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Straightforward Oxidative Wastewater Purification

Fentox Makes Toxic Wastewater Biodegradable

Eliminating Toxicity – Oxidative wastewater purification based on the Fentox process is particularly suitable for the effective and cost-efficient elimination of COD, AOX and toxicity problems encountered especially at effluent from chemical production. The process is described by means of three practical examples from different sectors of the chemical industry.

Increasingly more stringent standards are being imposed by public authorities worldwide with regard to the biodegradability of undesirable water constituents. Particularly the requirements to be met with regard to the chemical oxygen demand (COD) are exceedingly stringent in some cases. At the same time, industrial wastewater from chemical, pharmaceutical or cosmetic production processes as well as from some metalworking sectors is often so heavily polluted with toxic organic substances that its purification in biological sewage plants is impossible. The same

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also applies for seepage water from landfills.

High salt concentrations, high temperatures or large variations in the wastewater inflow can also make biological degradation of the organic compounds more difficult. In such cases, the COD can only be reduced by chemical oxidation using such familiar processes like ozone, UV light, hydrogen peroxide or suitable combinations of these. However, all these processes involve very high investment and operating costs and must be considered relatively inflexible.

Advantages of the Fentox process

A much more advantageous alternative involves a process using the well known laboratory chemical Fenton's reagent on an industrial scale. Eisenmann has further improved the process under industrial conditions and patented the resulting Fentox process which is based on the oxidation of organic water constituents with a mixture of hydrogen peroxide and iron-II salts as catalyst under acidic conditions. With the aid of the hydroxyl radicals produced during the reaction, problematical or bactericidal pollutants can be detoxified, rendered biodegradable or

Fentox plant for purifying wastewater from the production of organic siloxanes Figures courtesy of Eisenmann

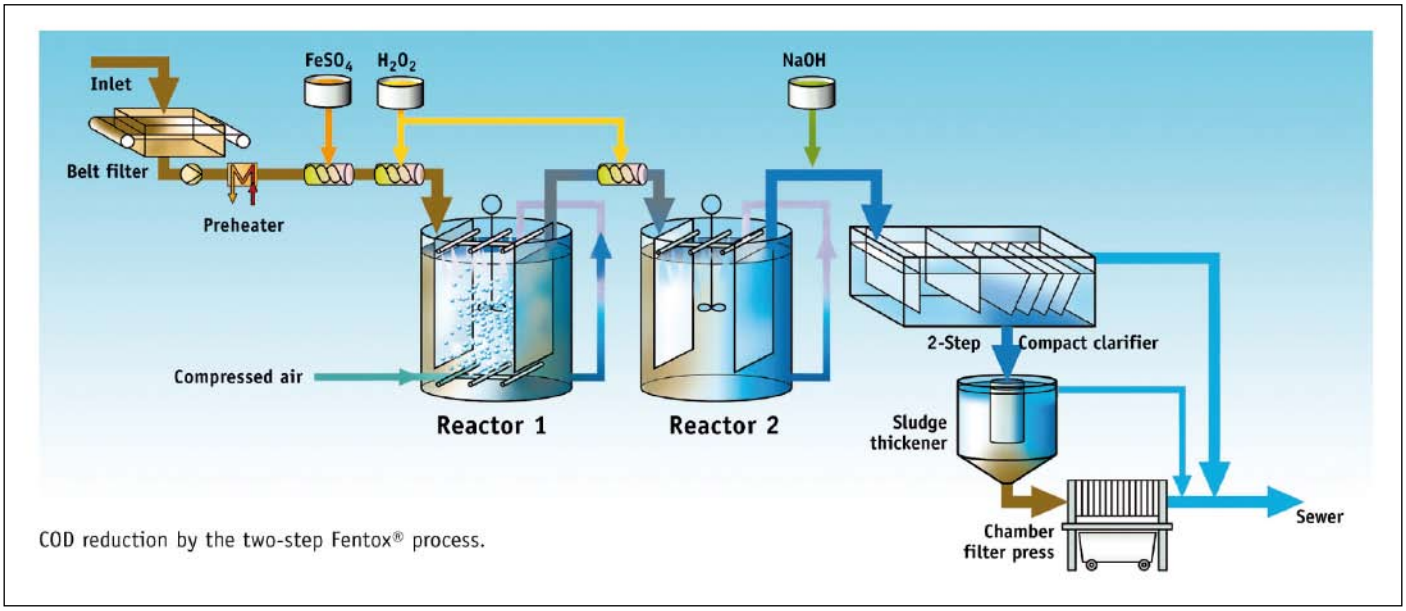

Fig. 1: Process schematic of the two-stage Fentox process

Figures courtesy of EISENMANN

completely eliminated from the wastewater before it is discharged into municipal sewage treatment plants or open waters.

The selected multi-stage process with reactor cascade is more economical and more practical than the single-stage systems used in the past. It avoids the problems associated with such systems, such as high chemical consumption, difficulties in treating wastewater with a tendency to foam and overheating in the presence of high COD concentrations. Low oxidant consumption, which can also be precisely adapted to the particular case, and the considerably lower volume of sludge produced along with low investment costs, compact space requirement and its simple ability for retrofitting are the advantages of this multi-stage process, which has already proven its value in a number of practical cases.

How Does it Work?

