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TESI DI LAUREA

OZONATION OF DOMESTIC WASTEWATER MODEL CONTAINING PHARMACEUTICAL RESIDUAL: TEMPERATURE EFFECT

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ABSTRACT

According to an estimate by the United Nations, by 2050 66% of the world's population will live in urban areas, giving rise to extensive challenges regarding air and water pollution, congestion, waste management and human health. For this reason, the treatment of urban wastewater and its recovery are becoming important and increasing issues to be faced for the future.

As a matter of fact, for a sustainable water management, in recent years, in Europe, building or urban developments had as main objective the reduction of drinking water consumption, by the exploitation of the less noble waters (rainwater or recycled properly treated) and the use of high quality water only where it is needed (i.e. as drinking water).

It is important, therefore, to promote water sustainability policies, linked to a smart management of the resource, considering a new different approach. In this sense, the output streams from the house units could be separated before to reach the drainage system, avoiding the mixing between different types of wastewater. After, a defined part of the separated water could be treated and reused for other purposes. Following this way, the discharged water would become a resource, instead of being considered a waste to be eliminated.

In a typical house water cycle, three different output streams, which differ on a quality level, are identifiable: Rainwater, Greywater and Blackwater.

Starting from these considerations, a new approach, in which a different house water cycle is introduced, can be hypothesized, as shown in Figure 1.

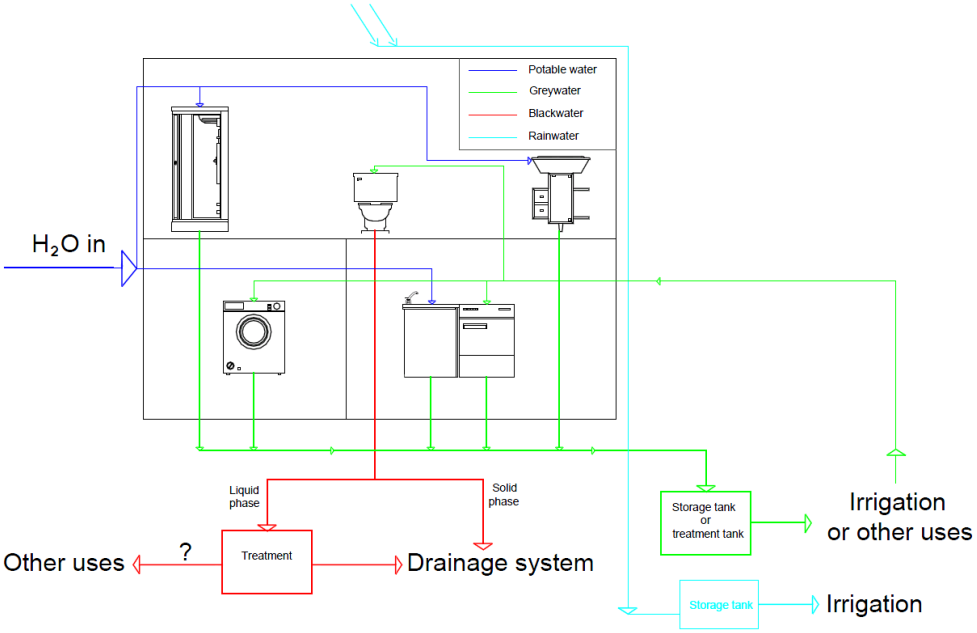

Figure 1: House water cycle in a different approach

In this approach, a new model of toilet is proposed: the no-mix toilet system. The device opportunely separates the liquid and the solid phases of blackwater, using a volume of discharge 60-80% lower than standard toilet (0,1-0,3 liters). Once separated, the liquid fraction of blackwater could be treated in a local treatment unit, so to allow a direct re-cycle.
The main feature of interest of this new model is that the concentration of emerging pollutants becomes relevant; high concentrations allow a more efficient treatment of the emerging contaminants, contained in the liquid fraction of blackwater, in an on-site plant specifically designed. In this way, it is possible to recovery water or to send to the MWWTPs (Municipal Waste Water Treatment Plants) a wastewater without or with less content of emerging pollutants.

