Department of Mathematics

Experimental Model of the Interfacial Instability in Aluminium Reduction Cells

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A solution has been found to a long-standing problem of experimental modelling of the interfacial instability in aluminium reduction cells. The idea is to replace the electrolyte overlaying molten aluminium with a mesh of thin rods supplying current down directly into the liquid metal layer. This eliminates electrolysis altogether and all the problems associated with it, such as high temperature, chemical aggressiveness of media, products of electrolysis, the necessity for electrolyte renewal, high power demands, etc. The result is a room-temperature, versatile laboratory model which represents Sele-type, rolling pad interfacial instability. The method can be used to obtain detailed experimental data and to test various theoretical models, which has never been done before

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Overcoming magnetohydrodynamic (MHD) instabilities in aluminium reduction cells is a problem of enormous industrial importance [1]. This is not surprising as current production facilities consume about 3% of all the electricity generated worldwide, which translates into

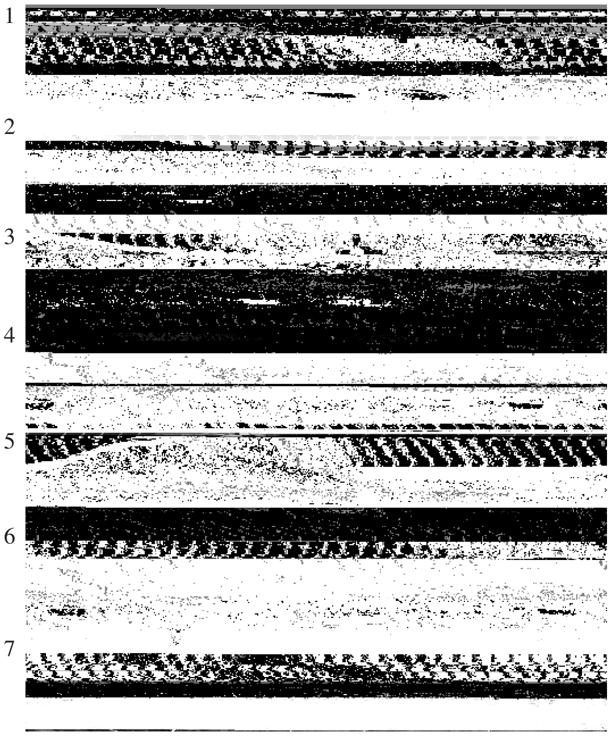

Figure 4: Sequence of video frames showing passing liquid metal wave along a sidewall of the cell; time step between the frames is 0.2 s; wave period is 1.2 s; h_2 = 35 mm, I_0 = 1.2 kA, B_0 = 100 mT; vertical scale is 55 mm per frame.

terruption between some of the electrodes and the liquid metal. This second liquid, however, does not conduct electric current, but may serve to minimise density difference between the °uids thus making interfacial waves less stable.

Maximal anode current in the experiment has been 1.8 kA, which allows to achieve the maximal current density in the experiment of $2{:}2A{=}cm^2$. This is more than 4 times higher than that in real cells. The background magnetic ¯eld is 6-

Figure 6: RMS value of interface °uctuations h* vs. current I_0.

the direction of rotation. The sequence of video frames in Fig. 4 demonstrates a high-amplitude wave passing along one of the sidewalls of the cell.

Fig. 5 provides time-history of the measured electric