Natural Convection effects on Fluid Flow and Heat Transfer in Liquid Slag Layers of Continuous Casters

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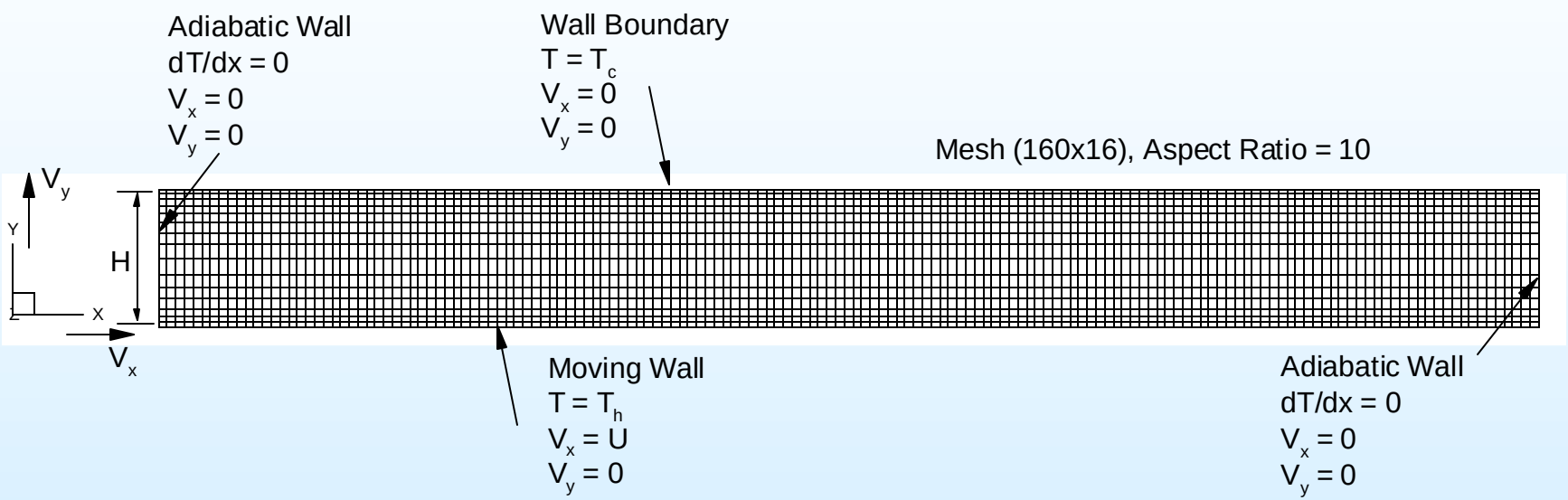
Computational Domain with Mesh and Boundary Conditions



Pure Natural Convection

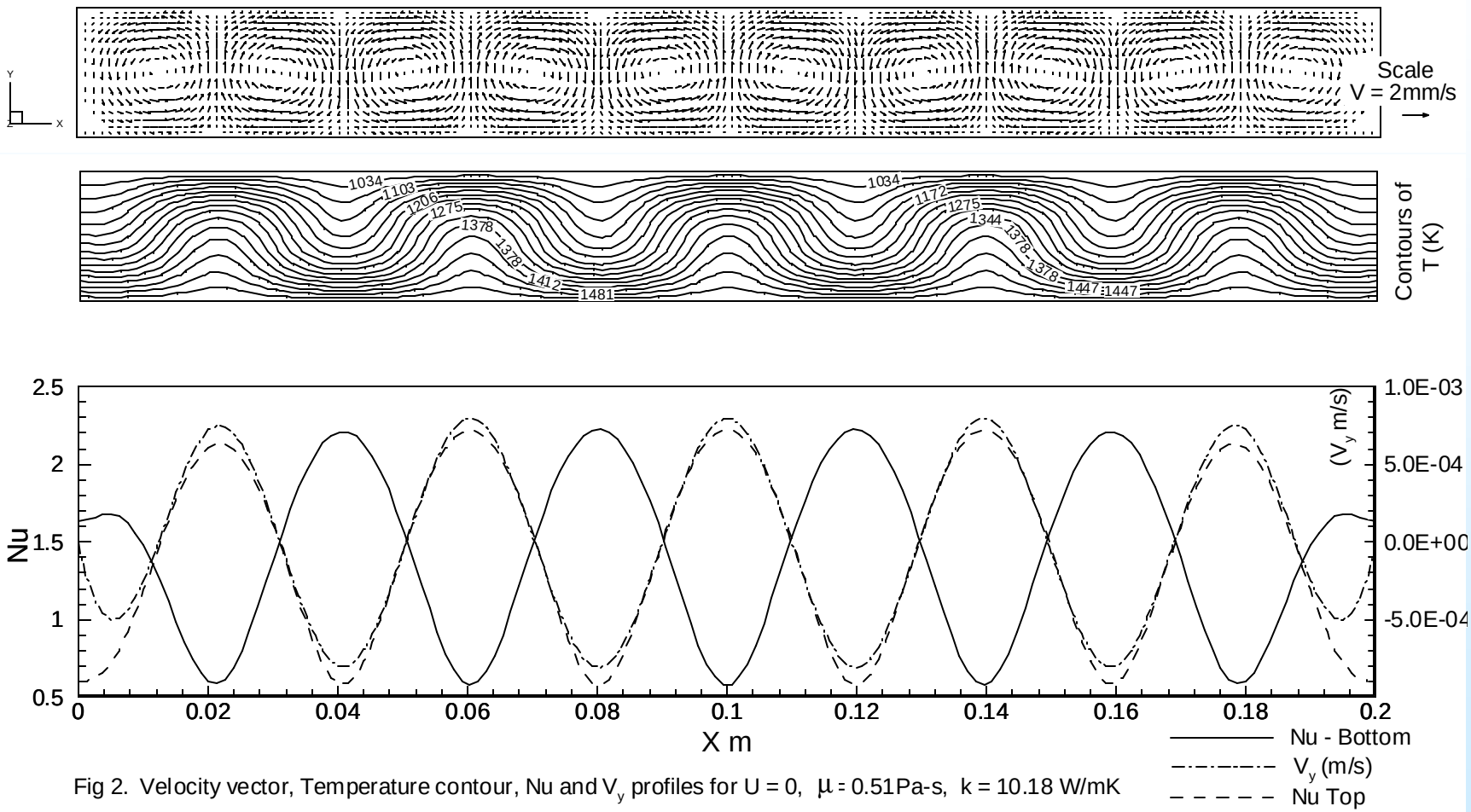
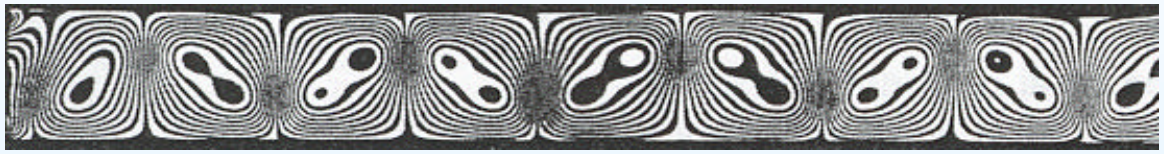
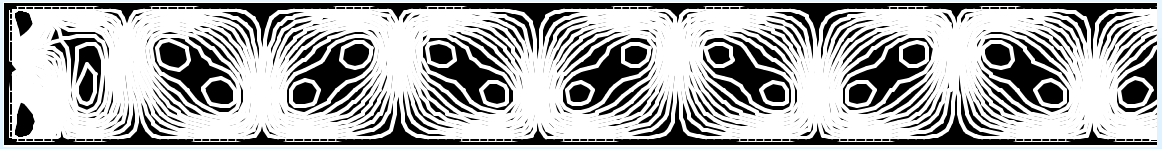


Fig 2. Velocity vector, Temperature contour, Nu and V_y profiles for U = 0, μ = 0.51Pa-s, k = 10.18 W/mK

Contours of Horizontal Density Gradients
(Calculated vs Experimental Interferogram)



Oertel measurement (1988)



