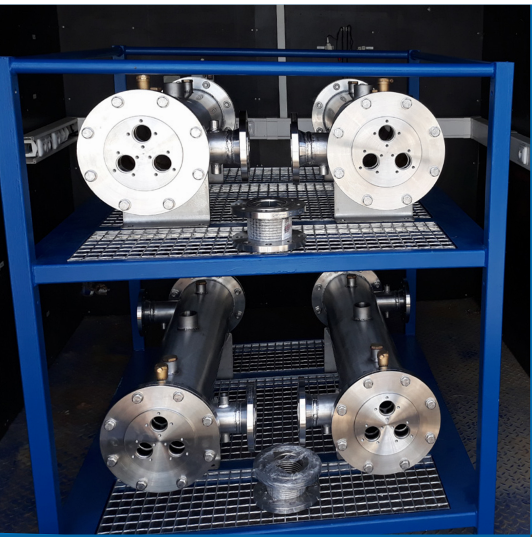
WASTEWATER TREATMENT USING PHOTOCHEMICAL OXIDATION

Proven, Fast & Effective Technology



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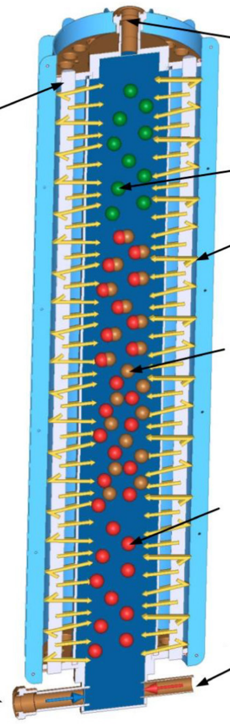
PRINCIPLE

The photochemical oxidation method uses reactive hydroxyl radicals formed from H_2O_2 for oxidation of organic compounds. H_2O_2 is decomposed by UV irradiation (wavelength 254 nm) during the photochemical oxidation process and the hydroxyl radicals are formed. Hydroxyl radicals are a very strong oxidizing agent (with the oxidation-reduction potential E^0 = 2.8 V) and are able to destruct a majority of organic compounds. The hydroxyl radicals react with dissolved organic contaminants in a series of successive reactions during which less toxic intermediates are formed, leading to the final oxidation products CO_2 and H_2O. When substituted hydrocarbons are being treated, then also corresponding mineral acids and salts are formed.

Fig.1 Scheme of the photochemical oxidation process.



DESCRIPTION

The basic technological element of the whole unit is a photochemical reactor through which water to be treated (containing the dosed H_2O_2) flows, with simultaneous action of UV irradiation.
In the reactor, decomposition of H_2O_2 takes place by the catalytic effect of the UV radiation. Hydroxyl radicals are formed that attack the molecules of organic contaminants, as shown in Fig.1.
The numbers of germicidal fluorescent lamps and the total power delivered by UV-C radiation are determined experimentally, based on the flow of water to be treated and the concentration of contaminants. The technology can operate either in a continuous mode or in a discontinuous mode, where the treated water circulates in a closed water circuit in a photoreactor. The output cleaned water flows through a catalytic filter bed (e.g. activated carbon or MnO_2) to remove residual H_2O_2.

Main advantages of the technology

- Highly effective oxidation technology for water purification and disinfection
- Contaminants are oxidized to non-toxic products of CO_2 and H_2O and mineral salts
- No secondary waste produced (concentrates, sludge, saturated sorbents)
- An automatic process that needs periodic checking only

Potential limitations

- Maximum organic pollutant contents according to an analysis 1500 mg/l TOC or 5000 mg/l CODCr
- Presence of metals in water (maximally 5 mg/l Fe and 2 mg/l Mn)
- High content of FNI (phenol index), indicates bad radiation transfer into water
- Presence of suspended solids in water

