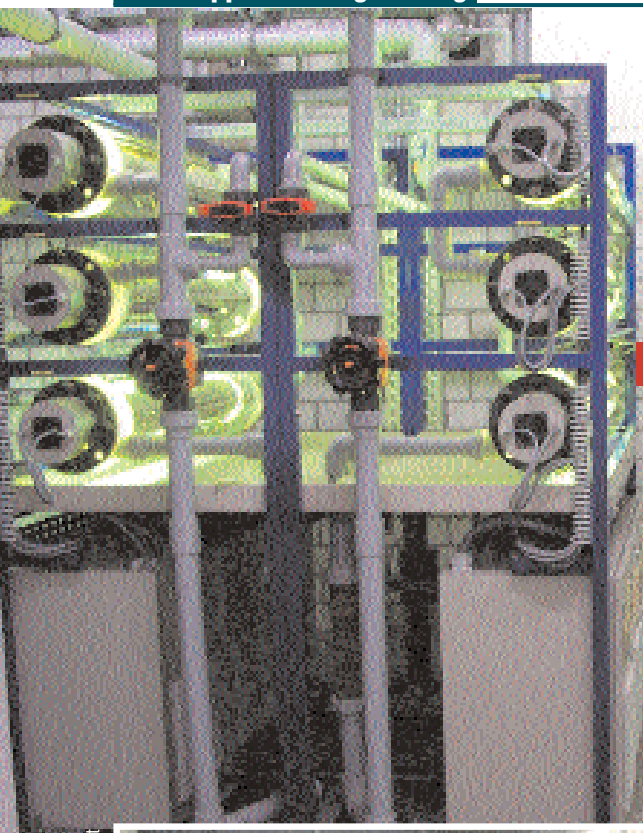

Photos: Aqua Concept

Enviolet UV oxidation system with fully automatic control unit and link to the main control system.

How to dispose of 1,4-Dioxan

The Enviolet method is used to break down 1,4-Dioxan with no residue

1,4-Dioxan is suspected of being toxic to fish, and it is not bio-degradable in the aquatic environment. It is produced as an intermediate during production of emulsifiers for dispersions which are used in the painting, construction and paper industries. 1,4-Dioxan is removed from the production process and collected separately. But then what do you do with this toxic substance?

Martin Soerensen,
Juergen Weckenmann

Left to right: storage tanks for oxidizing and sensitizing agents, batch tank with process equipment, Enviolet UV unit.

Stringent environmental standards and the responsible care initiative dictate than only minute amounts of non-bioavailable chemical compounds should be released into the environment. The allowable discharge limit for 1,4-Dioxan is only 0.1 mg/liter of waste water. Due to the characteristics of the particular production process, the concentration of waste process water is about 15,000 – 20,000 mg/L. The goal is to reduce the concentration of 1,4-Dioxan in the waste water to 5 mg/L. Since the manufacturer, one of Europe's leading chemical producers, only discharges about 18 tons of process water a day, the amount of 1,4-Dioxan which is released would be far below the detection limit of 0.001 mg/L. The problem was to find a reliable, low-cost method of breaking down 1,4-Dioxan, because internal disposal using thermal treatment is very expensive and consumes a lot of primary energy. The maximum breakdown capacity of ozonolysis is 70 percent, which is not sufficient in this application.

Advantages of the method used

A total of 50 liters of production waste water were sent to A. C. K. Aqua Concept in Karlsruhe to determine whether Enviolet UV oxidation is a dependable method for breaking down 1,4-Dioxan.

This method is based on selective transformation, which is a big advantage because it tends to drive down overall disposal costs. The process uses a photo-sensitizer to break down the 1,4-Dioxan. Lab test results were encouraging, and the 1,4-Dioxan was totally eliminated from the sample. Breakdown does not occur as a direct result of stimulation by UV light.

Instead, a compound is added to the process solution in very small amounts which absorbs the UV light and transfers it to the target molecule. Reactivity increases to the point where 1,4-Dioxan,

Table 1: Enviolet-UV system performance data

Waster water volume	2 ¥ 8 t/d
Batch size	8 t/batch
Treatment sequence	1 batch/12-hr shift
Initial concentration 1,4 Dioxan	7000–20,000 mg/L ϕ(2005) ≅ 16 000 mg/L
Concentration following treatment	3–10 mg/L ϕ(2005) < 5 mg/L
Breakdown rate	>99.95 percent
BOD following treatment	>95 percent
Treatment cost	approx. € 70,–/batch

The authors work at A.C.K. Aqua Concept, Karlsruhe, Germany

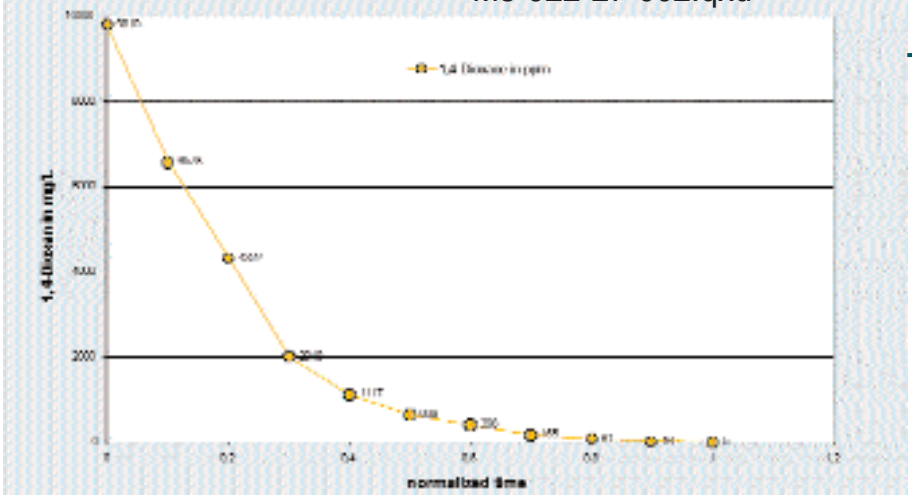

Figure 1: Degradation of 1,4-Dioxan in the lab-test

which is stable under normal conditions, breaks down.

The oxidation process produces small organic molecules which are all biodegradable. A Zahn-Wellens test conducted at the manufacturer's test lab confirmed these results. The new method had a high breakdown rate and offers considerable cost savings potential compared to the other options which were available.

The manufacturer also wanted a fully automated solution, and all functional components including the reactors, control cabinets, reaction vessels, chemical storage tanks, metering station, ventilation system and other process equipment had to fit into less than 50 m^2 of space with a maximum height of less than four meters.

The manufacturer wanted a fully automated solution

Only ten weeks were available for the entire project, from the planning and approval phase right through to final deployment. To save time, planning and approval activity were performed jointly by the supplier and the customer. The product was used in the process directly after installation and the so-called pure water run. Following optimization of the automatic program sequence while the first batch was being processed, the system was handed over to the customer eleven weeks after the project got underway.

On average, more than 99.95 percent of the 1,4-Dioxan was eliminated. According to the customer, the major advantages of Enviolet technology are a high elimination rate and relatively low operating costs. The system has already been prepared to handle higher concentrations in the future, and interfaces for a possible expansion are in place. ■