

# Flow parameters in an unpressurized circular right-angle elbow under secondary flow propagation

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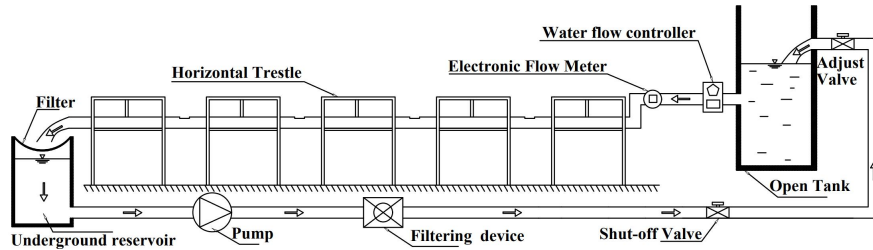
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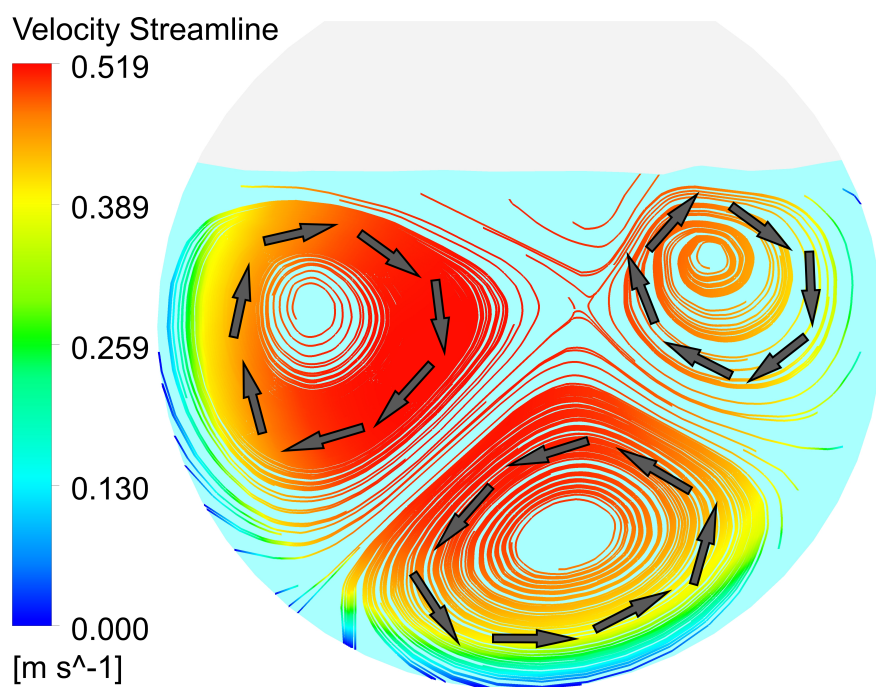
