Show that the following two expressions of the differential form of the continuity equation are identical:

\[ \frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{V}) = 0 \]
\[ \frac{D\rho}{Dt} + \rho (\nabla \cdot \mathbf{V}) = 0 \]

**IF IDENTICAL EQ. 1 IS EQUAL TO EQ. 2**

\[ \frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{V}) = \frac{D\rho}{Dt} + \rho (\nabla \cdot \mathbf{V}) \]

**EQ. 1**

**EQ. 2**

\[ \frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{V}) = \nabla \cdot \mathbf{V} \]

**THEY ARE EQUAL**

**SEE SECTION 2.10**

Simplify Equation 1 for the conditions that the flow is *steady* and *incompressible*. Will your result change if the additional condition of inviscid flow is applied?

**EQ. 1**:

\[ \frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{V}) = 0 \]

**IF STEADY**

\[ \frac{\partial \rho}{\partial t} = 0 \]

**IF INCOMPRESSIBLE**

\[ \rho = \text{CONSTANT} \]

\[ \frac{\partial \rho}{\partial t} + \nabla \cdot \mathbf{V} = 0 \]

\[ \nabla \cdot \mathbf{V} = 0 \]

**WILL NOT BE INFLUENCED BY VISCOSITY (FRICTION)**

**NOTE: BE CAREFUL**

\[ \frac{\partial \rho}{\partial t} + \frac{D\rho}{D\bar{t}} = \frac{d\rho}{dt} \]

**PARTIAL OR "LOCAL" DERIVATIVE**

**TOTAL DERIVATIVE**

**READ SECTIONS:**

2-9 AND 2-10