The onset of vortex rolls in the thermal entrance region of plane Couette flow

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The onset of longitudinal vortex rolls due to buoyancy forces in the thermal entrance region of plane Couette flow is investigated theoretically. In the present study, to examine this streamwise roll−type convection, the Boussinesq equations are solved by using the finite volume method. In order to observe the behavior of longitudinal vortex rolls, the local growth rates of the mean fields and fluctuations, r_0 and r_1 are defined. We suggest that the critical condition of the onset of convective instability would be $r_1=r_0$ at $x=x_c$, which is here called the onset distance of intrinsic instability. Also, we define x_D where secondary flow can be detected and x_m where r_1 shows the maximum. The undershoot distance x_u where the Nusselt number has the minimum has usually been considered as the onset distance of manifest convection. Here we suggest that $x_c < x_D \leq x_m (\approx x_u)$. In the present study the above characteristic positions are clarified in comparison with available experimental data.