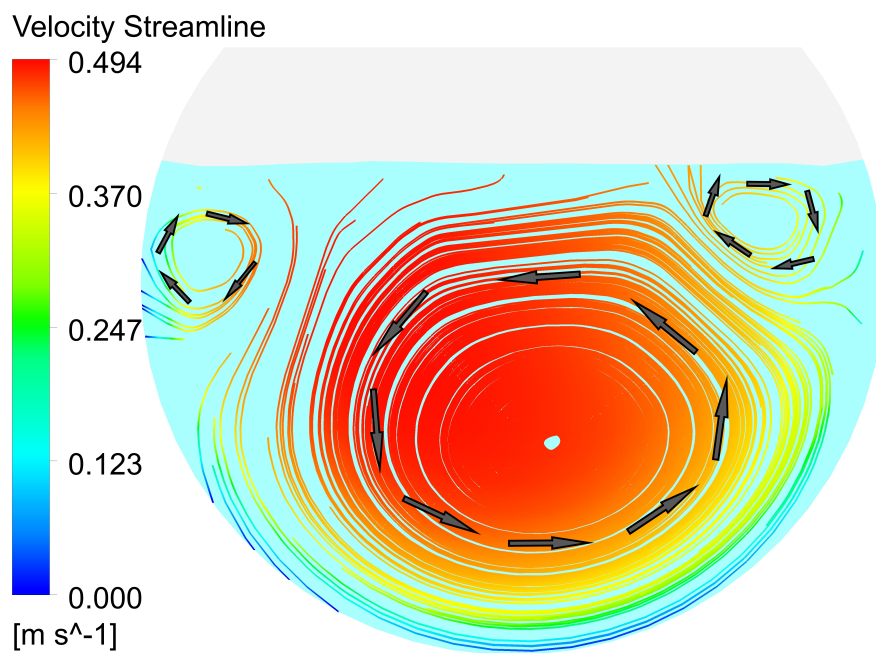
## Abstract

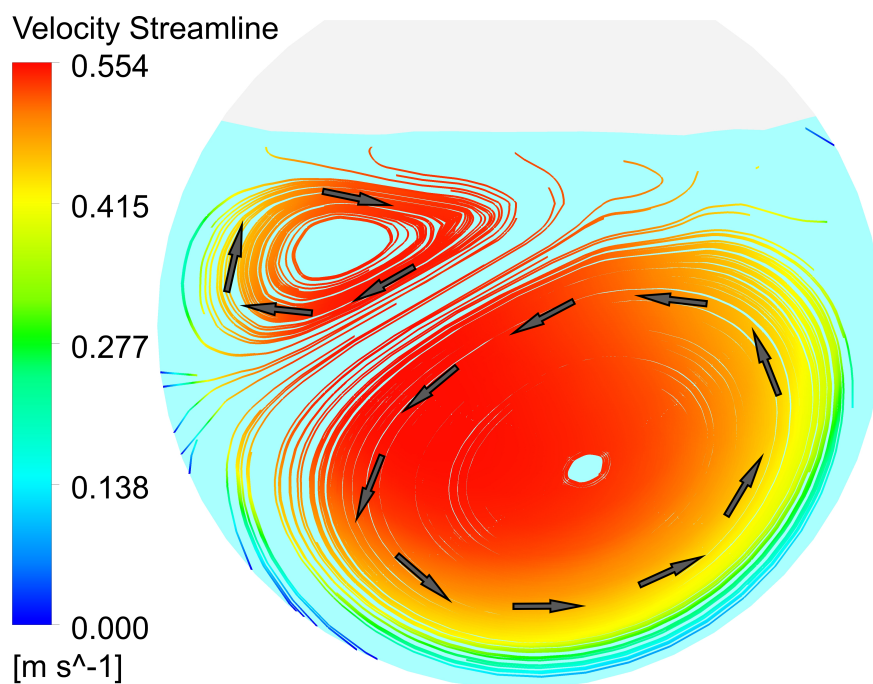
The secondary flow is deflected under pressure and superimposed on the main flows. This research investigated its characteristics, including velocity gradient, vorticity, shear stress, and Reynolds stress in unpressurized