Onshore test trials with ultraviolet light, ultrasound and ozone Technologies

Executive Summary

The laboratory scale test trials previously conducted in the Work Package 3 gave some promising results regarding the efficiency of the ultraviolet light, ultrasound and ozone technologies in inactivating the target organisms in the MARTOB-soup. However, the results comprised inconsistence and uncertainty and therefore it was decided to carry out onshore test trials in order to confirm the designed operation of the devices and to achieve reliable results in respect to the target organisms in the Baltic Sea marine environment.

The onshore test trials were conducted utilising the facilities provided by the Tvärminne Zoological Station. VTT was responsible for the technical installations and Abo Akademi University carried out the sampling and analysing. The trials were carried out in two phases, September-October 2002 and August-September 2003. The test water was extracted directly from the sea without filtering to ensure water volume large enough for the test execution and to maintain the link to the local marine environment.

The ultraviolet light and ultrasound devices operated as flow through processes and the ozone device was utilised for the ozone production. The ozone was fed to the contact tanks. Various flow rates, i.e. 200, 400, 520, 800 and 1600 L/h, for ultraviolet light and ultrasound and two ultrasound transducers (2 kW and 4 kW) were included in the test programme. Regarding the ozone technique two sizes of contact tanks, 60 L and 360 L were utilized and various contact times were studied. In addition to the single techniques, also the combinations of ultrasound and ultraviolet light and ultraviolet light and hydrogen peroxide were tested as part of the hurdle experiments.

The treatment efficiency was studied for four groups of mesozooplankton species, i.e. copepods, copepod nauplii, water fleas and rotifres, which are typical for the area and the seasons. In addition barnacle larvae and mussel larvae were present in the samples occasionally and were included in the analysis. Wider generality of the results in respect to changing seasons and species was achieved by conducting the trials during two separate periods. Since the composition of the species fluctuated a lot during the test phases, the water samples for the zooplankton assemblage were taken bidaily. The water samples for the biological analysis were taken before and after the treatment. The samples were sieved through a 100 µm sieve and studied after a recovery time of 2-5 h with stereo microscope. Three replicates were included in the analysis with ultraviolet light, ultrasound and ozone, two replicates for the combination of ultraviolet light and hydrogen peroxide. Due to the variation in the samples the minimum density of 1 individual per litre was included in the analysis. The statistic analyses were carried out utilizing parametric Student's *t*-test, analysis of variance (ANOVA) or Mann- Whitney U-test or Krustall-Wallis non-parametric, depending on the distribution and homogenous of the data.

The results with considerable reliability for ultraviolet light treatment were 94-99 % for copepods, 78-100 % for copepods nauplii and 98-100 % for rotifers. For the ultrasound technology the achieved mortality rates were 94-99 % for copepods, 86-99 % for copepod nauplii, 95-98 % for cladocerans, 80 % for rotifers and 97 % for barnacle nauplii. For the combination of ultrasound and ultraviolet light the mortality rates were between 97-100 % and the combination of ultraviolet light and hydrogen peroxide achieved the mortality rates of 94-100 %.

The results with considerable reliability for ozone treatment with ozone dosage of 17 mg/L were 96-100 % for copepods, 98-100 % for copepod nauplii and for rotifers 99-100 %. When ozone dosage was 7 mg/L, the results were 95-100 % for copepods, 96-100 % for copepod nauplii, 97-100 % for rotifers and 99-100 % for barnacle nauplii. The volumes of the contact tanks were 60 L for the ozone MARTOB GRD1-2000-25383 DTR-4.4-VTT, 02/02/04 5 (48) dosage of 17 mg/L and 360 L for dosage of 7 mg/L. The ozone dosages were kept constant throughout the trials.

The onshore test trials confirmed that all the devices were working as they were designed and also most of the error of sources occurred during the laboratory scale test trials could be reduced. The results were relatively reliable due to the adequate number of replicates and provided basis for the upscaling of the ultraviolet light, ultrasound and ozone treatment processes.