FIDAP

Validation Using Experimental Results

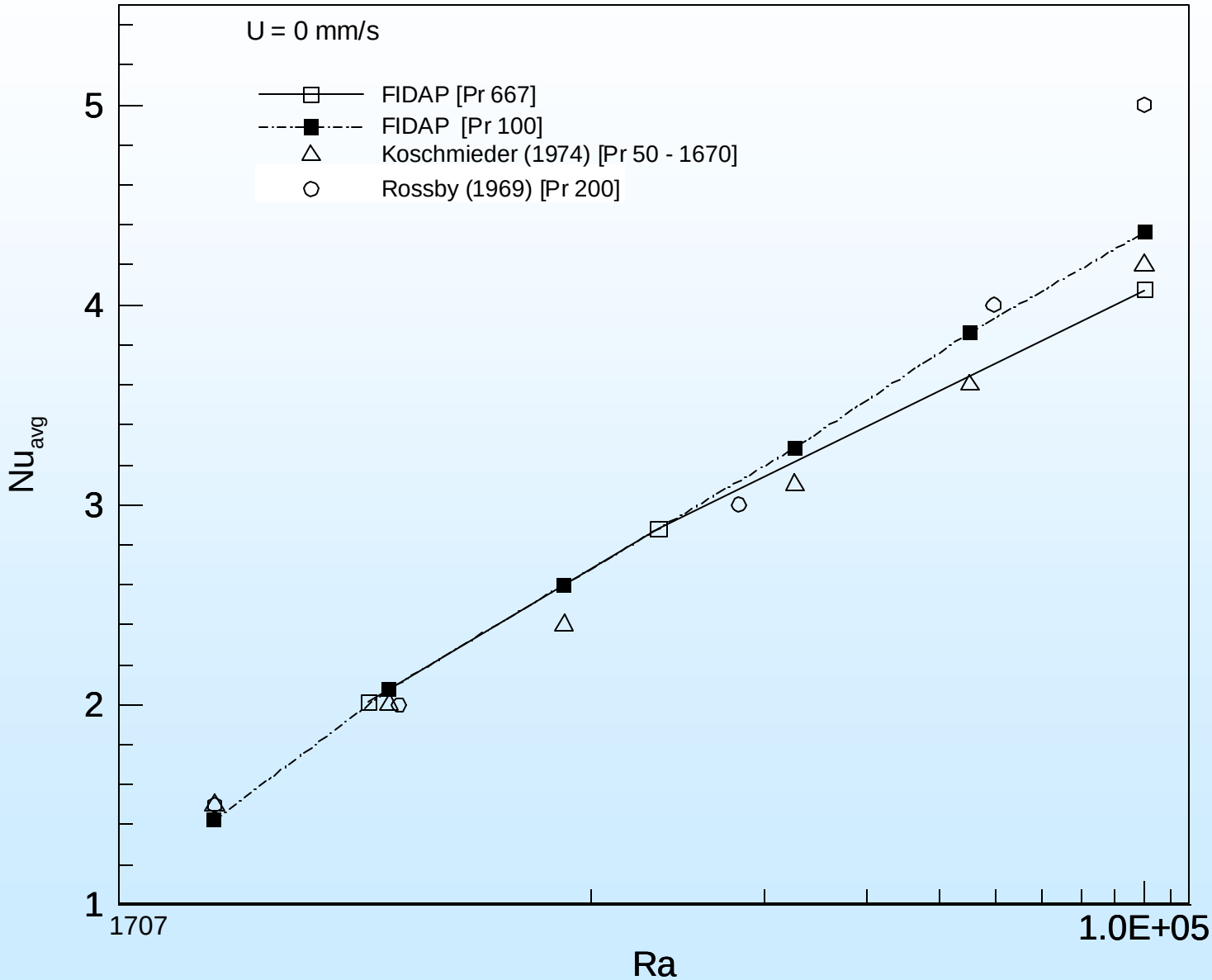


Fig 4. Variation of Nu_{avg} with Ra (comparison of FIDAP with experimental results)

Mixed Convection

(Sub-critical Interface Velocity)

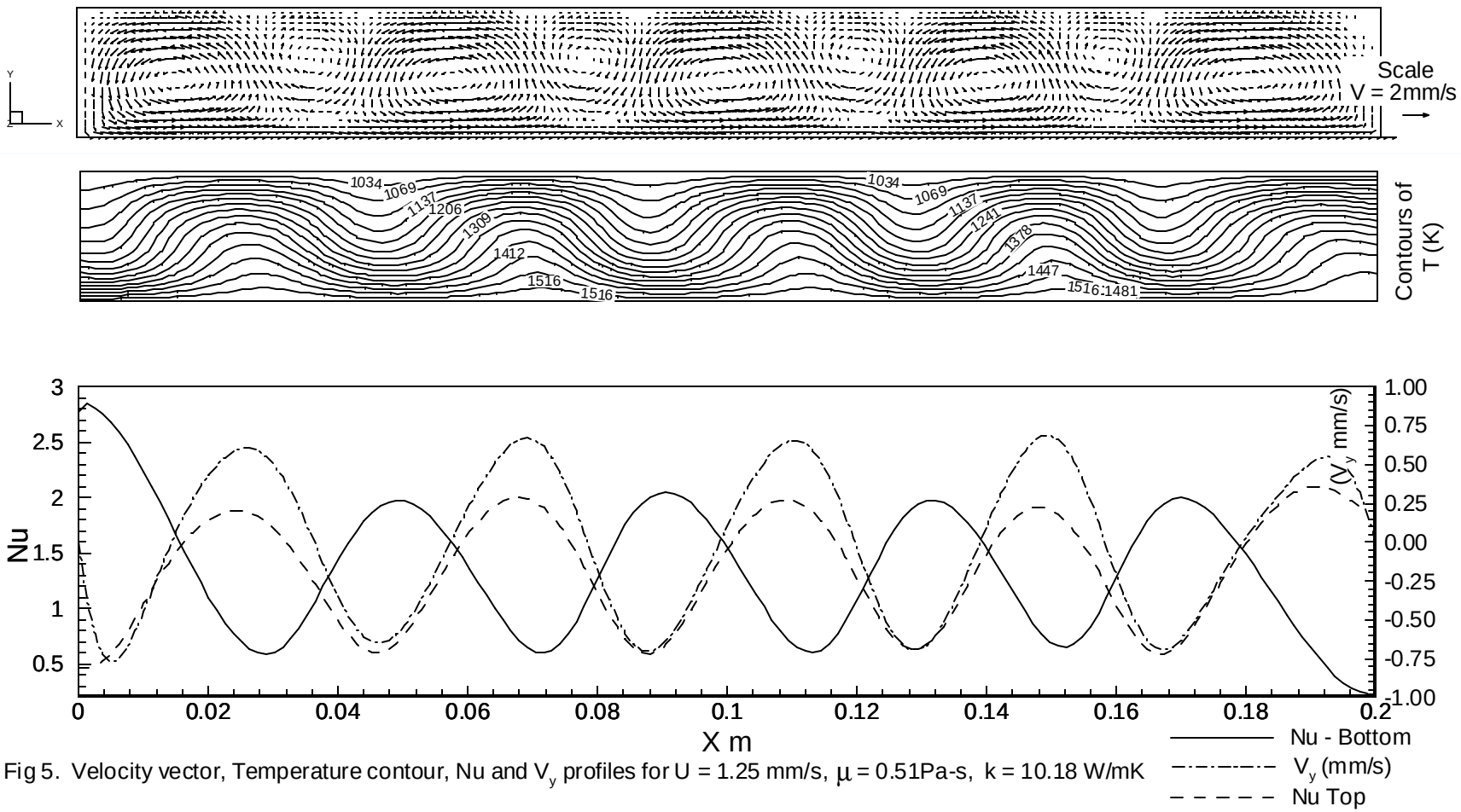


Fig 5. Velocity vector, Temperature contour, Nu and V_y profiles for U = 1.25 mm/s, μ = 0.51Pa-s, k = 10.18 W/mK

Forced Convection
(Post-critical Interface Velocity)

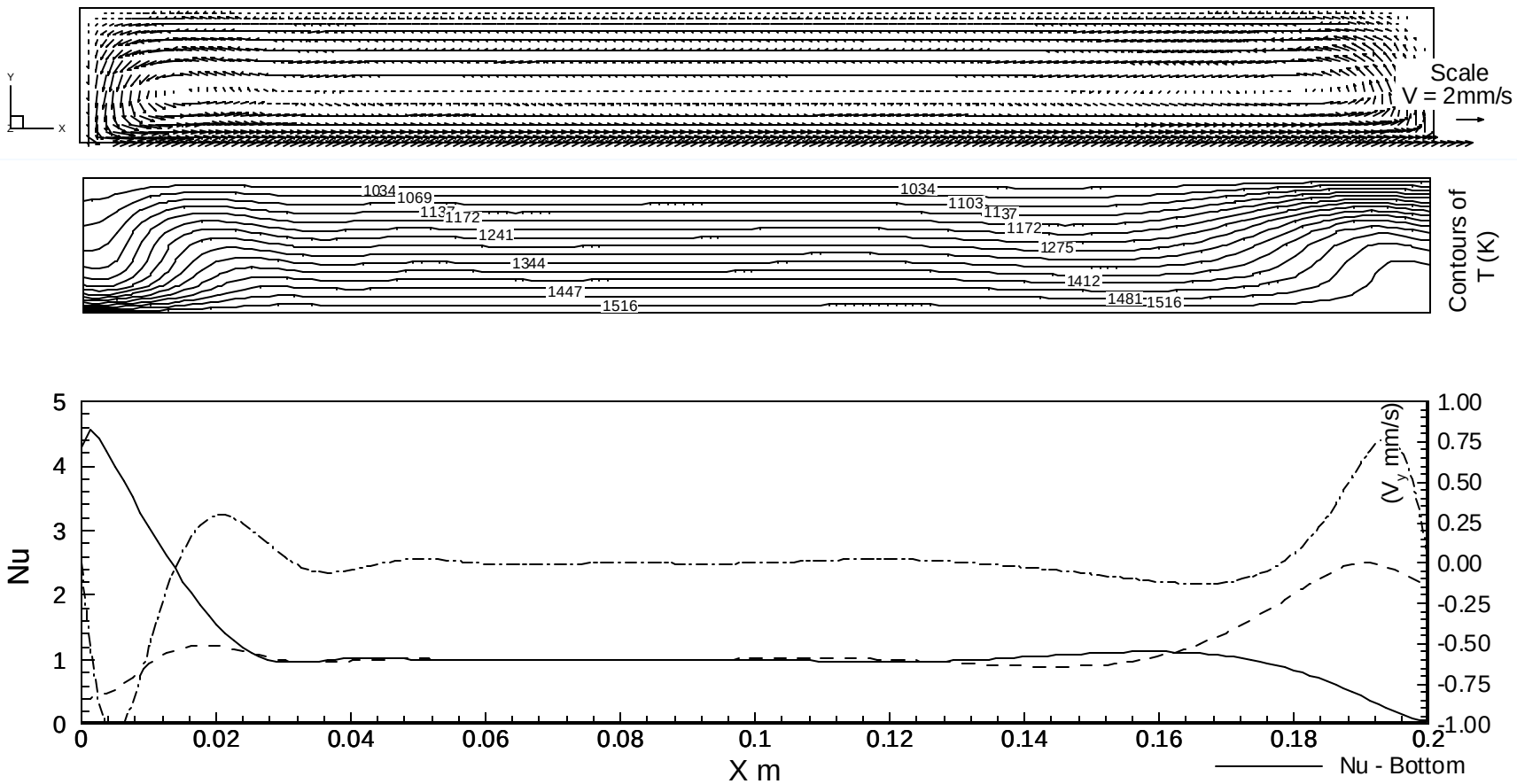


Fig 6. Velocity vector, Temperature contour, Nu and V_y profiles for U = 3 mm/s, μ = 0.51Pa-s, k = 10.18 W/mK