circular pipes, through physical experiments and Computational Fluid Dynamics numerical simulations. Combining numerical simulations with the physical experiments under three flow rates ( $30 \text{ m}^3/\text{h}$ ,  $35 \text{ m}^3/\text{h}$ , and  $40 \text{ m}^3/\text{h}$ ) and width-perimeter ratios ( $W_r = 0.43, 0.4$ , and  $0.35$ ), the experimental data demonstrate the secondary-flow propagation in unpressurized circular pipes. The secondary flows manifest as deviations of velocities, substitutions of secondary vortices, and flips of shear stresses, which present decay tendencies and are negligible at 52 times the pipe diameter. The secondary flows are driven by the velocity gradient or Reynolds stress, the dominance of which shifts with the increase of diffusion distance. The secondary flow turbulence is reduced and smoothing when the width-perimeter ratio reaches a threshold (approximately  $W_r = 0.40$ ) because of Dean vortices collisional depletion.

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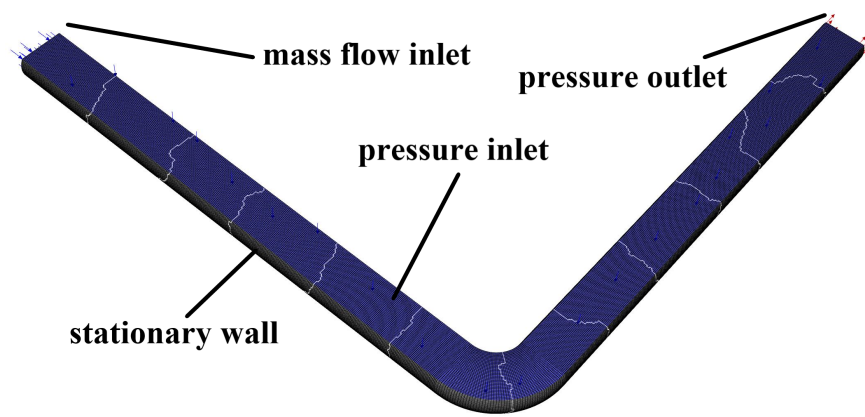


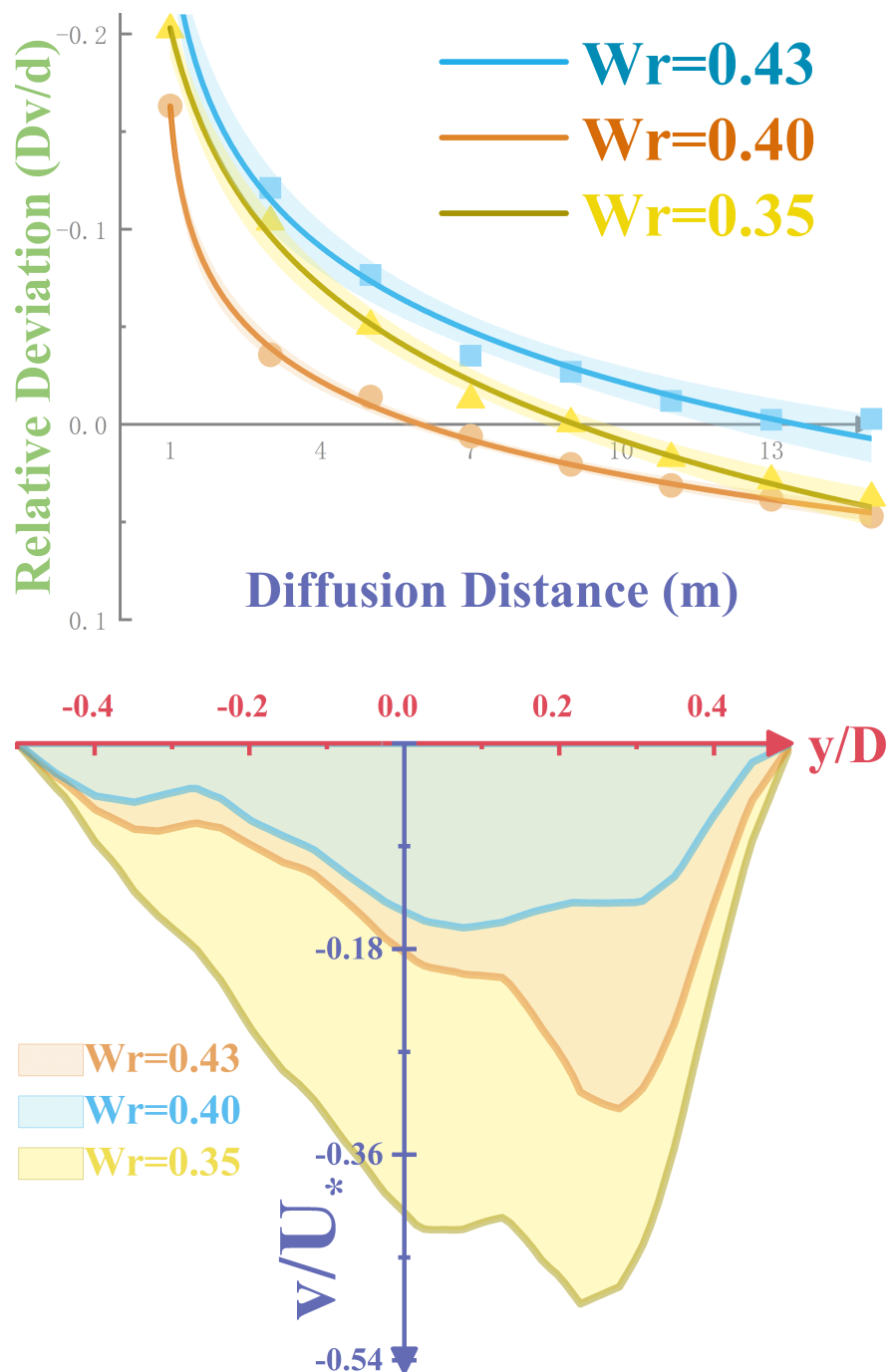




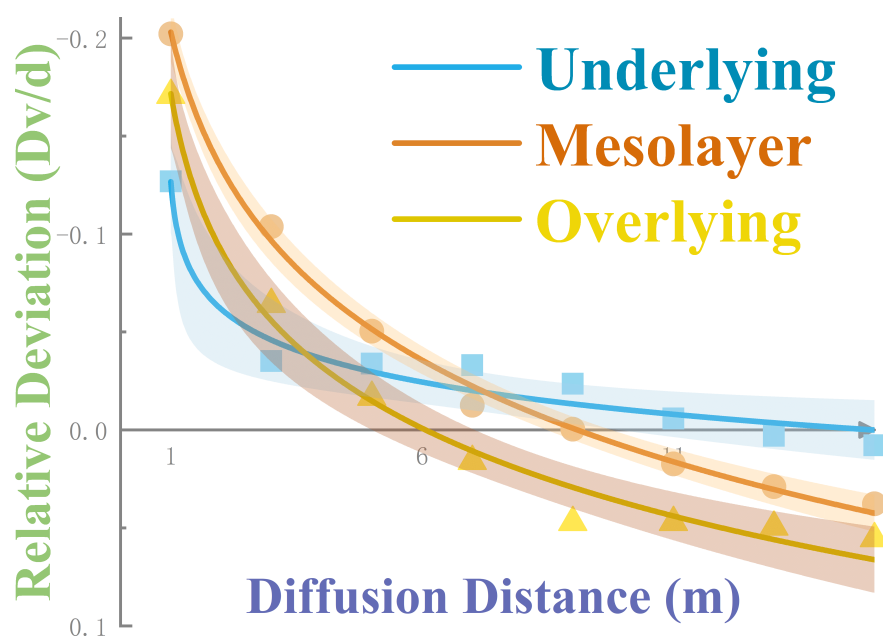
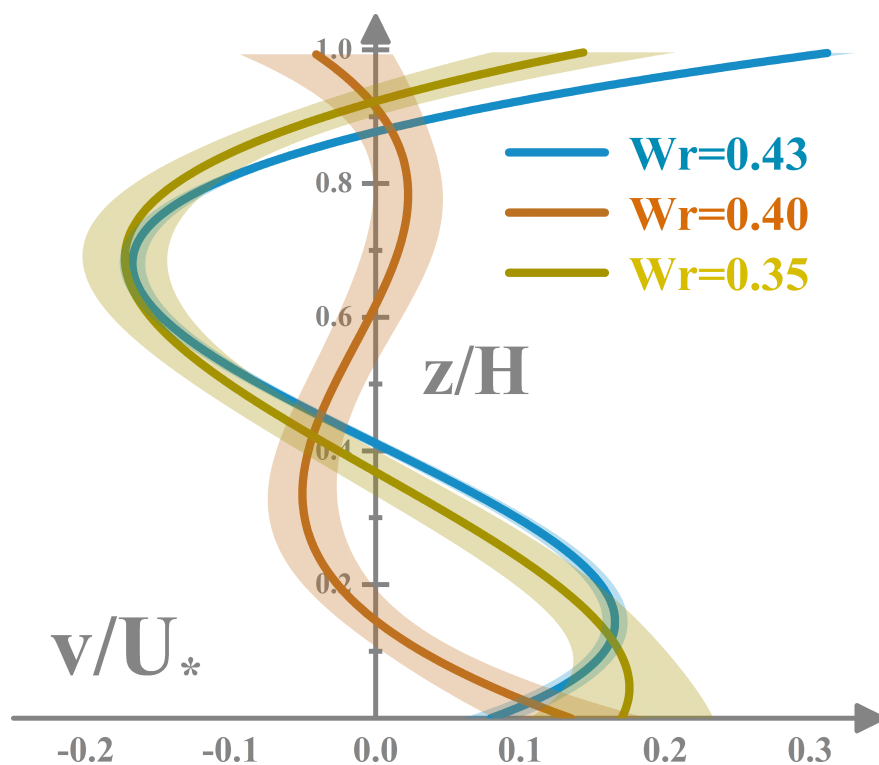
