WASTE WATER TREATMENT IN COASTAL TOURISTIC AREAS USING STANDARIZED MODULAR BIOLOGICAL FILTRATION SMBF

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ABSTRACT

The selection of appropriate wastewater treatment technology for coastal tourist areas is an important engineering challenge. The local situation in coastal tourist cities and villages is characterized by important daily and seasonal fluctuations in hydraulic flow and pollution, high annual temperature variations, scarcity of building area and high housing density. In the same time coastal zones have to meet stringent effluent limits all over the year and need simple and easy technologies to operate.

This article presents the innovative technology of standardized modular biofiltration SMBF as adapted solution for waste water treatment in sensitive coastal areas and demonstrates practical results of existing plants.

Keywords: waste water treatment, touristic areas, biofiltration

1. INTRODUCTION

On 1 July 2013, Croatia became the 28th Member State of the European Union. With its Mediterranean climate and long Adriatic coastline, Croatia is a popular tourist destination. In 2012, residents from EU Member States made more than 7.2 million trips to Croatia, accounting for 70.4 million tourism nights and EUR 3.5 billion of tourism expenditure. Compared with the EU-28, Croatia's tourism activities are much more seasonal. The strong seasonality is confirmed by volume data, presented in Figure 1, for the monthly number of nights spent at tourist accommodation establishments. The peak months of July and August accounted for 58 % of nights spent in Croatian tourist accommodation establishments during the year 2012. The winter months from November to March had a share of nearly 25 % of European guest nights in 2012. These figures prove that the Croatian Adriatic coastline is a popular location for holidays with the result that the population of the concerned areas multiplies itself by many times depending on the season. This situation leads to important daily and seasonal fluctuations in municipal waste water hydraulics and pollution.

Beside the mentioned hydraulic and pollution annual variations annual waste water temperature variations has to be taken into account for the design and operation of each single waste water treatment plant. Croatia's coast and islands, from Istria and Kvarner in the north through to Dalmatia in the south are governed by a Mediterranean climate. In summer, the max temperatures are in the range of 26°C along the coast. In winter, the min temperatures are below 0°C (see Figure 2).

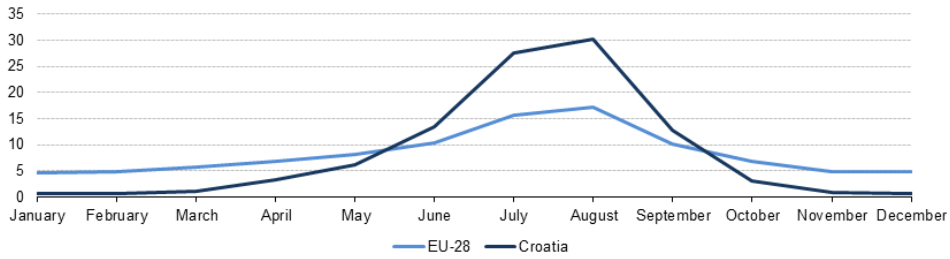

Figure 1: Monthly distribution of the total number of nights spent at tourist accommodation establishments, EU-28 and Croatia, 2012 (%) in Mio. - *Source:* Eurostat

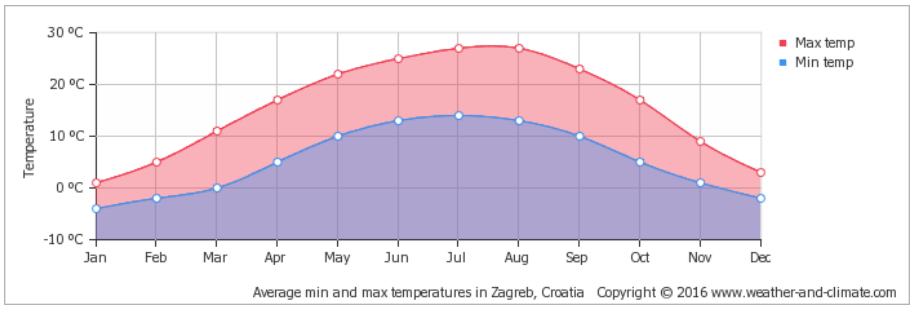

Figure 2: Monthly mean minimum and maximum temperatures over the year in Zagreb, Croatia - *Source:* www.weather-and-climate.com

Nevertheless the special situation in terms of annual variations in waste water quality and quantity, coastal zones has to meet stringent effluent limits all over the year and need simple and easy technologies to operate. Especially for decentralized small to medium Waste Water Treatment Plants specialized trained operators are often not available. Scarcities of building area and high housing density also have to be taken into account when planning a waste water treatment station. Based on these specific situations the selection of appropriate wastewater treatment technology for coastal tourist areas is a major engineering challenge.

The applied waste water treatment technologies need to be adapted in terms of investment and operation costs. Treatment plants should be easy to operate, mostly automatic, modular and flexible for different hydraulic and organic loads.

