

**The onset of mixed convection in the thermal entrance region of plane Poiseuille flow**

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Buoyancy driven secondary flow in a forced laminar flow through a bottom heated horizontal channel can cause significant heat transfer enhancement. In the present study the finite element method was used to simulate this mixed convection in a horizontal fluid layer. In order to observe the behavior of vortex rolls, the three characteristic streamwise distances ( $x_c$ ,  $x_d$ ,  $x_u$ ) and the growth rates ( $r_0$ ,  $r_{1,TE}$ ,  $r_{1,KE}$ ) based on the numerical data are suggested newly. We suggest that the critical condition of the onset of intrinsic instability would be  $r_0 = r_{1,TE}$  at  $x = x_c$ . Also, we suggest that the secondary flow would be detected with  $r_{1,KE} = \text{maximum}$  at  $x = x_d$ . Finally, we suggest that the significant heat transfer enhancement starts from  $x = x_u$ . In the present study the above characteristic distances agree well with available experimental data.