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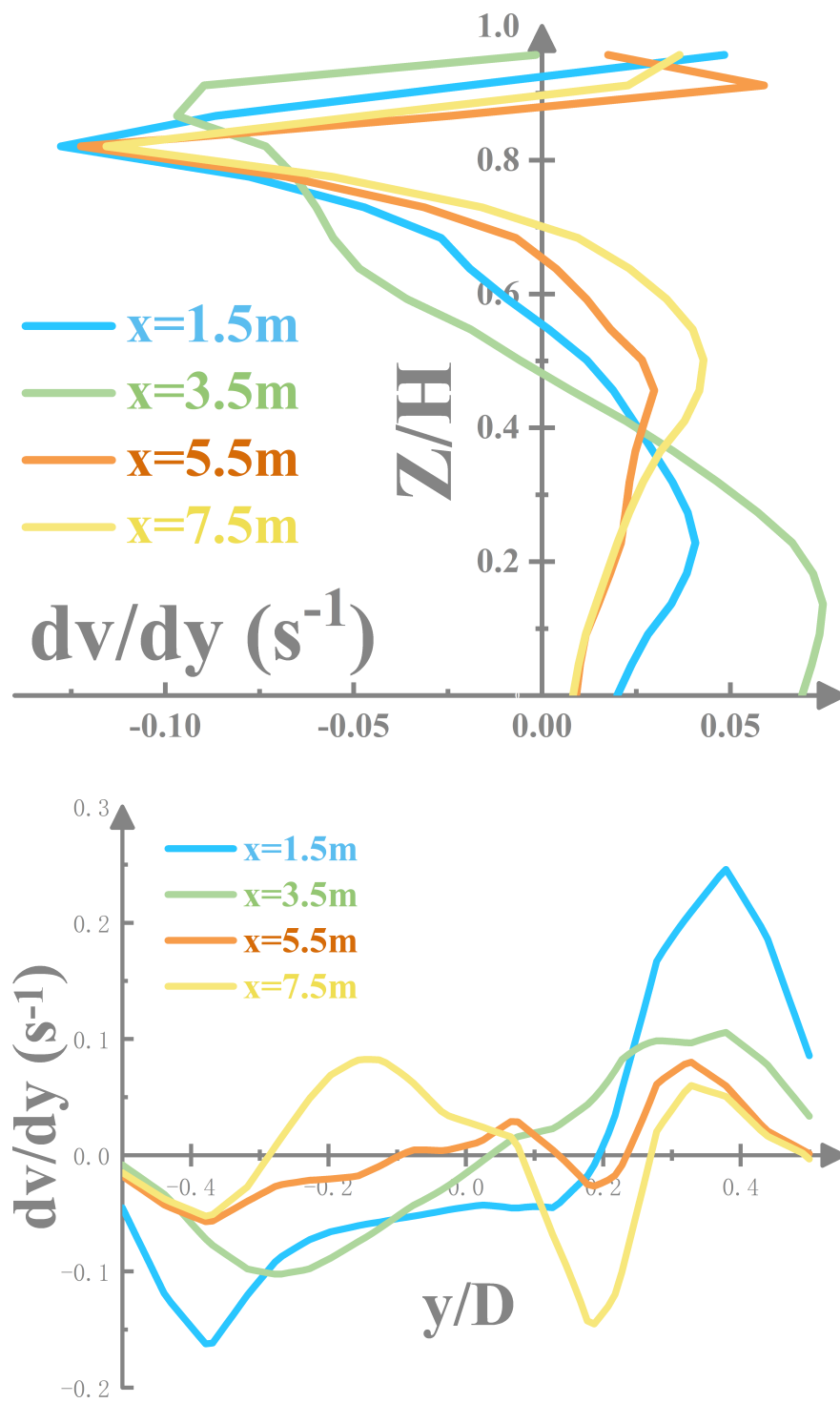
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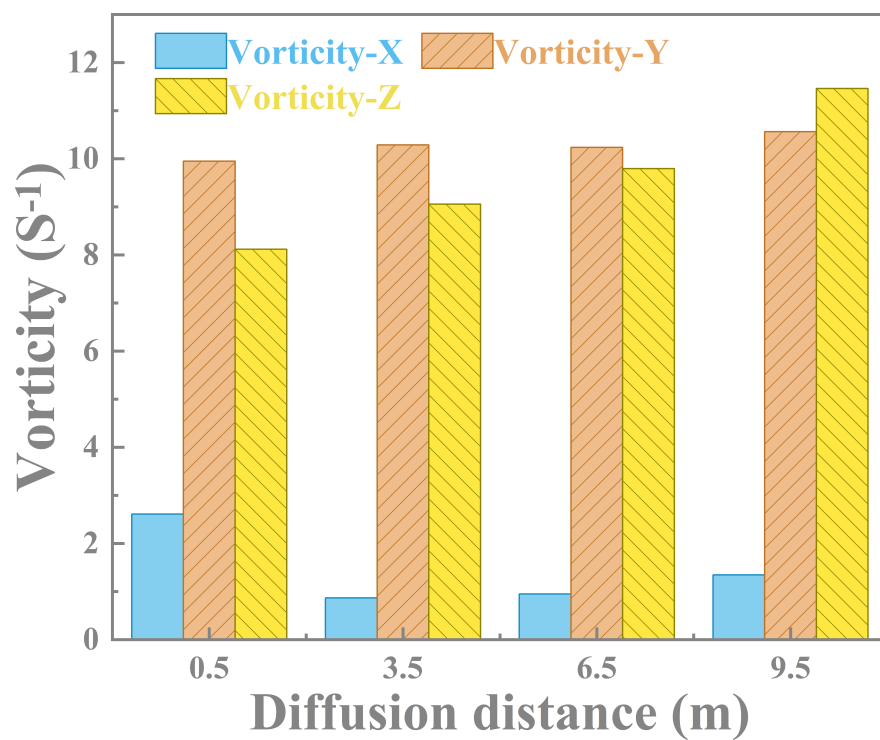
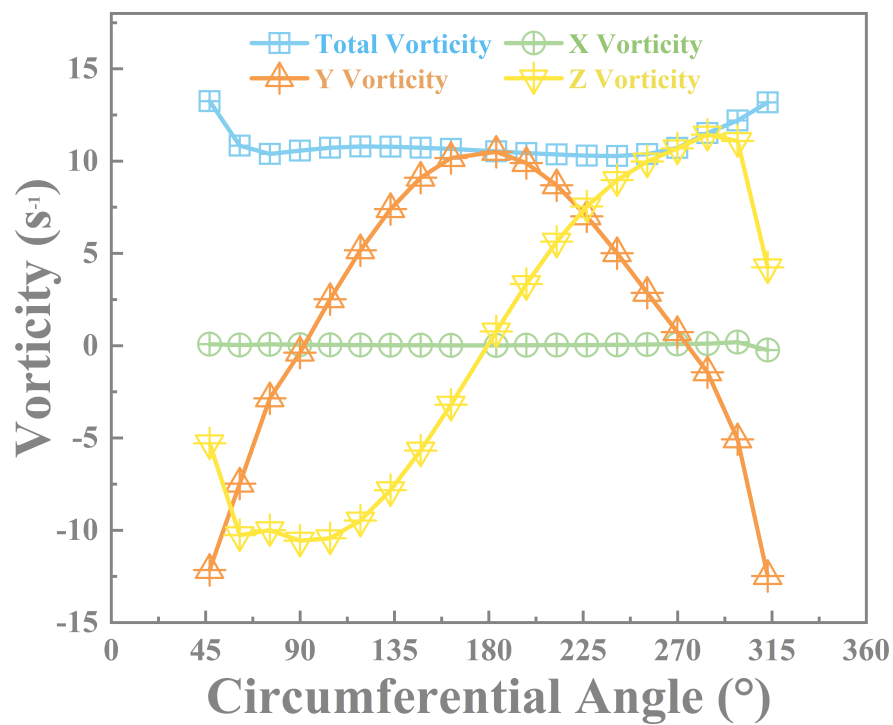


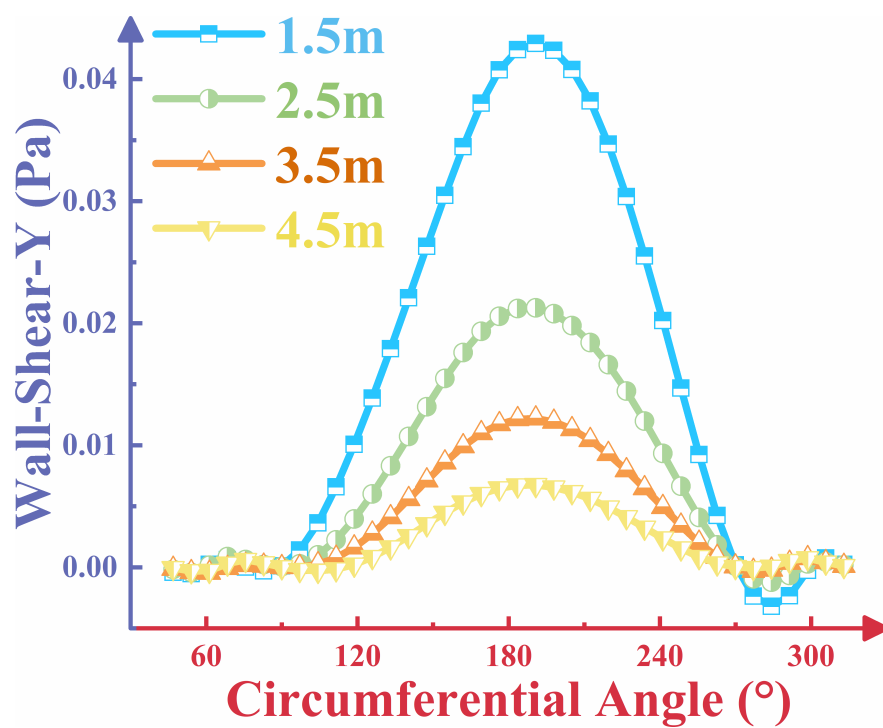
