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Cause and effect relationship between foam formation and treated wastewater effluents in a transboundary river

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The occurrence of foam downstream of weirs in a lowland river in Austria and short after the Austrian-Hungarian border and thereby associated protests from the Hungarian locals led to investigations to (i) objectify the dimension of the appearing foam (ii) evaluate the reasons for the foam formation and (iii) to set abatement-measures*.

The concerned river is characterised by periodically low discharge conditions and a high industrial and economical exploitation. Therefore, the designed one year monitoring programme included a close network of surface water sampling sites as well as the sampling of thirteen municipal and industrial wastewater treatment plants along the river stretch. Next to classical physical and chemical parameters (some of them using innovative online monitoring equipment), the surface tension and surfactants were analyzed. The constant observation of the foam formation in Hungary was achieved by the installation of an online webcam and resulted in the development of a seven-stage foam index (0-6) based on the evaluated webcam pictures. The effluents of the considered wastewater treatment plants were subject of standardised foaming tests. Intention of the test was to detect (i) foam on the sample and (ii) the dilution of a sample at which no more foam could be observed. The obtained dilution factor showed good correlations with the surface tension of the samples, which indicated the objectiveness of the method. The dilution factor was used to calculate the so called foam potential of an effluent characterising the volume of river-water, which can potentially get foamed by the waste water treatment plants' effluents. Foam potential was adopted as sum parameter for surface active organic compounds, as no specific surfactant could be

identified as foam causing substances.

The spatial distribution of foam downstream of weirs along the river stretch as well as the results of the foam tests allowed the identification of three tanneries as the main foam potential emitters, although their wastewater treatment plants were operated with the best available technology. The sum of their foam potential emissions was approximately as high as the river's discharge at heavy foaming conditions. A well correlated relation between foam potential, foam index and the river's discharge could be identified. The foam index increased with decreasing discharges of the river, but at the same time the index size at a certain discharge changed with the amount of emitted foam potential.

The implementation of an accepted degree of foam formation was desirable to develop measures to reduce the foam index. As no criterion exists for foam in rivers in Austria, the not accepted degree of foam formation was defined as the limit, at which population protests from Hungary arose. This resulted in a foam index higher than 3.5, which occurred with 40% probability during the investigation period. By performing a simple mathematical approach achieved by the correlation of foam index, river discharges and foam potential the required reduction of foam potential emissions could be calculated in order to minimize the foam index to an accepted standard. By the elimination of 75% of foam potential a foam index lower than 3.5 would be assured with 95% probability based on long term discharge development.

*The developed measures and their cost effectiveness are highlighted in M. Zessner et al. (submitted to EGU 2007, HS37).