Material description: tracking / following a fluid particle.

Spatial description: description at fixed locations.

All laws of physics are readily available to describe fluid particle in motion. Tool to express them at fixed spatial locations is the material derivative. \( \left( \frac{D}{Dt} \right) \)

\[
\frac{Df}{Dt} = \frac{df}{dt} + (\nabla \cdot \mathbf{v}) f
\]

where \( \nabla = \frac{\partial}{\partial x} \hat{i} + \frac{\partial}{\partial y} \hat{j} + \frac{\partial}{\partial z} \hat{k} \)

In Cartesian coordinates:

\[
\frac{Df}{Dt} = \frac{df}{dt} + u \frac{df}{dx} + v \frac{df}{dy} + w \frac{df}{dz}
\]

Lines of fluid motion:

Pathline: trajectory of a fluid particle

Streamline: line everywhere tangent to velocity vector field.

\( \Rightarrow \) provides qualitative and quantitative info.

BUT: difficult to obtain experimentally.

Streakline: locus of all particles that have passed through a common point.

\( \Rightarrow \) does not provide much info.

BUT easy to obtain experimentally.

all the same for steady flows