Lecture F6 Mud: Control Volumes, Mass Conservation
(33 respondents)

1. **The 18.02 math stuff in the lecture was rather complex.** (3 students)
   Yes, but it's tough to avoid when doing Fluids. I'll try to review the math concepts as they come up.

2. **How do you calculate the divergence?** (1 student)
   Using its definition. In the general continuity equation the vector in question is $\rho\vec{V} = \rho u\,\hat{\imath} + \rho v\,\hat{\jmath} + \rho w\,\hat{k}$, so we calculate:

   $$\nabla \cdot (\rho\vec{V}) = \frac{\partial(\rho u)}{\partial x} + \frac{\partial(\rho v)}{\partial y} + \frac{\partial(\rho w)}{\partial z}$$

   If ρ is a constant (low-speed flow), it can be taken outside the derivatives, but not in general.

3. **How can one increase volume and decrease density in the steady flow equation?** (1 student)
   In a steady low speed flow ($M_\infty^2 \ll 1$), the only way to decrease the gas density is to add heat to it, as in the heater-in-pipe PRS question. In high-speed flow (M_∞^2 not small), density will increase locally wherever the pressure increases, such as just in front of an airfoil leading edge. In liquids the density is pretty much constant no matter what happens, short of boiling.

4. **Didn't understand how you got** $\quad -\rho_1 V_1 A_1 + \rho_2 V_2 A_2 = 0$ (1 student)
   I'll go over this again on Monday.

5. **There's a typo in the notes ("mass flux" should be "mass flow" in one equation).** (1 student)
   Thanks. It's fixed. The Fluids notes this term will be hot out of the oven, so typo reports are welcome.

6. **No mud** (26 students)