Thus, the present work deals with the treatment of water contaminated by these emerging pollutants, through an ozonation process. The study was carried out in ENEA Centre of Research of Portici (Naples) and was focused on the treatment of the liquid fraction of the blackwater (LFB) deriving from urban discharges. To this aim, a semi-batch lab-scale reactor was used in order to simulate an on-site unit for the treatment and subsequent re-use of the LFB.

The simulated LFB is a deionized water, containing four representative pharmaceutical compounds (ofloxacin, atenolol, hydrochlorothiazide and 17-βestradiol). The concentrations of these emerging pollutants in LFB are determined hypothesizing an average consumption of pharmaceuticals of a typical family and the consequent excretion into discharges.

The performance of the treatment was assessed in terms of TOC measurements. The parameters investigated in the pollutants degradation are:

- Temperature (16-40 °C)
- Initial TOC concentrations (3.56-9.22 mg/L)
- Ozone productions (0.5-1.0 g/h).

The efficiencies of removal of the tests carried out to assess the variation of the mineralization efficiency according to the temperature condition are shown in Figure 2.

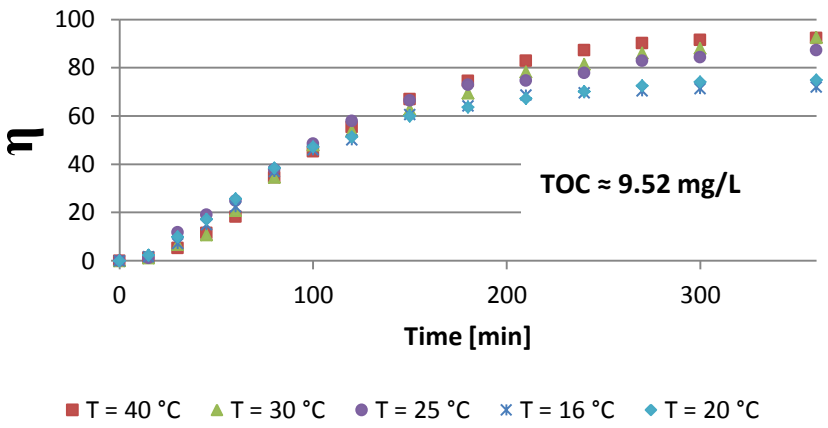

Figure 2: Variation of the efficiency of mineralization in time at different temperatures.

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As shown, the TOC removal rate was higher for higher temperature (30 and 40 °C), since, higher temperatures improve the reaction kinetics. On the other hand, at lower temperatures (16 and 20 °C), lower reaction kinetics occurred.

The efficiencies of removal of the tests carried out to assess the variation of the mineralization efficiency according to the initial TOC concentrations are shown in Figure 3.

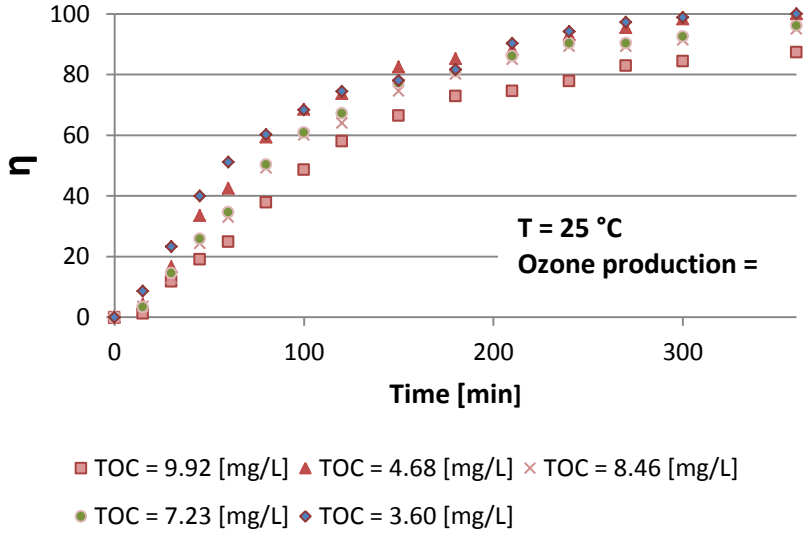

Figure 3: Variation of the efficiency of mineralization in time at different TOC concentrations.