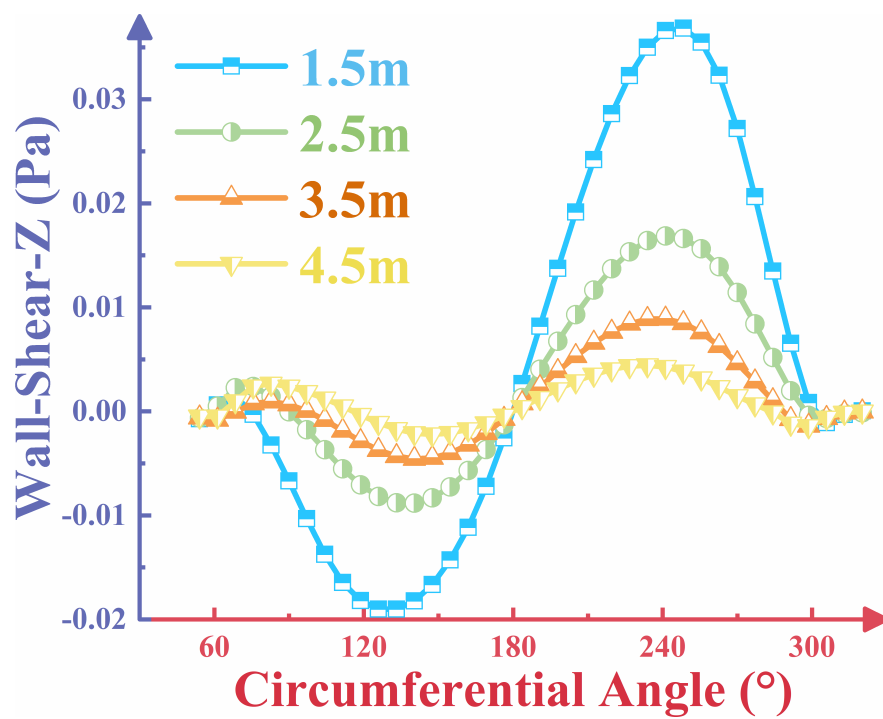


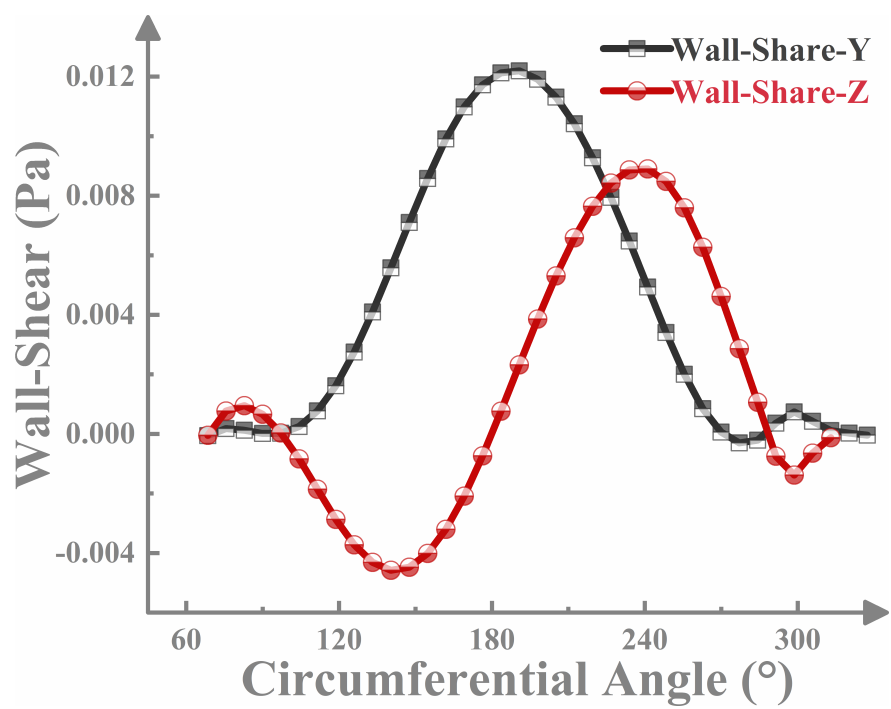
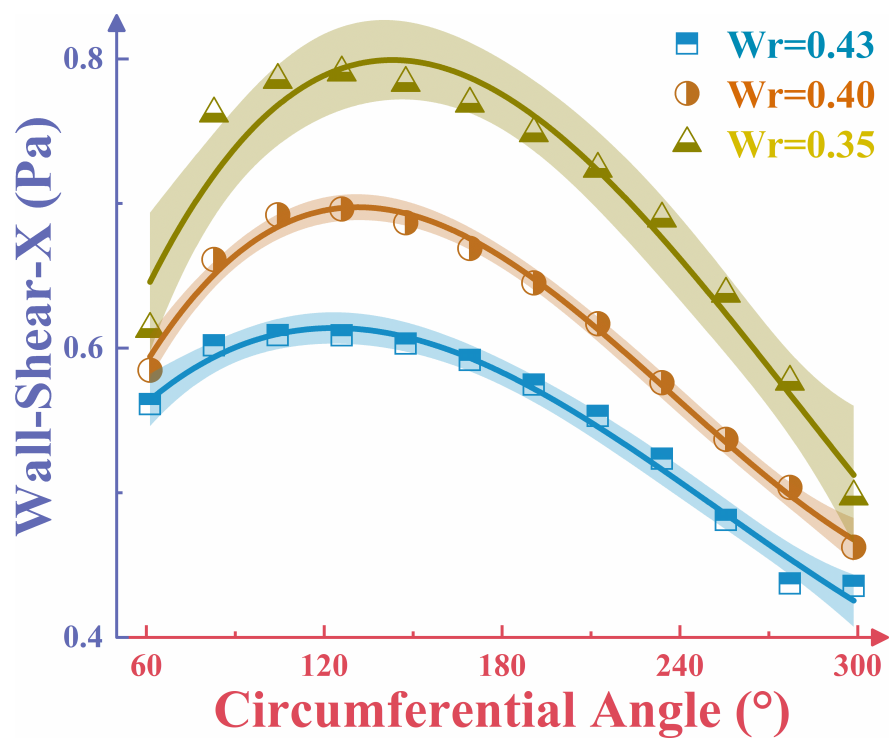


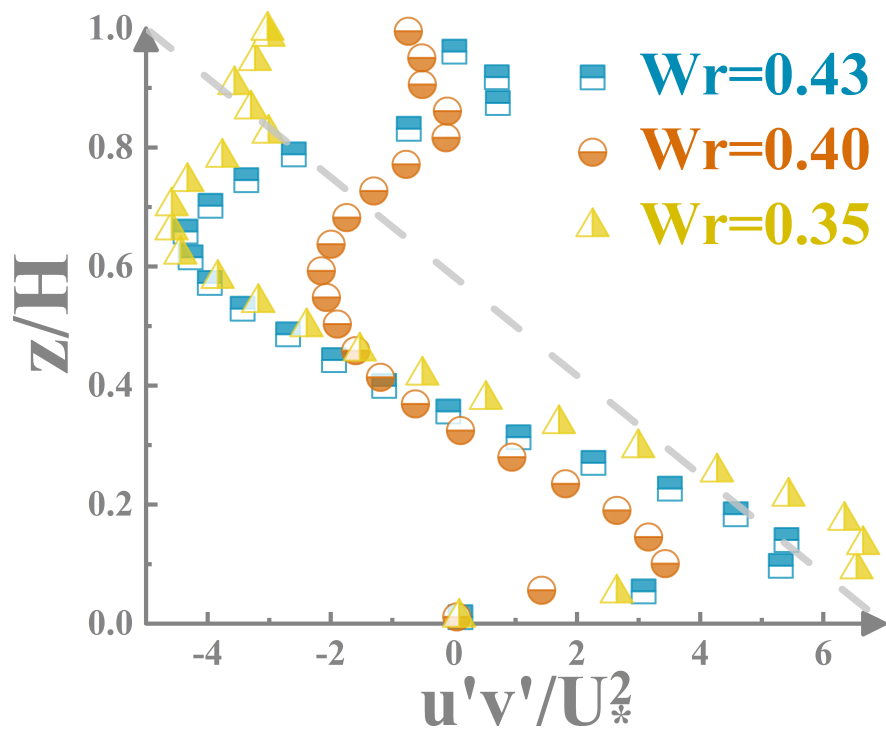
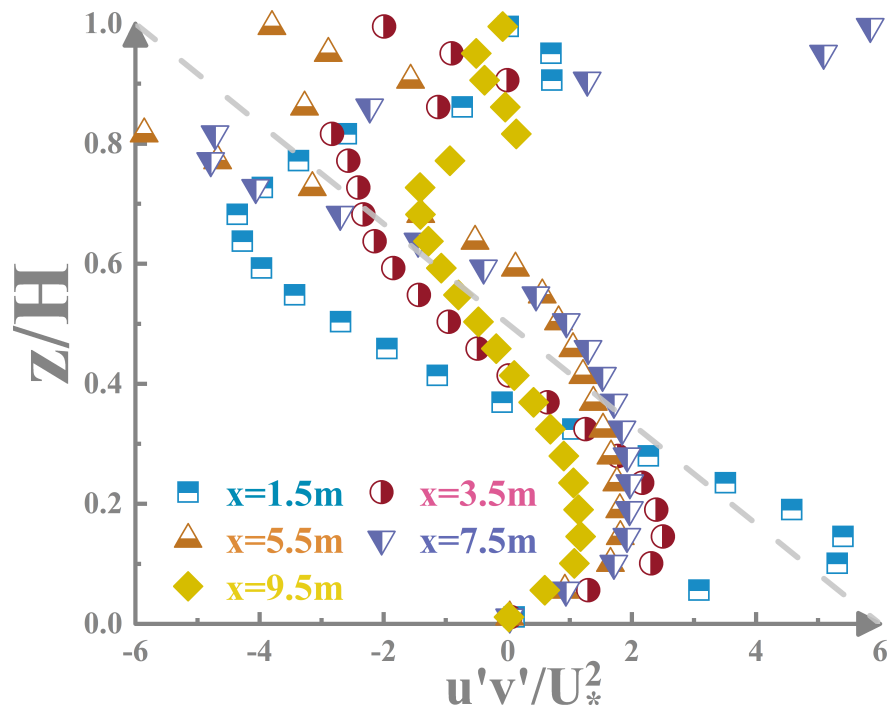




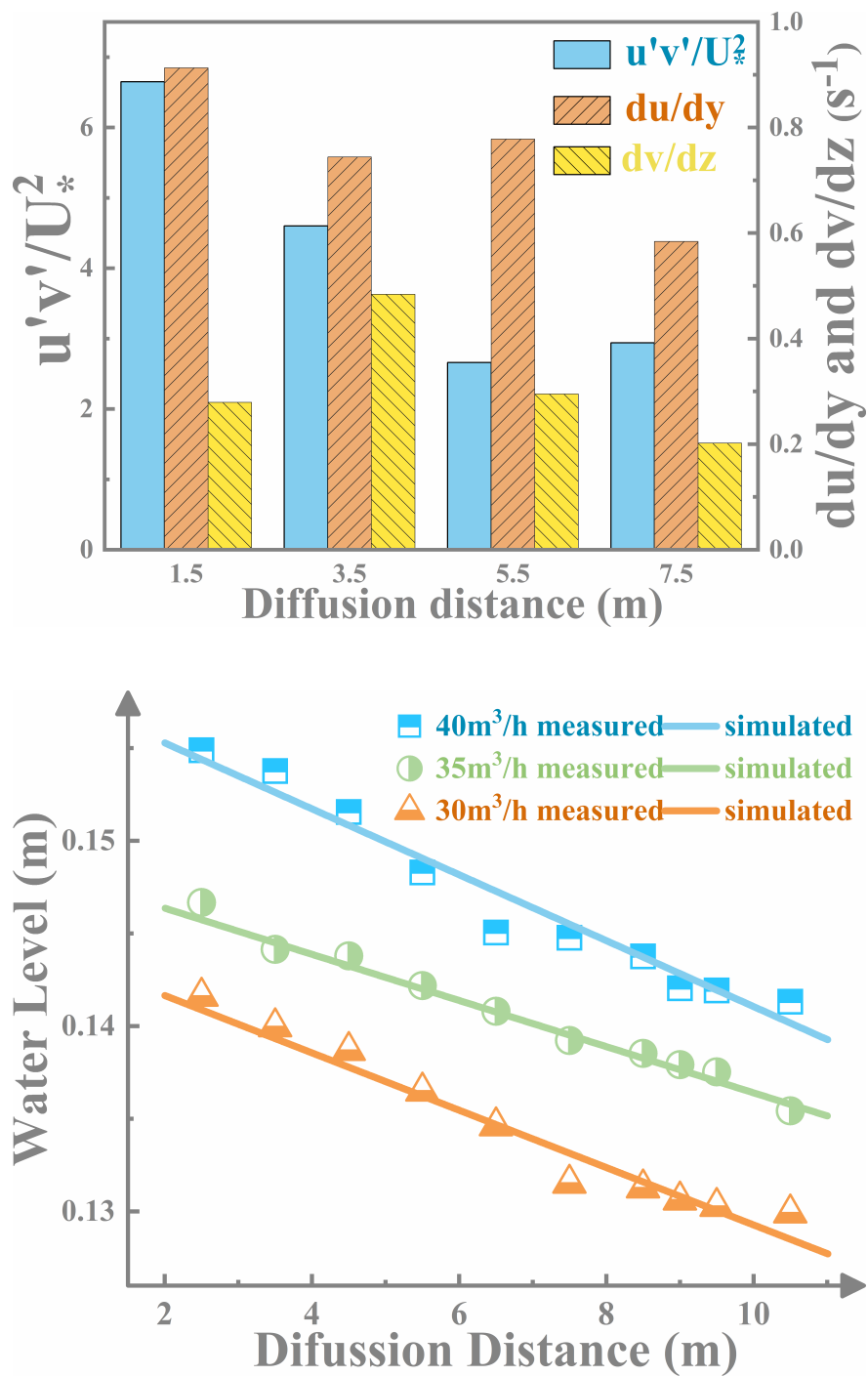












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