Heat Flux vs Velocity,Viscosity & Conductivity

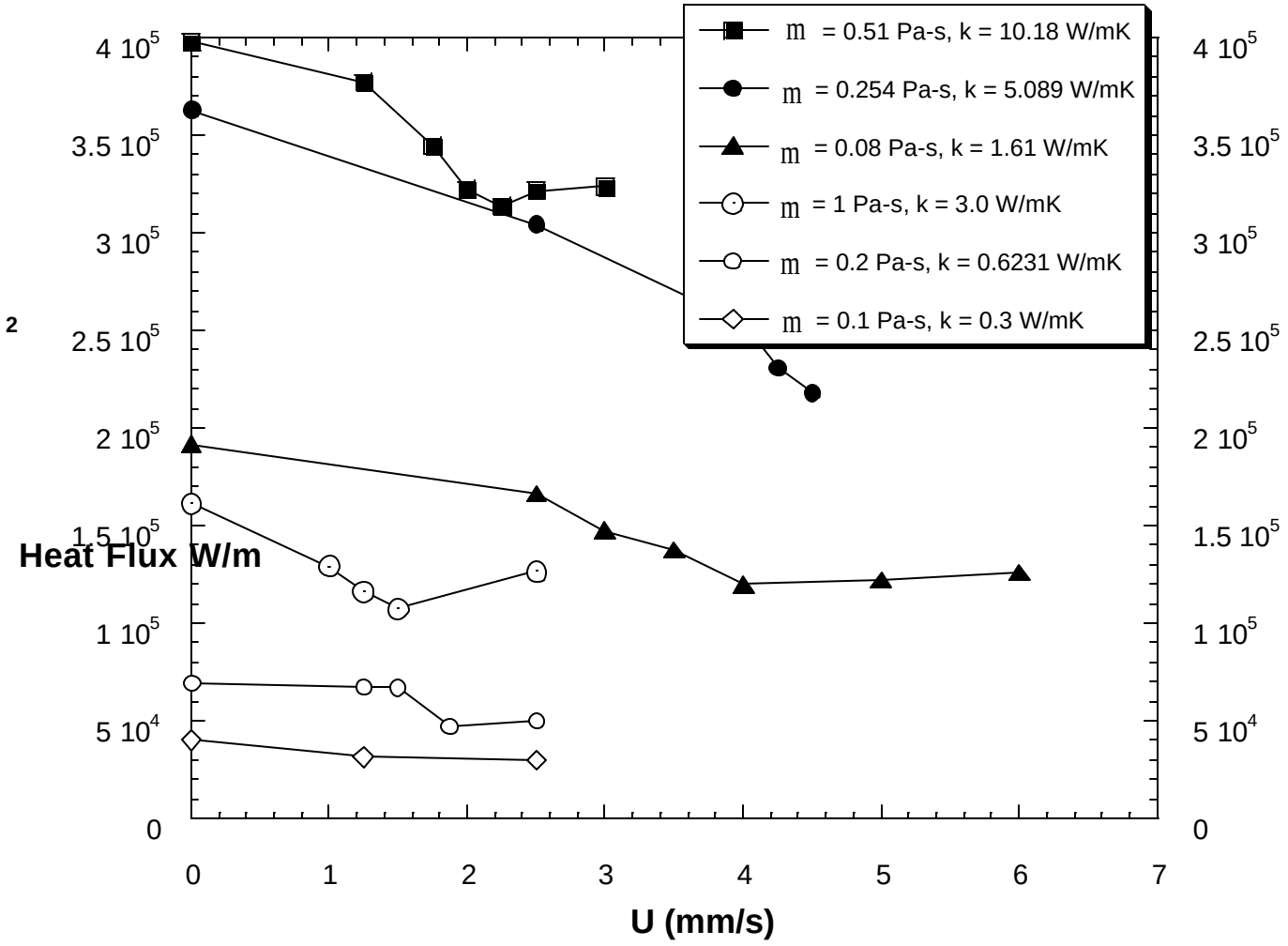


Fig 8. Heat Flux as a function of m , k and U

Average Nusselt Number vs Shear velocity

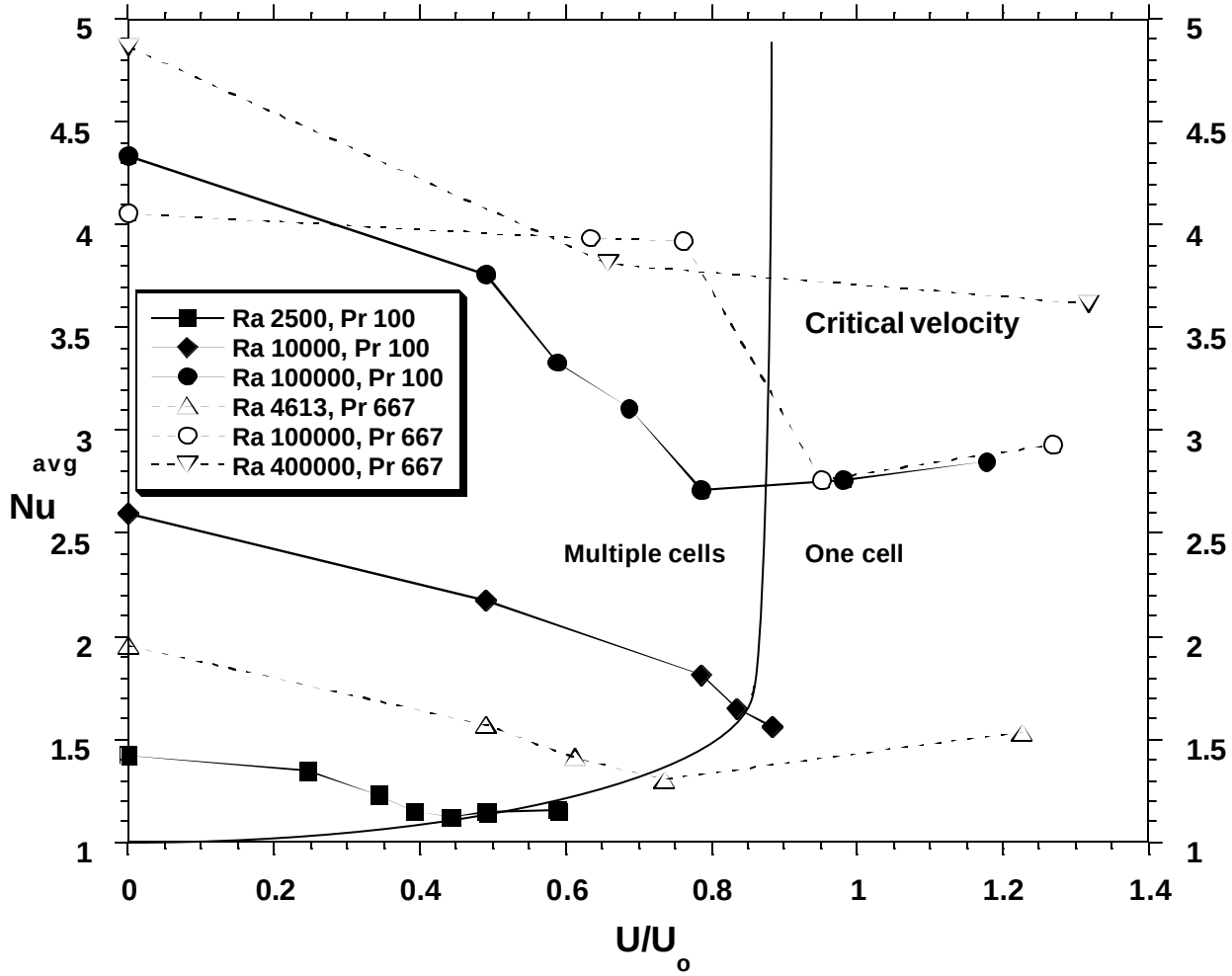


Fig. 8 Nu_{avg} as a function of Ra, Pr and U/U_o

Right Peak Nusselt Nos vs Velocity, Viscosity & Conductivity

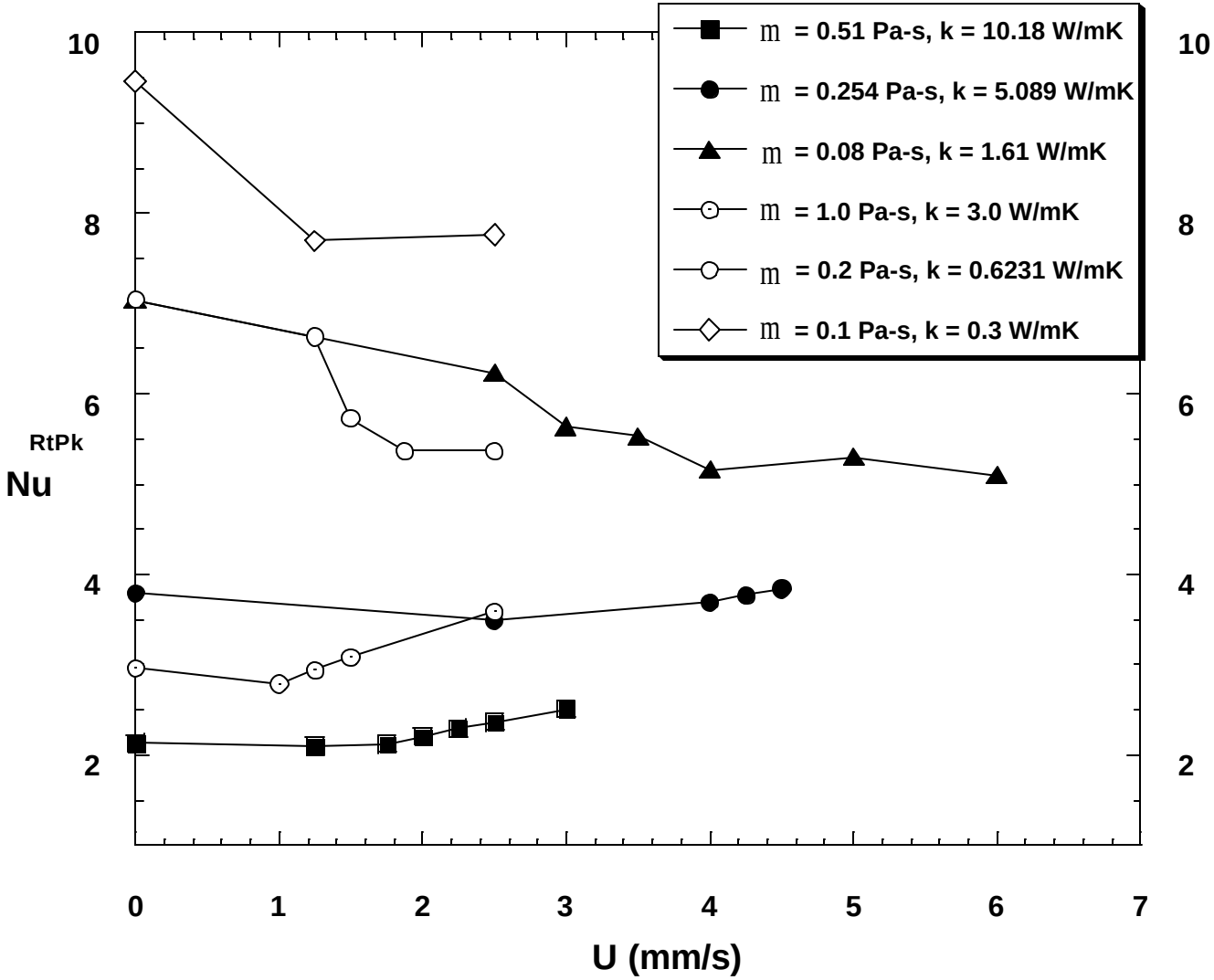