In the patented Fentox process, the wastewater is first filtered if necessary (Fig. 1) and then conditioned to maintain a temperature of 50 °C in the reactors. The reactor temperature is adjusted in an upstream heat exchanger in accordance with the heat released by the reaction in the reactor. Sulphuric acid, iron-II salt and hydrogen peroxide are added in upstream mixers. Hydrogen peroxide is again added in the second reactor and reacts with the iron still present. As already mentioned, this means that less iron-II salt needs to be added altogether, thus significantly reducing the formation of sludge. The addition of chemicals leads to the formation of highly reactive OH radicals which oxidize most of the organic constituents to form CO_2 in a chain reaction. Figure 2 shows the decrease in organic load on the basis of the COD and adsorbable organic halides (AOX).

COD is reduced as the amount of hydrogen peroxide is increased. For the wastewater in this case, COD was reduced by roughly 80 % with 100 % of active oxygen. AOX was reduced by 95 % at the same time. The amount of iron-II catalyst required normally correlates directly with the amount of hydrogen peroxide. The wastewater from the oxidation reactors is neutralized in a downstream reactor and can then be discharged directly into a downstream wastewater treatment plant. Alternatively, the precipitated heavy metals and other solids in the water can be transferred to the sludge phase and removed.

Practical Examples

Three typical examples have been selected from the projects already realized in practice. In particular, the Fentox process is used as a pretreatment stage for problematical wastewater from a whole variety of chemical production processes (see examples 1 and 2). As example 3 shows, it has also proved its practical value for lowering the COD of seepage water from landfills, as stipulated by law, before the water is discharged into biological wastewater treatment plants.

Example 1: Pretreatment of toxic wastewater from production of crop protection agents by a global chemical corporation. Four production lines with 8,000 production hours per year, output roughly 2.5 m^3 wastewater per hour with a COD concentration of up to 40,000 mg/l. The multi-stage Fentox process eliminates the effluent's toxicity and makes it biodegradable so that it can safely be discharged into the company-owned biological sewage treatment plant. Due to consistently positive results in technical and financial terms over a period of many years, Eisenmann has also won another major contract from the parent company in Germany.

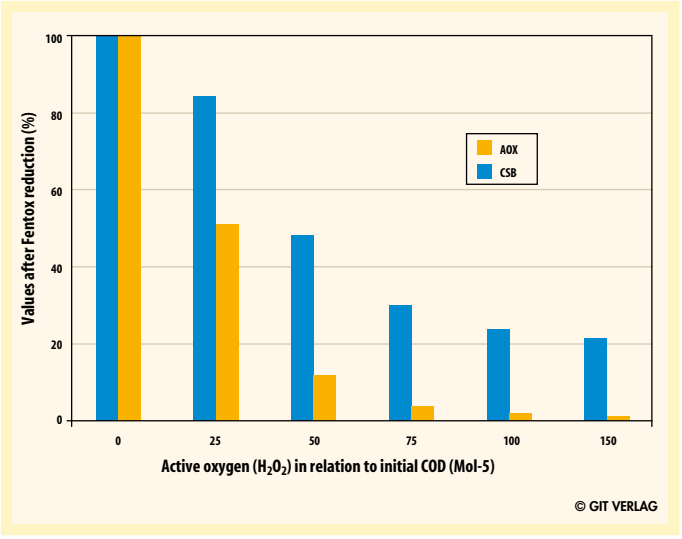

Fig. 2: Reduction in COD and AOX depending on the addition of hydrogen peroxide

Figures courtesy of Eisenmann

Fig. 3: Fentox plant for purifying seepage water from landfills on the site of a chemical park operator

Figures courtesy of Eisenmann

Example 2: This case involves wastewater from the production of organic siloxanes for further processing in synthetic materials and silicone products. The wastewater flow rate equals 1.2 m³/h, with a COD load of up to 23,000 mg/l. The objective in this case is to reduce the COD by breaking down the binding agents so that the formerly emulsified silicone rises to the surface of the wastewater and can be recovered by flotation if necessary. The discharged wastewater has a COD of less than 1,000 mg/l.

One special advantage which must be mentioned is that only 20 % oxidant is needed to reduce COD by over 90 %. The resulting low cost for wastewater treatment is reduced still further when the silicone fraction is recovered. Plans are already under way to enlarge the plant to a capacity of 2 m³/h in a second construction phase.

Example 3: Physico-chemical wastewater treatment with downstream biological sewage treatment is used to dispose of production effluent from another chemical corporation's Bavarian branch. For many years, the biological plant has also purified seepage water from municipal landfills. Increasingly stringent water regulations have caused problems here: for some of the production effluent, the stipulated COD value could not be achieved by the treatment methods applied to date. Moreover, seepage water from landfills can now only be discharged into a biological sewage treatment plant if the COD value is reduced by at least 75 % at the same time.

The company therefore decided to use the Fentox process to lower COD. The installed pretreatment stage has a capacity of 12 m³/h (Fig. 3) and treats not only problematical wastewater from production, but also seepage water from landfills which is delivered by road tankers from three rural counties. In this way, the problem of COD values was eased, not only for the plant operator, but also for the local municipal authorities.

Laboratory plants in which wastewater can be tested with regard to its suitability for treatment using the Fentox process are available in the Holzgerlingen facility. Appropriate tests provide information on both the fundamental feasibility and the expected operation costs.

Fentox pretreatment of toxic wastewater from production of crop protection agent

Figures courtesy of Eisenmann

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