Hurdle Method

Executive Summary

The hurdle method consists of combining disinfecting technologies offer the option of eliminating the limitations of individual techniques as well as the advantage of using the synergy of different methods. From food industry it is known that combinations of two disinfecting techniques have more effect than the sum of individual conservation methods. One well known application of hurdle technology in ballast water treatment is the combination of filter technology (hydrocyclons) and UV disinfection.

During the Newcastle trials various combinations were tested based on the expected synergistics effects, i.e. the combination of mechanical filter + US + UV, filter + UV + oxicide (H_2O_2), H_2O_2 + UV, thermal treatment + de-oxygenation and H_2O_2 + heat treatment. From the results of the hurdle technologies, the treatment that worked better was the thermal + deoxygenation, which had a 100% efficiency for *Tisbe battagliai* and *Nereis virens*, and 97 % for *Acartia tonsa*. Because there were no replicates, the results must be interpreted with care. Comparing the efficiency of UV+H_2O_2 with and without filter (150µm), the results showed that the filter did affect the survival of the organisms, as the percentage of organisms removed increased for *Acartia tonsa* and *Nereis virens* when the filter was used. The combination of US and UV achieved a 68 % reduction of chlorophyll *a* levels compared to samples taken before treatment. The combination of filter, US and UV achieved a 57 % reduction of chlorophyll *a* level.

The combination of US and UV was also tested in the Espoo triails carried out by VTT. The result of total reduction of *Artemia salina* was 82-99 %. In terms of hurdle technology, a better performance from the filter (125 µm) + US + UV test compared to the US + UV seems apparent, mainly for *Acartia tonsa* and *Tisbe battagliai*.

Regarding the phytoplankton results, it is difficult to be certain which of the combinations of technologies are the most effective. It would appear that combinations of heat with deoxygenation or H_2O_2 were not effective at reducing chlorophyll *a*. The remaining four treatments were all based on combinations of UV and H_2O_2, sometimes with the added combination of a filter. On two occasions this reduced the chlorophyll *a* by over 70 %, on another occasion the reduction was less than 20 % and the fourth run resulted in an increase in chlorophyll *a*. It is therefore impossible to say with any certainty whether this combination of technologies is effective.

In conclusion, the results obtained don't support a combination unambiguously. Results from some combinations and process parameters showed improvement, where others combinations gave poorer results.