

Summary Chart of Incompressible Flow Turbulence Models

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- The order is from least complex to most complex.
- Consider incompressible flow without buoyancy, but the flow is three-dimensional.
- DNS is included for completeness, even though it is not a turbulence model.

Model Classification	Number of additional transport eqs.	Assumptions/Approximations/Models
Algebraic models (zero-equation models)	0	<div style="border: 1px solid green; padding: 5px; display: inline-block; color: green;">Mixing length</div>
One-equation models	1	<div style="border: 1px solid blue; padding: 5px; display: inline-block; color: blue;">Boussinesq eddy viscosity model, $-\overline{\rho u_i u_j} \approx -\frac{2}{3} \rho K \delta_{ij} + 2\mu_e S_{ij}$</div>
Two-equation models	2	
Algebraic Reynolds stress models (ASM)	2	<div style="border: 1px solid red; padding: 5px; display: inline-block; color: red;">Nonlinear extension of Boussinesq eddy viscosity model, $-\overline{\rho u_i u_j} \approx -\frac{2}{3} \rho K \delta_{ij} + 2\mu_e S_{ij} +$ additional higher-order terms</div>
Reynolds stress models (RSM) & Anisotropic Dissipation Rate models	7	<div style="border: 1px solid orange; padding: 5px; display: inline-block; color: orange;">Solve for ensemble-averaged quantities only (no details about time-dependent turbulence quantities)</div>
Detached Eddy Simulation (DES) & similar hybrid models (PANS)	additional equations in RANS regions only	<div style="border: 1px solid purple; padding: 5px; display: inline-block; color: purple;">Model all turbulent scales, but only in RANS regions</div>
Large Eddy Simulation (LES)	0 (algebraic) or 1 (transport) for smallest scales only	<div style="border: 1px solid orange; padding: 5px; display: inline-block; color: orange;">"Exact" time-dependent solution of large scales</div> <div style="border: 1px solid blue; padding: 5px; display: inline-block; color: blue; margin-left: 200px;">Model small-scale turbulence</div>
Direct Numerical Simulation (DNS)	0	<div style="border: 1px solid gray; padding: 5px; display: inline-block; color: gray;">"Exact" - solve <i>all</i> scales of turbulence (small to large)</div>