation of environmentally harmful pollutants, which are released at a rate of 9600000 billion tonnes a year into the world water. A novel non-hazardous photocatalytic material effectively removes chemicals, plastic waste, pharmaceuticals, antibiotics, fertilizers, sewage water, agricultural runoff of nitrates and phosphates including TOC, and heavy metals. SOLAROXY-3C can adsorb 100% of the dye and enhancing the rate of dye breakdown rapidly using (VISIBLE LIGHT) from the sun.

By mixing crystalline Titanium dioxide (Watch TiO$_2$) and Oxydes-P (Oxidant) the mixture provides a huge surface area for organic and inorganics capture. The SOLAROXY-3C in the water or wastewater proceeds to adsorb heavy metals and break down organics into small and harmless molecules using the energy provided by sunlight, in a process known as

**“PHOTOCATALYTIC DEGRADATION”**

Having removed the harmful organics, the catalyst may simply be filtered from the clean water by CRYSTOLITE filtration media.

Both of the materials used in the SOLAROXY-3C have been manufactured by Watch Water® Mannheim. Titansorb-P is considered as one of the most promising materials for a range of Photocatalytic application’s, owing to its high electrical conductivity, chemical stability, and surface activity, in addition to its strong light absorbance. As a low band-gap-semiconductor, Watch TiO$_2$ is white in colour due to its ability to adsorb almost the entire spectrum of VISIBLE-LIGHT and therefore extracts a high amount of energy from sunlight to generate Hydroxyl radicals and sulphate radicals to power the degradation processes.

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**SOLAROXY-3C Super Advanced Oxidation**

**Medicines and Pharmaceuticals**

- Diclofenac
- Ibuprofen
- Atorvastatin
- Para and ortho hydro atorvastatin
- Propanolol
- Erythromycin
- Noverythromycin
- Azithromycin
- Clarithromycin
- Ciprofloxacin
- Metformin
- Ranitidine
- Carbamazepine
- 10.11 – epoxy carbamazepine
- Sertraline
- Novsetraline
- Fluoxetine
- Tamoxifen
- Trixylenyl phosphate
- 1,2,3 benzotriazole
- Tolytrizole
- 4,5 benzotriazole

**SOME OF SOLAROXY-3C MAIN BENEFITS**

- No Toxic by products or sludge produced
- No Operational costs related to energy used
- Chemically and environmentally sound
- Safe to use and a simple dosing system

**METALS & HEAVY METALS**

- Arsenic
- Chromium
- Selenium
- Antimony
- Cadmium
- Lead
- Copper
- Aluminium
- Mercury
- Nickel
- Zinc
However, the true potential of the Watch TiO₂ and Oxydes-P was only realized, once they were combined into a single SOLAROXY-3C. Due to the exchange of electrons between the two materials, the organic and inorganic's were broken down by the SOLAROXY-3C at around double the rate achieved by Oxydes-P on its own, while Oxydes-P alone is incapable to degrade heavy metals. In contrast to all other leading catalytic materials, many of which are toxic to both humans and aquatic life, both our Watch Water® products are classified as Non-Hazardous-Materials.

The Watch Water® GmbH, believes that their SOLAROXY-3C has a huge potential. As we introduced and we know the Capabilities of our SOLAROXY-3C.

Our aim is not only to market the product but we’re also exploring its viability in other areas, such as the photocatalyzed adsorption of CO₂ to generate Carbonates.

Watch Water® is a team of highly experienced specialists in Water Treatment Sector and provide new superior technologies compare to old conventional technologies and products. Our experience and very successful products are unmatched in the industry and we have been recognized as an innovative industry leader. Watch Water® takes full responsibility in all water treatment problems, with its innovative concepts and pragmatic solutions, geared towards bio-friendly water treatment chemicals and systems.

Disclaimer: The information and recommendation in this publication are true and based on data we believe to be reliable. They are offered in good faith but do not imply any warranty, liability or performance guarantee. Specifications are subject to change without notice. Watch Water® will not be liable under any circumstance for consequential or incidental damages, including but not limited to, lost profits resulting from the use of our products.