**Appendix B: Relations for convective heat transfer at the water surface**

The recovery temperature in Eq. (22), *Trec*(*i,j*) , is defined as follows:

 (B1)

The recovery factor, *r*, is a function of the Prandtl number and depends on flow regime:

 (B2)

The calculation of the convective heat transfer coefficient is mainly based upon a modified Nusselt number [31], and is extended to be applied to 3D simulation. In the stagnation region the lower bound of the heat convention coefficient is taken to be

 (B3)

With dVe /ds the velocity gradient at the boundary layer edge.

Unlike two-dimensional case, the direction of boundary-layer velocity in 3D flow varies with the streamline direction, as shown in Figure 8. In order to compute (*dVe*/*ds*)(*I,j*), the process of linear interpolation was carried out graphically (see Figure 10). The external velocity, *Ve*(*Q*), needs to be known. Making use of linear interpolation, the derived *Ve*(*Q*) take the form:

 (B4)

For turbulent flat-plate boundary layer, the convective heat transfer coefficient can be calculated with the following relationship:

 (B5)

Where the factor  has been chosen equal to 2, which gave the best agreement between calculated ice shapes and ice shapes found in experiment [32,33]. Pr is the Prandtl number, Re*s* is the Reynolds number based on the distance *s* from the stagnation point and using the local velocity from the potential method:

 (B6)

For the case of 3D,

 (B7)

Where  is the distance along chordwise, *θ* is the angle between velocity vector and its chordwise velocity component, as shown in Figure 10.