Fig 9. Right Peak Nusselt number as a function of m , k and U

Avg Cell Aspect Ratio vs Velocity, Viscosity & Conductivity

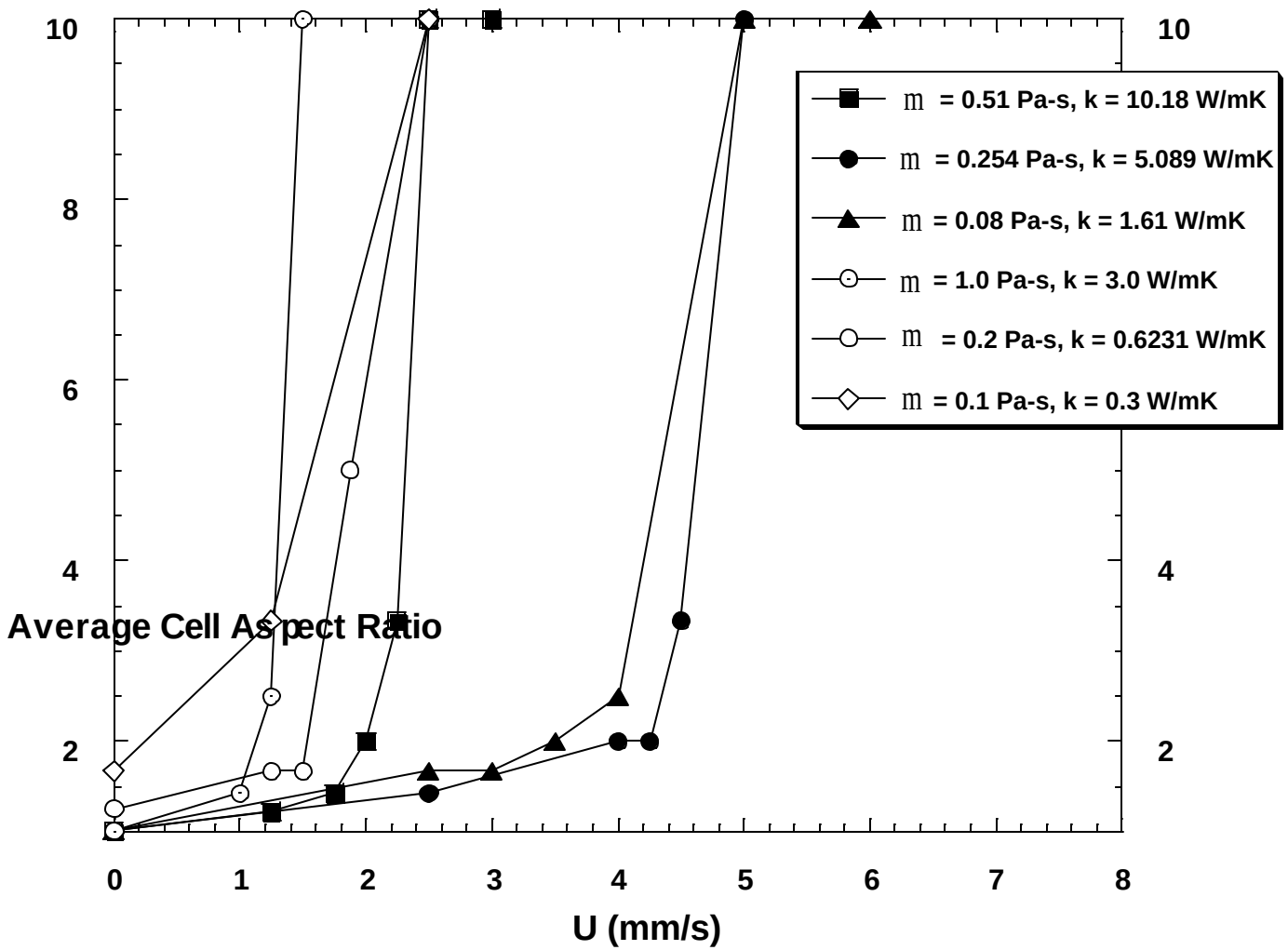


Fig 10. Average Cell Aspect Ratio as a function of m ,k and U

Nu Profile Uneveness vs Velocity, Viscosity & Conductivity

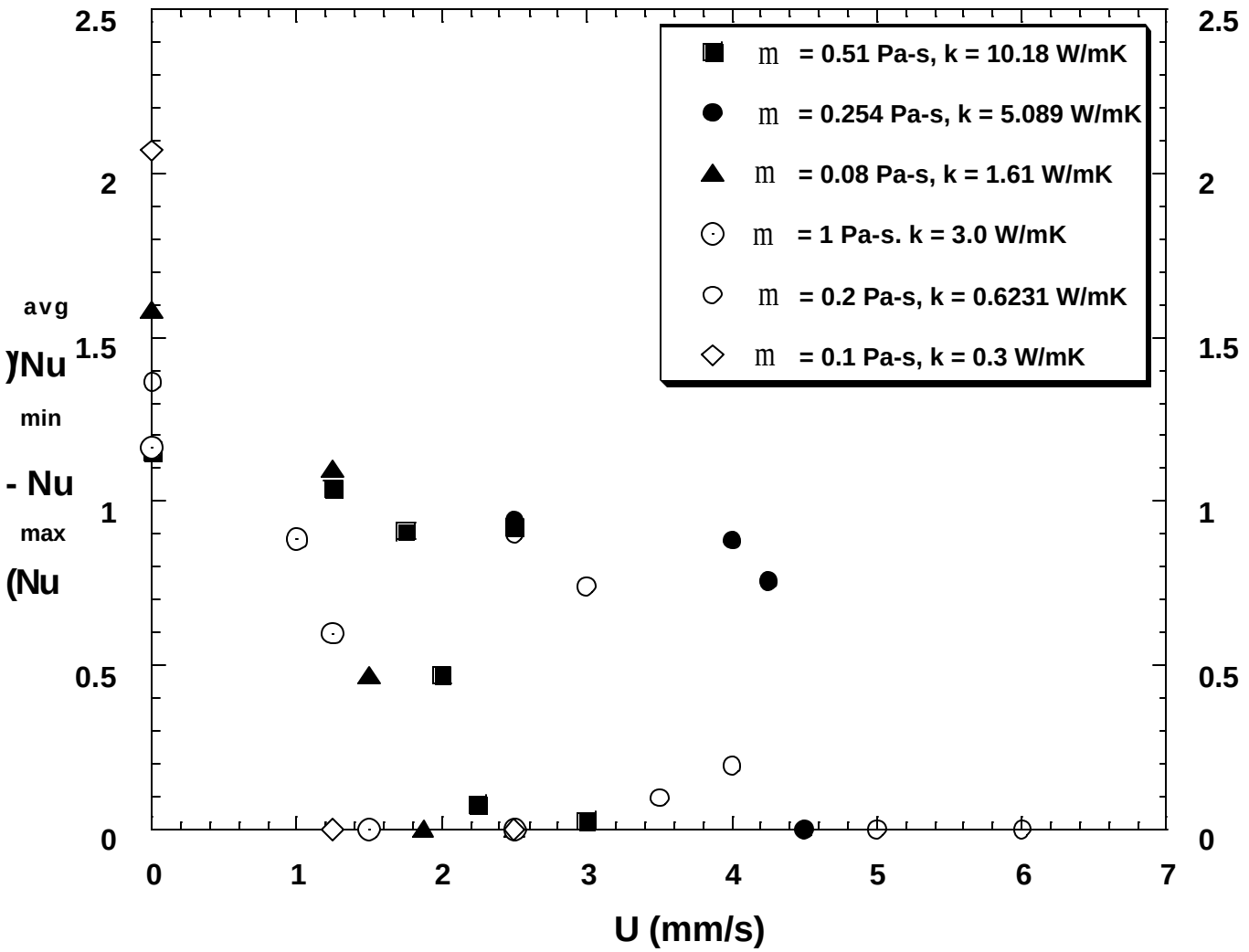


Fig 11. Relative uneveness of Nu profile as function of U, m and k