Services and products

- Monitoring and evaluation of contaminated areas
- Laboratory photochemical oxidation tests of a delivered sample of water
- Verification of the photochemical oxidation process on wastewater at the customer's company
- Renting a mobile pilot-scale photochemical oxidation unit
- Case study and basic technological design of a photochemical oxidation unit, estimate of investments and operating costs
- Provision of a full scale photochemical oxidation unit for 5 m^3/hour

DATA NECESSARY FOR THE TECHNOLOGY DESIGN

- Types and concentrations of the waste-water contaminants (TOC, COD, metal contents, pH)
- Wastewater input capacity needed
- Contaminant concentration limits in the cleaned water

REFERENCES

The photochemical oxidation technology was installed in a wastewater treatment plant in a village in Central Bohemian Region for purification of water containing residual pharmaceutical substances.

The treatment unit consists of two photochemical reactors installed in a mobile container. Each reactor consists of a quartz tube with a diameter of 150 mm and a length of 1200 mm surrounded by 20 low-pressure germicidal fluorescent lamps with a total output of 720 watts (300 watts of UV radiation).

Water flows continuously through the both photochemical reactors in parallel.

Before the photoreactors, 35% of H_2O_2 (10-150 ml/m^3) is dosed into the water to be treated. The cleaned water (from the photoreactor) flows through an activated carbon filter to remove residual H_2O_2 (the maximum H_2O_2 concentration in the cleaned water was 3 mg/l). The flow of water to be treated is 300 - 500 l/hour. By the photochemical oxidation method, persistent pharmaceutical substances, like gabapentin, diclofenac, sulfamethoxazole, hydrochlorothiazide, carbamazepine and tramadol are effectively decomposed, as shown in Fig. 2.

The main operating costs are electricity consumption, amounting to 0.3 – 0.5 EUR/m^3. H_2O_2 costs are low, just 0.05 EUR / m^3.

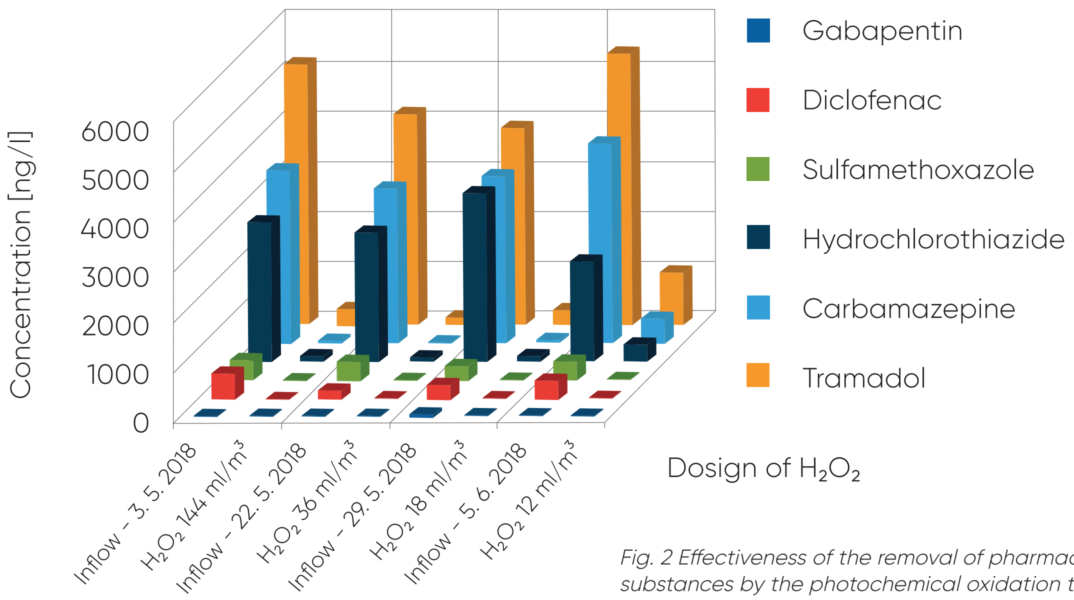


Fig. 2 Effectiveness of the removal of pharmaceutical substances by the photochemical oxidation technology

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