As shown, conversion rate of TOC increased with the decreasing initial concentration.

The efficiencies of removal of the tests carried out to assess the variation of the mineralization efficiency according to the ozone productions, are shown in Figure 4.

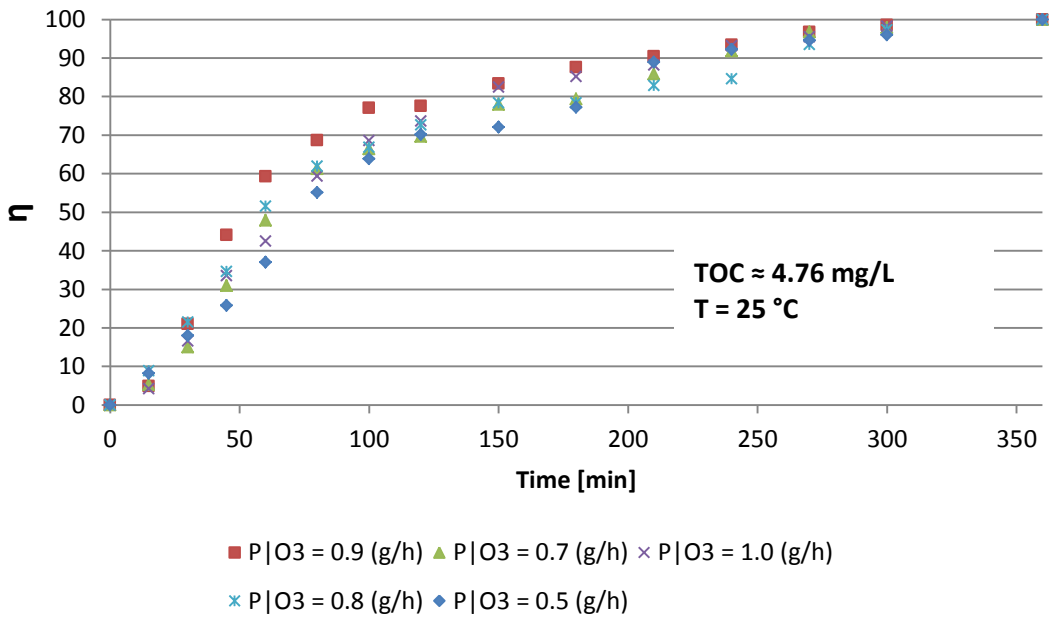

Figure 6: Variation of the efficiency of mineralization in time at different ozone productions.

As shown, concerning the ozone productions taken into account, there weren't significant differences in terms of final efficiency of mineralization, since for all the tests TOC was completely abated in 360 minutes. It may depend on the range of production investigated (0.5 -1.0 g/h), which didn't produce significant differences.

Although TOC was not completely removed from the wastewater in some tests, the ability of ozone to cause alteration in the molecular structures of dissolved compounds is clear and it may result in an increase in the water biodegradability. Future research should focus on pharmaceutical removal by coupling ozone with other AOPs technologies, such as photocatalysis and H_2O_2.

It would be also useful to improve the working conditions, in order to obtain greater doses and better mixing of ozone in water, which could allow total TOC abatement in less time. It could be considered the use of oxygen for ozone production, so that the rate of ozone production would be higher. At the same way, a new sintered steel injection system could allow a better homogenization of the gas in the liquid, so to determine a higher ozone solubilization degree. However, these variations could imply higher construction and management costs.