

## COMPUTATIONAL MODELING OF TURBULENT FLOWS OVER ROUGH SURFACES (TP70)

Gocha Chochua  
Dresser-Rand, Olean, NY, USA

Wei Shyy  
University of Florida, Gainesville, FL, USA

### ABSTRACT

Turbulent flows over rough surfaces are often encountered in nature and engineering practices and are often difficult to analyze. In this study, combined modeling and computational techniques is involved to investigate such flows over a surface covered with a large-scale roughness pattern. A simplified empirical engineering model is validated by taking area average of the flow field data over the surface. The approach can interpret fluid physics based on the empirical correlation. The area-averaged mean momentum transport resulting from the wall-normal time-averaged velocity component is found to be a significant contributing term into the near-boundary shear stress balance. This makes its behavior different from the flow over a smooth surface. Comparing alternative approaches for estimating the roughness coefficients, it is found that the massflow-rate-deficit approach produces superior results. Flow in a channel with one wall covered with an array of cylindrical cavities and the other smooth is used as an example. The extended wall functions, based on the k-E closure and the simplified engineering model, can be applied for a large-scale roughness pattern. The approach can significantly reduce required computational cost. On the other hand, the small domain periodic computations are needed to produce roughness lengths for a particular surface geometry. This model can develop a general correlation relating the roughness lengths to a surface geometry to aid engineering design.

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