2. STANDARDIZED MODULAR BIOFILTRATION SMBF

3.1 General aspects

The application of aerated upflow biofiltration in waste water treatment goes back to the beginning of the 1980s when the first municipal biofiltration plants have been realized in at the south coast of France. The basic concept of biofiltration is to achieve mechanical filtration and elimination of dissolved organic and inorganic pollutants, such as BOD and nitrogen (nitrification and denitrification) in one and the same reactor. The main advantages of biofiltration are fully high grade water purification at different hydraulic and pollution loads and independency of water temperature (high and low). Based on the long term positive results today more than 1.000 municipal waste water biofiltration plants are in operation worldwide. In France about 50 municipal biofiltration plants in touristic areas are in operation since more than 20 years (see figure 3).

The modern biofiltration technology today represents a standardized aerated upflow filter in stainless steel tanks filled with granular non floating media (burned clay 2-5 mm). The biomass is settling as biofilm on the filter material which has a specific surface of about 1.000 m²/m³. Each filter has a diameter of 3,40m with 7m height and is able to treat a pollution load of 3.000 Population Equivalents including BOD removal, elimination of suspended solids, phosphorus elimination, nitrification and denitrification (see figure 4). The space requirement of the treatment plant is only 25% compared with classical solutions. The SMBF is fully inside a building and is available for small to medium waste water treatment plants in the range from 2.000 to 12.000 connected persons.

Figure 3: Examples of municipal touristic biofiltration plants in France

Figure 4: SMBF Biofiltration tank (3.000 PE)

3.2 Presentation of SMBF technology

The principal function scheme of SMBF is portrayed in Figure 5. The waste water is pre-treated by coarse and fine screen followed by primary settlement. In order to equalize hydraulic and concentration variations the water is lead into an equalization tank. After equalization the water is pumped into several independent units of aerated biofiltration tanks. Waste water purification is affected through biological activity and mechanical filtration. The clean and filtered water with low concentrations of suspended solids of about 10 mg SS/L leaves the reactor at the top. A secondary clarifier is not necessary. The generated sludge is lead into the aerobic sludge digester for stabilization. After stabilization the sludge is dewatered by centrifugation before to be trucked away. The total sludge production of the SMBF plant is about 10 to 20% lower than a classical solution. Each biofilter is operated as independent unit and can be stopped or operated at any time and according to actual needs. Like this an adapted operation of biofilter units during day and over the year is possible (see figure 6). The function and operation of each filter is regulated automatically by the SCADA program according to continuously measured actual hydraulic load of the plant. In this manner low energy consumption and full results are achieved at any time of the year. The energy requirement of as SMBF plant is usually 20% lower than a classical solution. This energy saving is a result of high oxygen exploitation inside the filter and due to adapted operation of biofilter units according to actual load.

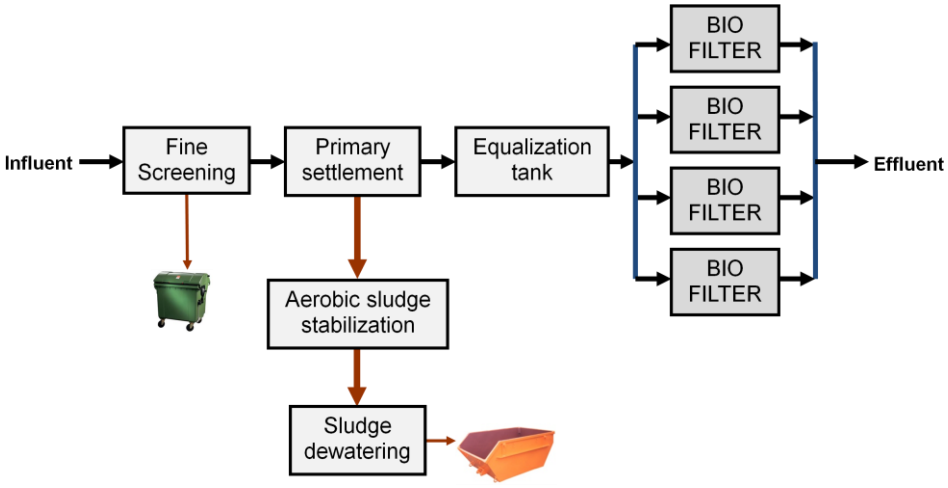

Figure 5: Scheme of Aerated Biological upflow Filtration SMBF

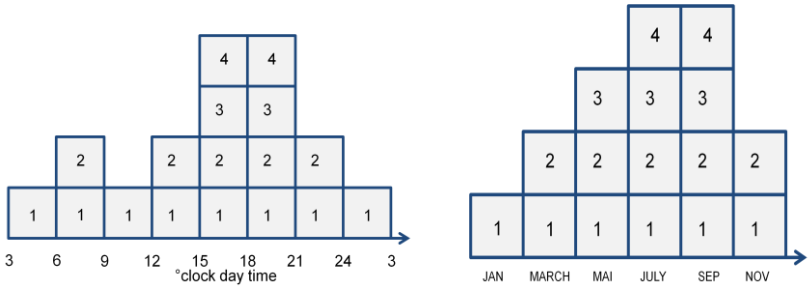

Figure 6: Adapted operation of biofilter units during day and year

3.3 Examples of SMBF treatment plants

The SMBF has considerable savings in volume and space. For example, the space required for a municipal sewage plant can be cut down to 25% compared to required space for activated sludge or SBR plants. The low space requirement for SMBF plants makes a fully covered in-house treatment plant economically possible. As a fully indoor solution without noise or bad odour inconveniences the WWTP can be constructed close or even inside villages or towns and inside or close to tourist areas. The fully indoor solution protects the plant against impact of hot and cold climates and against unauthorized entrance. Based on the mentioned advantages of SMBF technology numerous plants have been realized in touristic areas and are in operation now since more than 15 years. Figure 7 shows a touristic SMBF in France with 5.000 PE connected persons. The architecture of the building is assimilated in the natural environment. No noise, no smell is caused by the plant and close neighbourhood is possible.

