Studies of the Interaction Between Surface Films and Water Waves -Part I

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Work is presented on the interactions between waves and surface-active films. Understanding the process by which surface contaminants are dispersed is necessary for the prediction of the environmental damage caused by oil spills. The complete study is both theoretical and experimental and is aimed at the effects that the films have on wave creation and breaking, plus the mixing of these films after breaking. The breaking process is mainly responsible for the dispersion of surface films in the surf zone, but the presence of such a film can damp waves and influence breaking; the contaminant influences and inhibits the mechanism for dispersing it.

This paper is concerned with the experimental study of the mixing of the surface film into the water column after breaking. In parallel with this, a theoretical and experimental study into the effects that the film has on wave formation is being conducted and described in Schlicke et al. (2000).

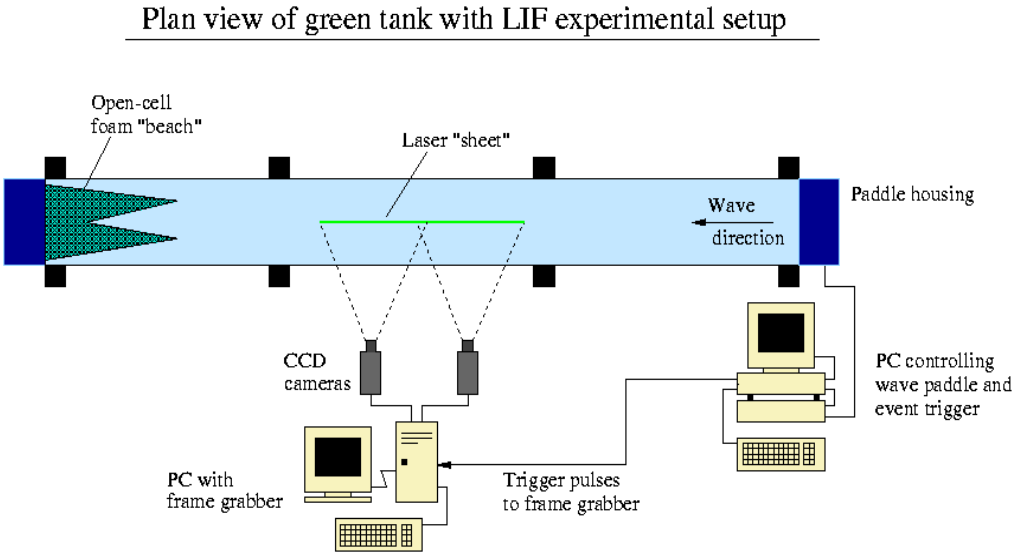

Figure 1. The wave/current flume used for the experiments

The experiments were conducted in the wave/wind/current flume in the Physics Dept. at Edinburgh University. Breaking waves were created in a tank by the superposition of wave frequencies generated by a computer controlled wave paddle. By using LIF and PIV simultaneously, the onset of vortices and turbulence after breaking can be related to the mixing of the surface film. A scanning laser beam system is used to produce a vertical ``sheet'' of light in the flume; the light sheet being approximately 2m wide at the water surface. The 3-D velocities of the fluid both with

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and without a surface film are compared using dual-plane PIV images of tracer particles within the fluid. The highly fluorescent dye Rhodamine B is added to the surface film, allowing the film's dispersion to be tracked using LIF. For this a pair of CCD cameras are positioned to view the light sheet with a small overlap between them as in figure 1. By filtering the laser light, film concentrations as low as 0.5 % can be detected. A series of false colour images of the concentration of the Rhodamine during and after breaking is shown in figure 2 (the apparent step in concentration in the centre of the images is merely the join line).

A large number of factors influence the dispersion of a surface film, including wave parameters, composition and thickness of the film, wind and bed slope. In this initial study, one plunging and spilling breaker, and two types of film (methanol and oleic acid) are being investigated.

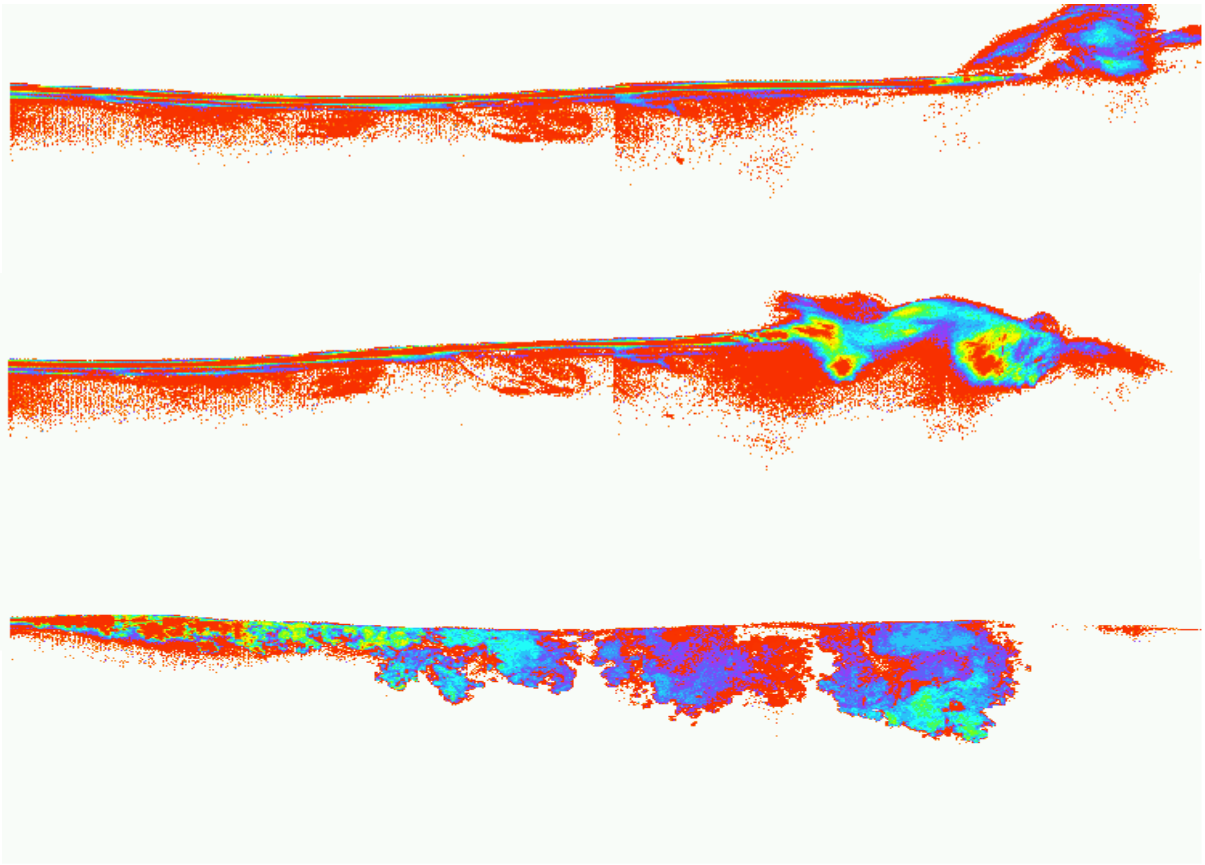

Figure 2. Concentration maps of Rhodamine/surface film dispersion at and after breaking

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References

Schlicke E, Arnott AD, Buick JM, Pullen J, Thomas NH & Greated CA. Studies of the Interaction Between Surface Films and Water Waves - Part II. To be presented at EuroMech 416 colloquium, Genova, Italy, 17-20 September 2000.