Profile of Horizontal Velocity Through Thickness

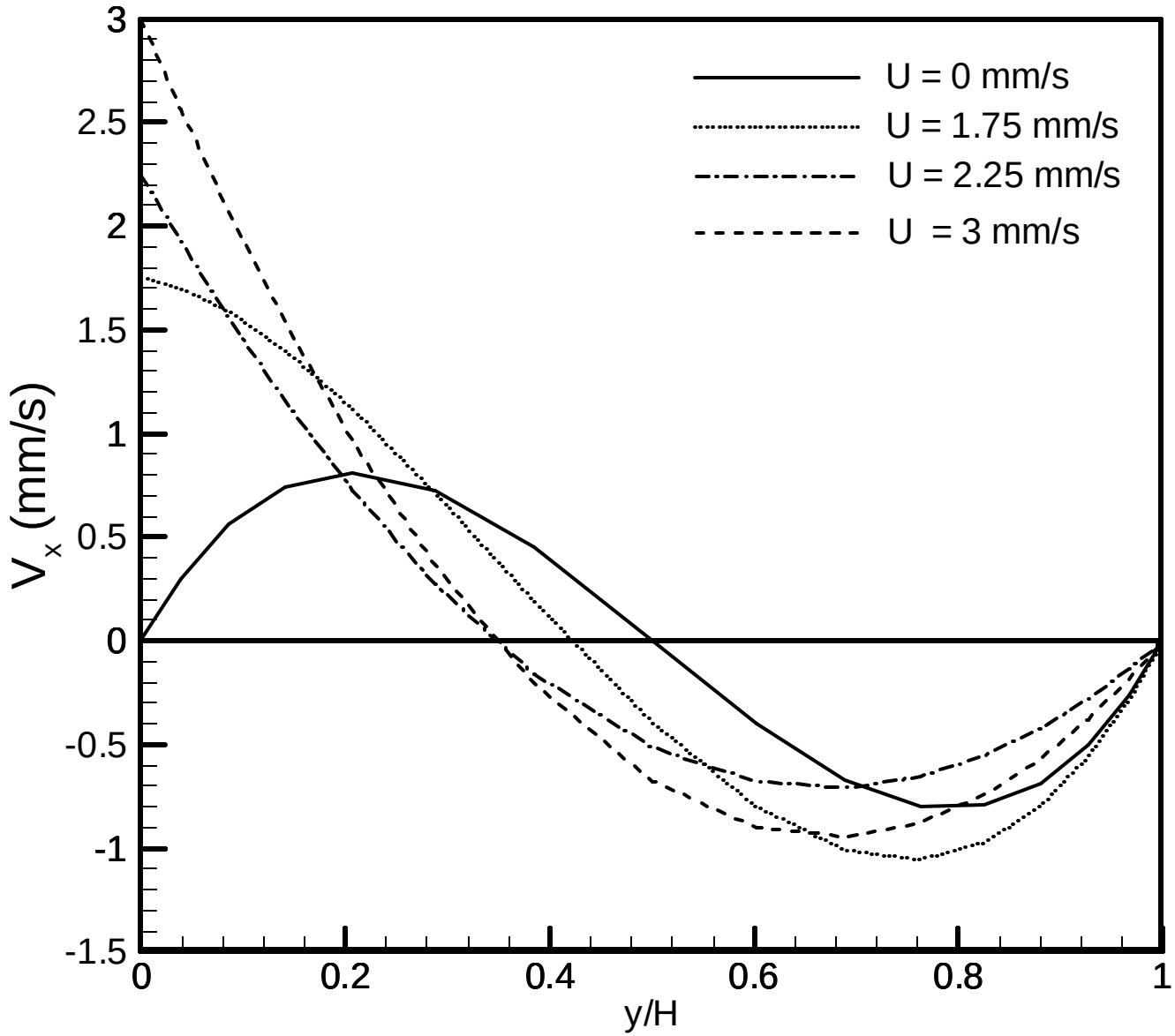


Fig 12. V_x as a function of (y/H) through the eye of the roll for different U

Eye Center Location Above Bottom vs Interface Velocity

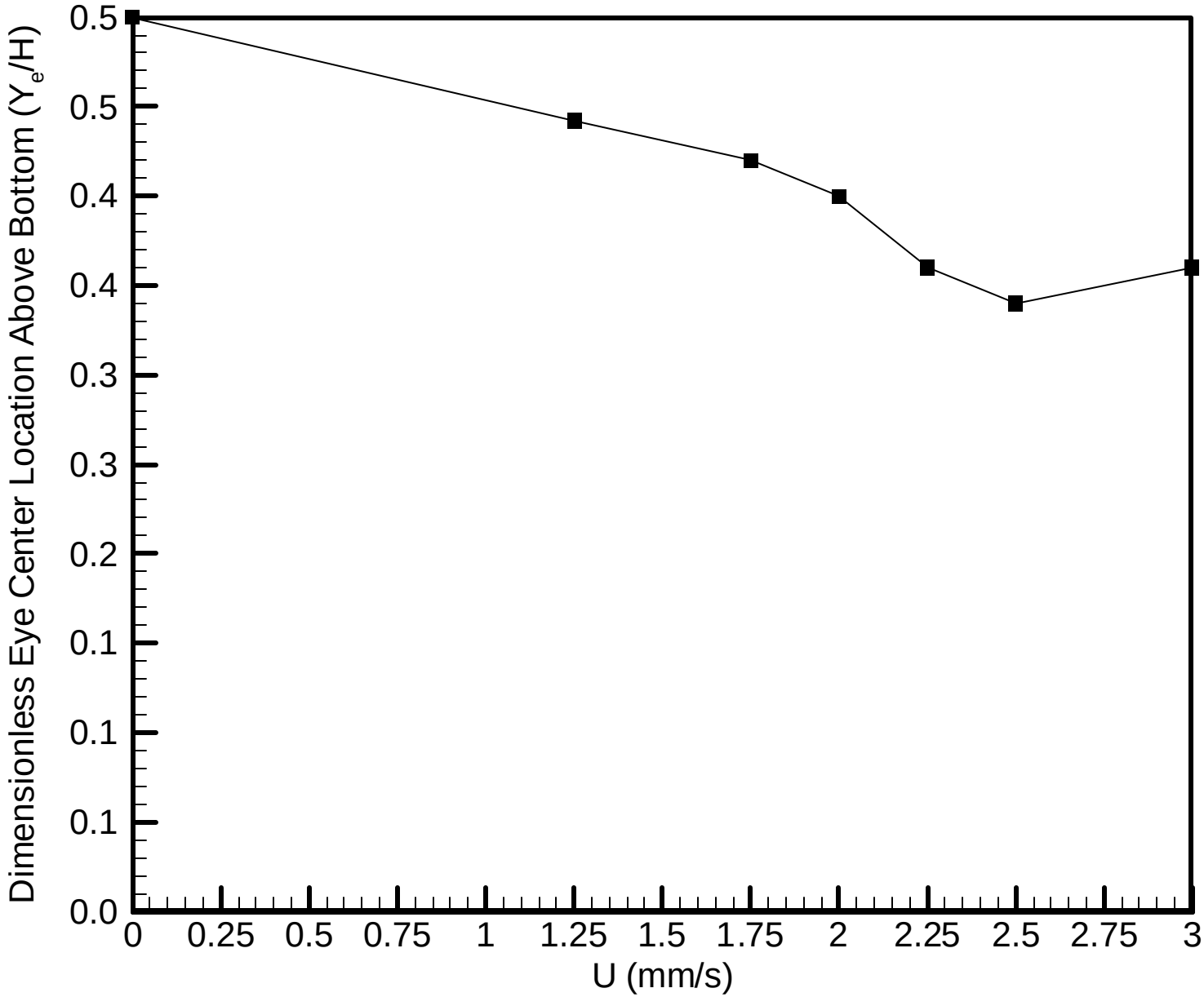


Fig 13. Eye center location as a function of Interface velocity for μ = 0.51 Pa-s, k = 10.18 W/mK