Figure 7: Example of SMBF plant in touristic site (5.000 PE)

3.4 Results

The treatment results of a municipal touristic SMBF plant during one year of operation are demonstrated in Figures 8 and 9. The results show that at the inlet of plant high variations in terms of total N and BOD concentration can be observed. These high variations are usual for touristic sites due to seasonal different population and water consumption. Nevertheless the high variations at the inlet, stable outlet concentrations in terms of BOD and Total Ammonia Tot-N are achieved. The outlet concentration for BOD is usually below 10 to 15 mg BOD/L. The Tot-N concentrations at the outlet are below 15 to 20 mg N/l.

Figure 10 shows the COD outlet concentrations of several municipal SMBF plants as a function of COD volumetric load of biofilter. Depending on the COD load, outlet concentrations in terms of COD in the range < 40 mg/l can be achieved.

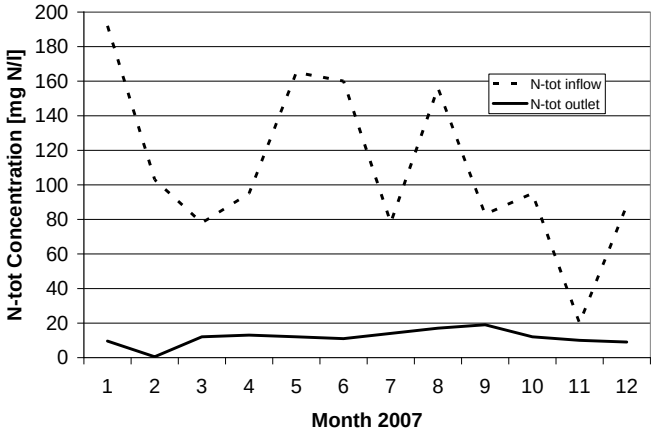

Figure 8: Tot-N in and outlet concentrations SMBF WWTP

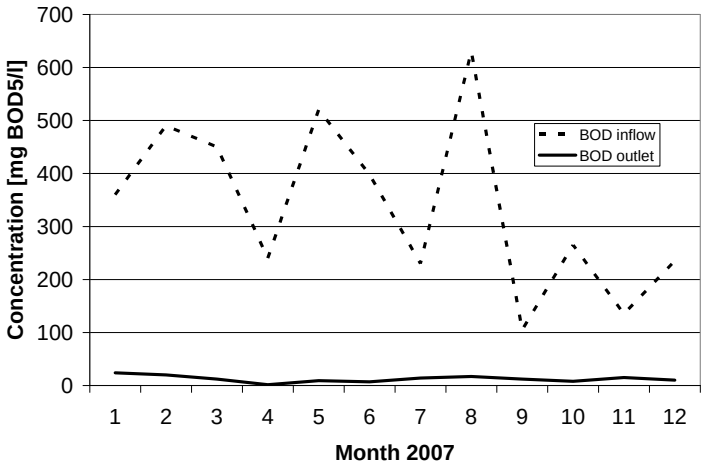

Figure 9: BOD in and outlet concentrations SMBF WWTP

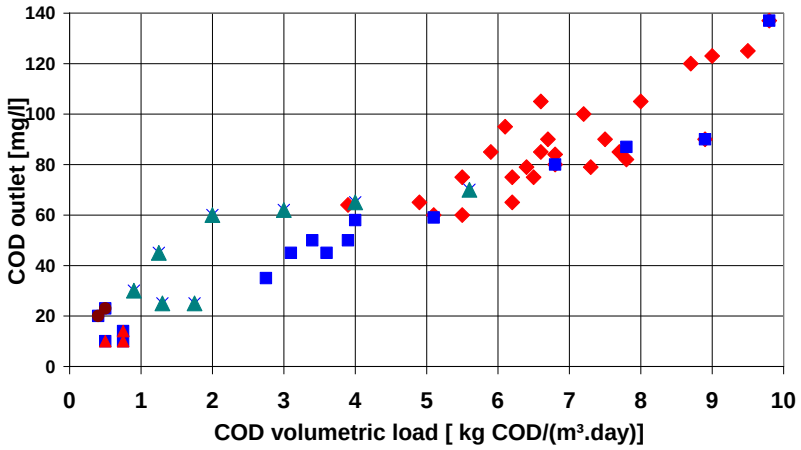

Figure 10: COD outlet as a function of COD volumetric load SMBF WWTP

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