Incorporation of 2^{nd} order-accurate bounce-back scheme into axisymmetric lattice Boltzmann revised method

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Abstract— **The second order bounce back scheme is applied for the axisymmetric lattice Boltzmann revised method in order to improve the accuracy and efficiency of this method. Any arbitrary geometry with a non-slip boundary condition can benefit from this enhanced technique. The bounce back approach involves particles' travelling toward a solid wall reflecting back into the fluid zone in the opposite direction while maintaining their velocity. Kim applied an interpolation parameter, ω to the particles travelling directions and proved that if $\omega = \frac{1}{2}$ is chosen, this method displays second order behaviour in error. In this study, the steady flows inside a cylindrical cavity are used to validate the second order axisymmetric lattice Boltzmann revised scheme. Also, the maximum value of the axial velocity component and the position of its occurrence are investigated, and the solutions are compared with the experimental data, the 3D lattice Boltzmann method (LBM) and the finite volume method solution of the Navier-Stokes equations. The comparison of the relative errors between the 2nd order AxLABR and the original AxLABR demonstrates the considerable improvements of the new scheme. Furthermore, the new technique delivers additional information and fewer errors, resulting in a more symmetrical and accurate flow pattern**.

Keywords— Axisymmetric Lattice Boltzmann method, Bounce back method, Reynolds numbers, Vortex breakdowns, Cylindrical flows, Rotating endwalls, Second-order accurate bounce-back scheme