Maximum Roll Speed vs Interface Velocity

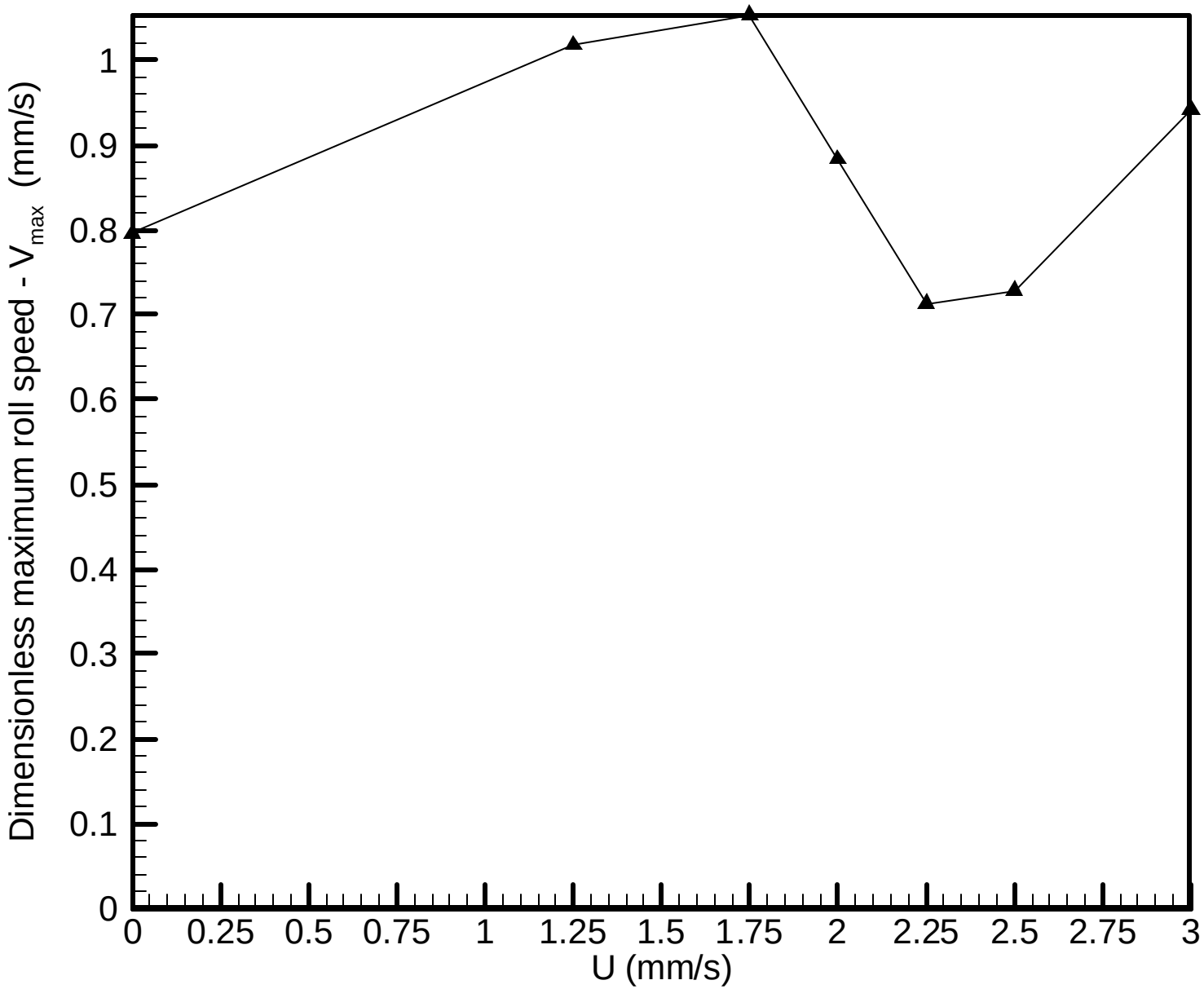
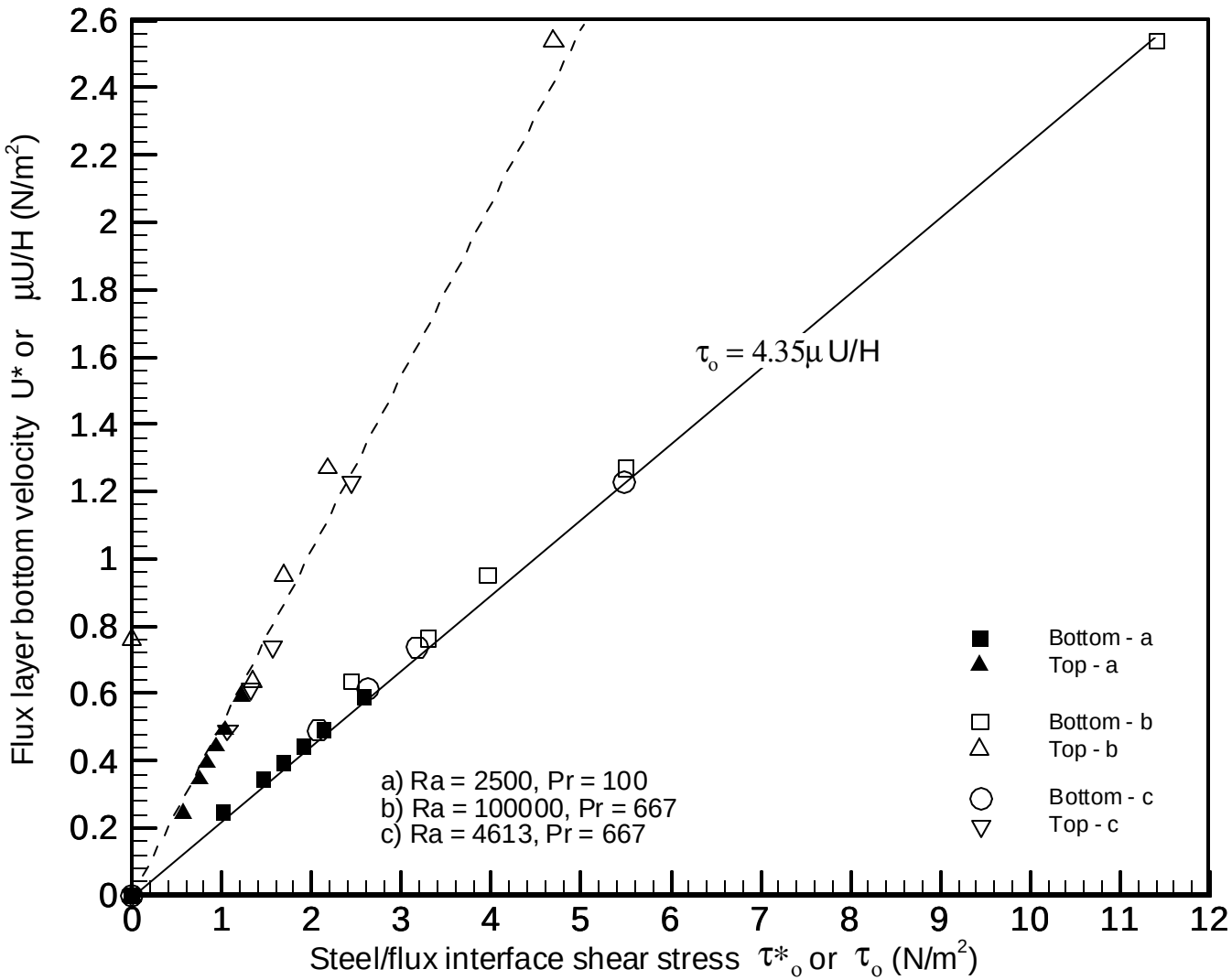
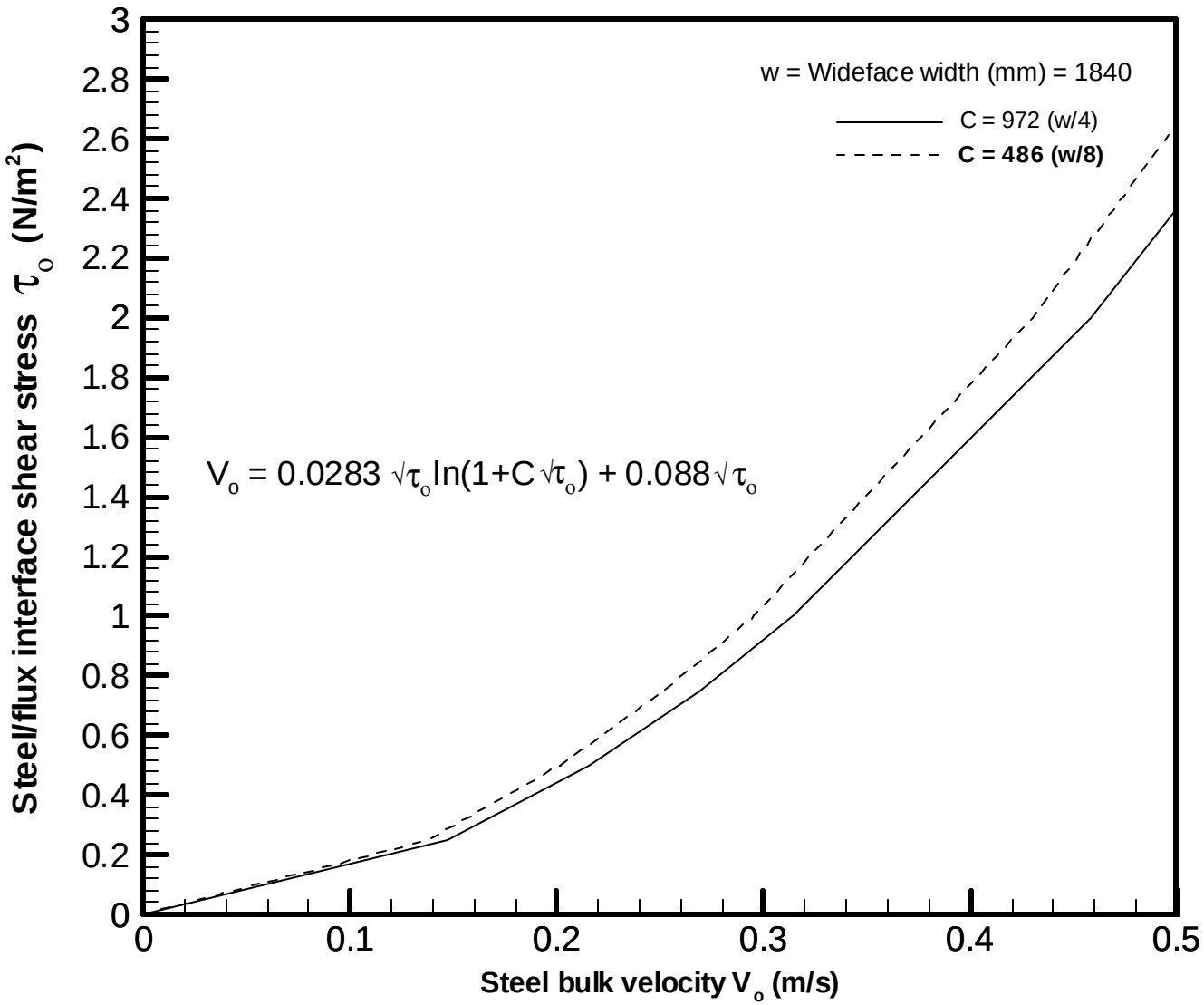


Fig 14. Maximum roll Speed as a function of Interface velocity for Ra = 2500, Pr = 100

