Purging organic liquids perks up with peroxide

Wet peroxide oxidation is a new French technique for treating liquid organic wastes, more cheaply than the conventional wet air process. A pilot plant successfully operated in Spain, treating polluted waters with 10kg/m^3 COD, as part of a European Union industrial site reclamation programme.

Wet air oxidation is ideal for treating organic liquid wastes, and it produces no pollution of its own. Instead, it converts waste to carbon dioxide and water by enhancing contact between molecular oxygen and liquid organic matter.

High pressure maintains the liquid phase while increasing the concentration of dissolved oxygen, as well as the oxidation rate. Typical conditions are temperatures of 200-325°C, pressures of 50-150 bar and one hour residence time.

The process is efficient, but only at high temperatures, which can be reduced using more effective oxidizers. To achieve this, Toulouse-based researchers at the Institut National des Sciences and the company IDE Environnement developed a technique replacing molecular oxygen with hydrogen peroxide.

The wet air process, using molecular oxygen as an oxidizing agent, involves transfer and oxidation steps. By using a liquid oxidizer, wet peroxide oxidation cuts out the transfer stage and increases efficiency.

Wet peroxide oxidation experiments used a batch loaded reactor with the organic compound solution and catalyst at pH of about 3.5. After heating to about 120°C, the run was started and hydrogen peroxide was continuously fed. Pressure in the reactor was kept at 3-5 bar to prevent vaporization.

At a low 70°C, the trial treatment eliminated phenol in the test compound, but left carboxylic acids and achieved a limited TOC removal. Increasing the temperature to 140°C removed almost all TOC by oxidation of carboxylic acids that appear when the initial compound is oxidized.

Laboratory work led the Toulouse team to design and build a transportable 5m^3/hour pilot plant with rated temperature of 125°C and pressure of 4 bar using the peroxide process. Costing about $450,000, the plant consists of a two-stage mixed reactor, various tanks and heat exchangers.

Total plant cost, including investment, running and peroxide supply was about $23/m^3, plus $7/kg COD, assuming a hydrogen peroxide (concentration 50%) is available at $650/tonne.

These figures show the process compares well with wet air oxidation and, especially, with incineration because of its ability to treat chlorinated compounds without releasing chlorine gas.

From: Water Science & Technology, Vol. 29, issue to be announced.

Capillary filter findings

Researchers in South Africa have found that hydrodynamic characteristics of prototype capillary ultrafiltration modules exhibit pressure drops that are predictable by combining Blasius and Darcy relationships for friction losses in pipes. Predictions can be used in design.

Researchers at Membratek (Pty) say that hydrodynamic characteristics are important in full-scale plants. Module pressure drops affect the plant's configuration, dictate circulation rates and determine performance. Advantages for the capillary modules are:

- Pressure drop across capillary bundle is less than in a comparable series tubular module;
- High packing density and low construction cost;
- Productivity can be increased and fouling controlled by faster flow than in tubular modules.

From SA Waterbulletin November/December 1993.

Acetate aids nutrient removal

Denitrification rates in alternating-type activated sludge nutrient removal can be limited by lack of readily-degradable carbon substrate. Danish university researchers have developed a way to enhance performance by adding COD material directly where denitrification occurs.

The strategy increases the denitrification rate on demand, and reduces or stops nitrate and nitrite accumulating during periods of peak nitrogen loading, say the researchers at the Technical University of Denmark. A demonstration pilot plant, using acetate for COD showed marked improvement in effluent water quality over an uncontrolled case.

The investigators used the alternating BIO-DENIPHO activated sludge nutrient removal process, developed by I. Krüger Systems with the university. The process is designed to remove nitrogen and phosphorus.

In this system, nitrification and denitrification are semi-batch processes. The flow path periodically changes through two parallel basins, which are aerated according to a fixed, or controlled, strategy. This operation avoids high rate recycling of process water between fixed aerobic and anoxic zones, typical of continuous processes.

Semi-batch operation also allows key reaction rates to be estimated by monitoring concentration gradients with respect to time in the aeration basins, which was a advantage in this work.

The pilot anaerobic zone consists of a 200 litre Plexiglass column with mild agitation. Feed to this zone is a mixture of preclarified municipal wastewater and return sludge. Next are two, 800 litre tanks, serving as aeration basins, each with an agitator and air diffuser, leading to a 1,100 litre settler.

The pilot plant is equipped with a flow injection analysis system for measuring aqueous concentrations of ammonia, nitrate plus nitrite and phosphate at the inlet, the top of the anaerobic column, the second aeration tank and the settler effluent.

To demonstrate the strategy, researchers induced a nitrogen overload lasting several hours over four trial days. To add COD, they introduced a solution of sodium acetate to the aeration tanks during their denitrification phases.

Researchers started adding acetate for each denitrification phase in each tank as soon as the dissolved oxygen concentration dropped below 0.5 mg/l. They stopped adding acetate to the second tank when the measured NO_x-N concentration fell below a set point, or at the start of the next aerated phase. For the first tank, the same duration of acetate addi-tion was applied as that for the second during the preceding half cycle.

An analysis of results shows that the general level of the denitrification rate is directly proportional to the strength of acetate solution added.

From: Water Research, Vol. 28, No. 3, pp 511-520, 1994.

Lagoon solids

Two US prisons injected biochemical additives into wastewater lagoons and increased aerobic bacterial activity and reduced solids.

Additives contain organic acids, buffers and nutrients, which may not be available for bacterial assimilation in anoxic lagoons. They transform carbon chain compounds into structures that are more easily degraded by aerobic bacteria.

After eight months, the solids dropped by 78% to 51%. Dissolved oxygen increased from 2mg/l to 10mg/l, reducing need for aeration.

The monthly treatment cost was $150/million litres of wastewater. Reducing aeration equipment operating time saved $1,500/month in electricity.

From: Water Environment & Technology, December 1993.