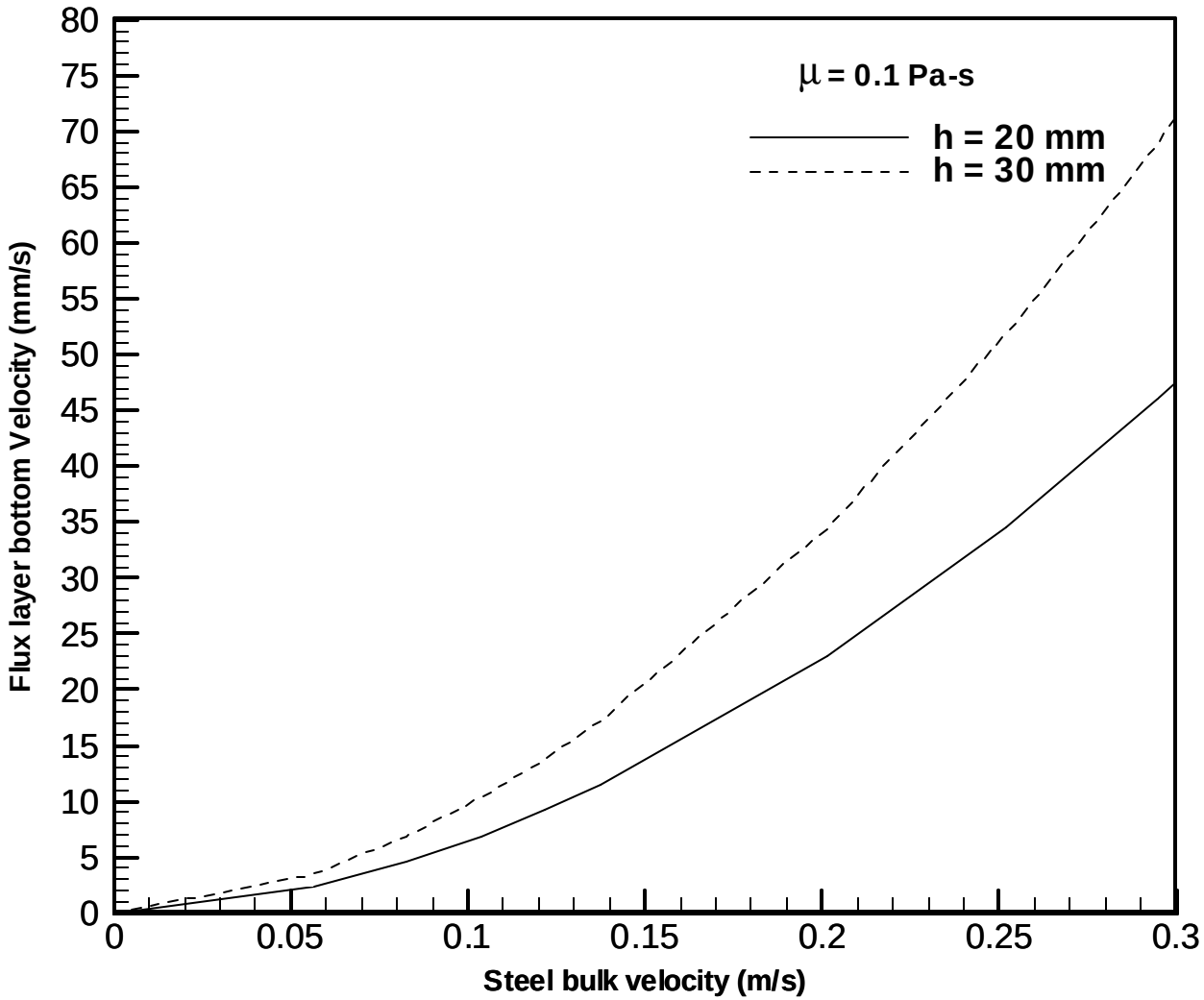
Flux Bottom Velocity vs Average Interface Shear Stress



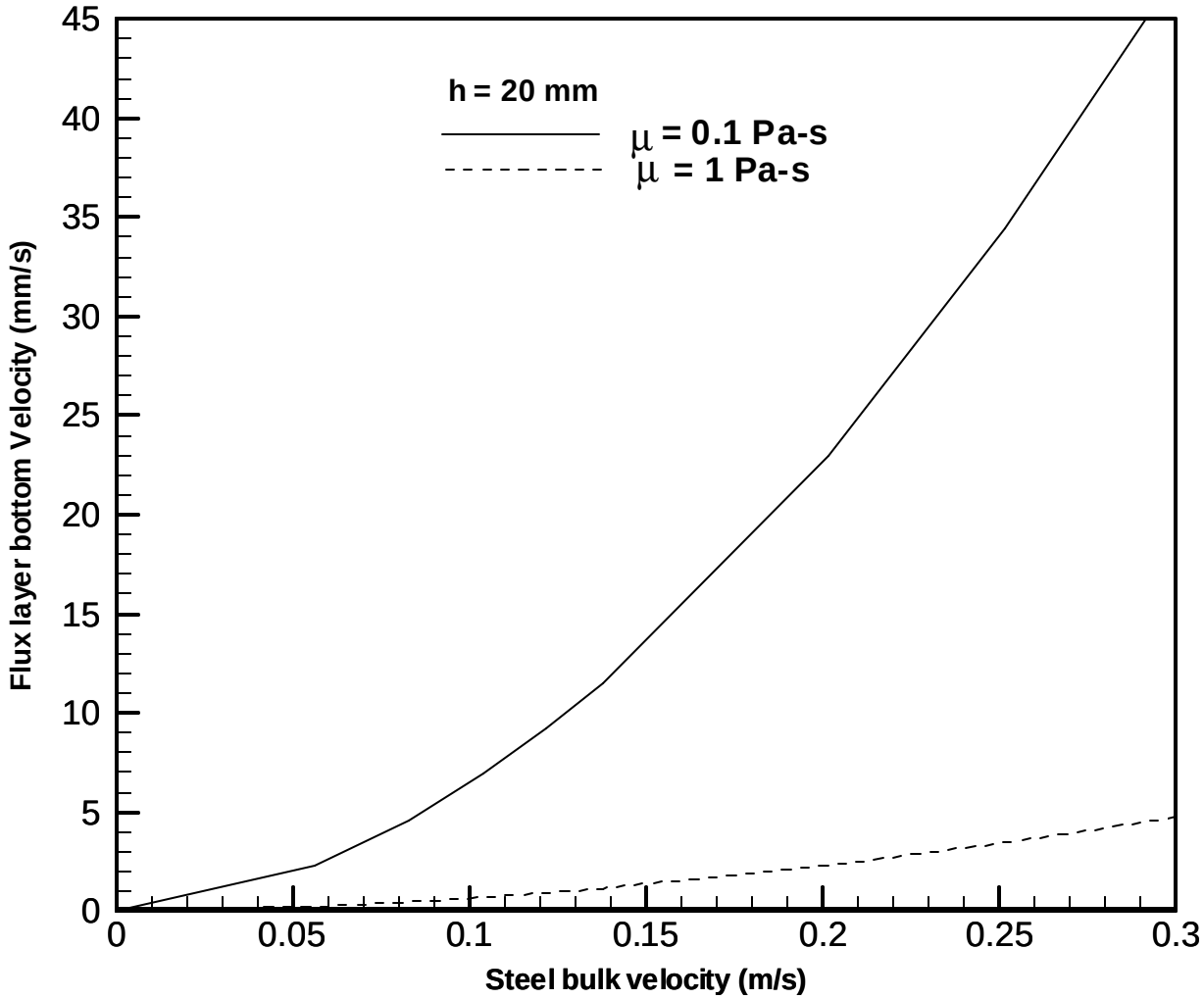
Average interface shear stress vs Steel surface velocity



Flux layer bottom velocity vs Steel bulk velocity (Effect of flux layer thickness)



Flux layer bottom velocity vs Steel bulk velocity (Effect of flux layer viscosity)



Heat Flux vs Interface Velocity, Temperature Difference

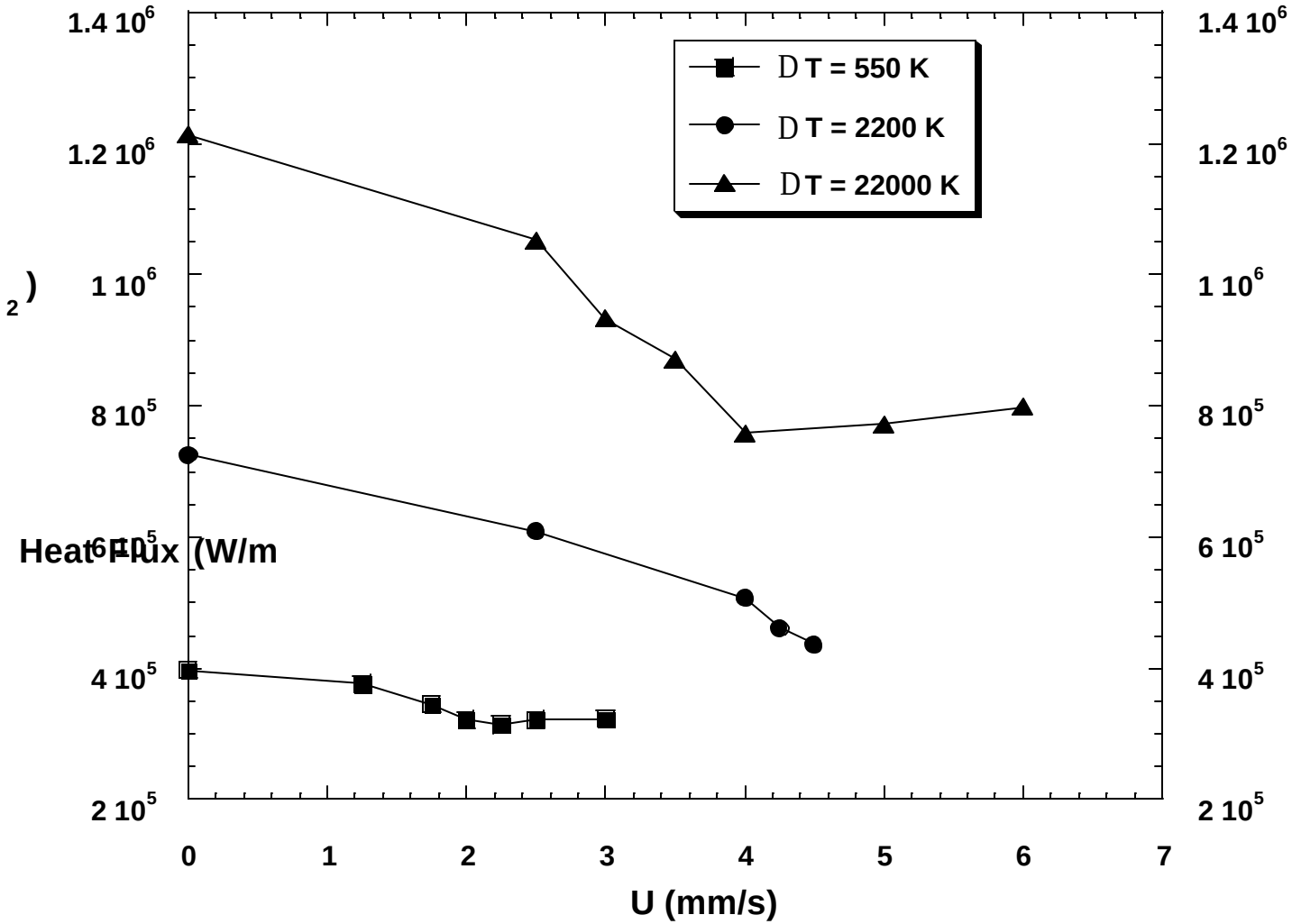


Fig 16. Heat Flux as a function of U and D T for m = 0.51 Pa-s and k = 10.18 W/mK

Heat Flux vs Interface Velocity, Liquid Layer Thickness

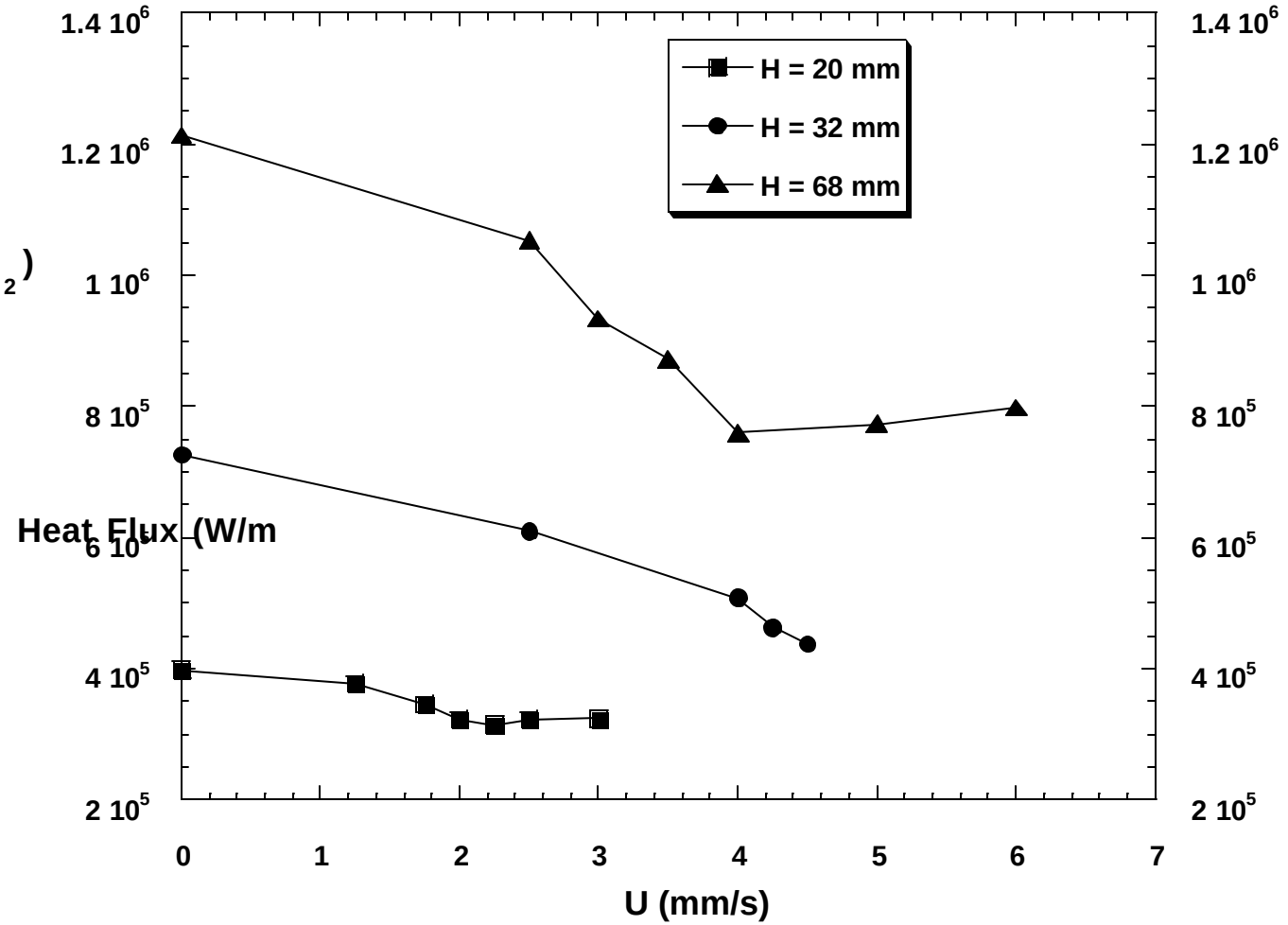


Fig 17. Heat Flux as a function of U and H for m = 0.51 Pa-s and k = 10.18 W/mK

Heat Flux vs Interface Velocity, Liquid Layer Thicknes

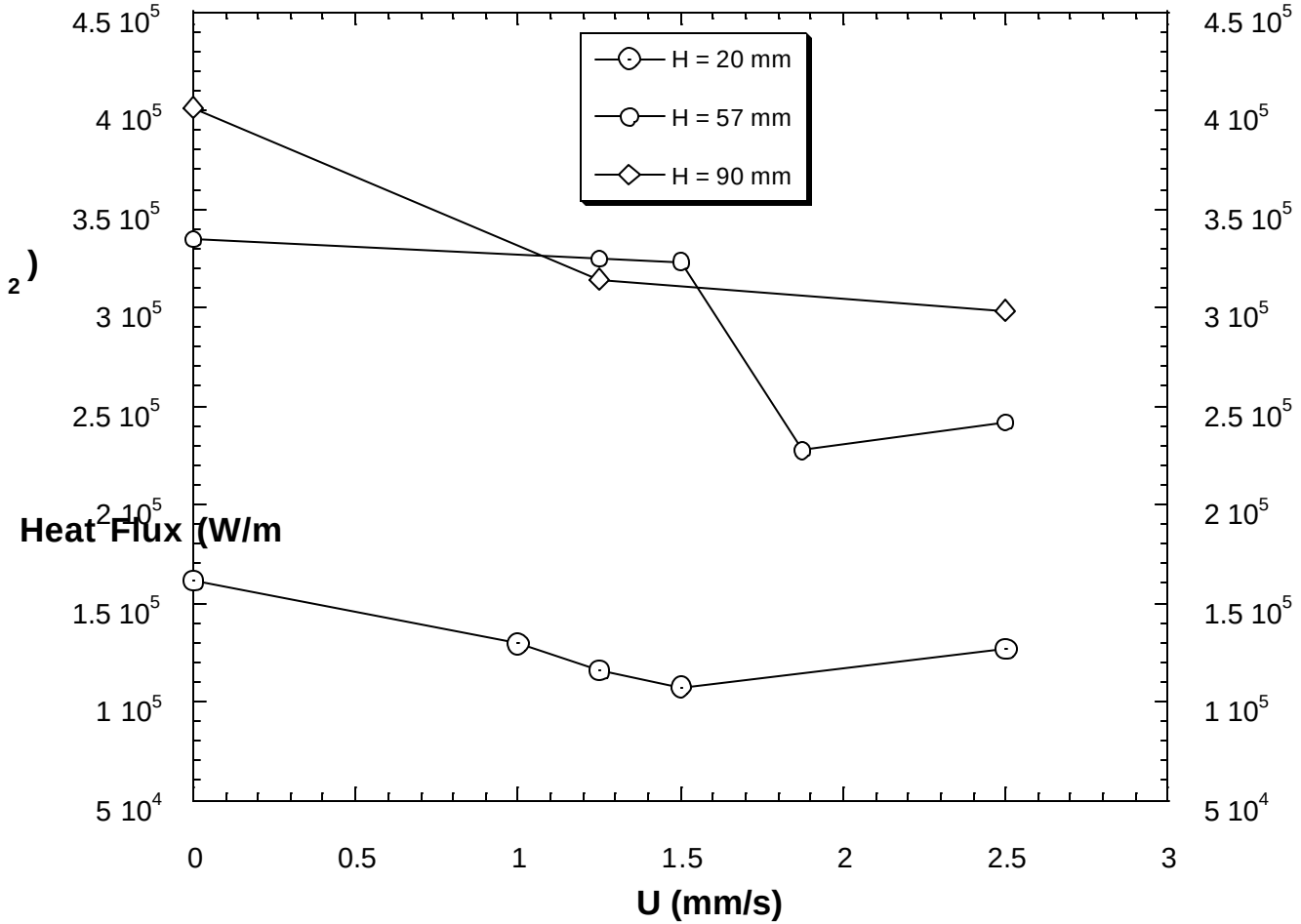


Fig 8. Heat Flux as a function of U and H for μ = 1 Pa-s and k = 3 W/mK