[insert into lecture notes as point II.B.5, in the notes on friction factors in tubes]

II. Turbulence and friction factors

B. friction factor in tube flow

5. A note on the Bernoulli equation

The Bernoulli equation is introduced in ***FTI*** as Eq. 5.9:

This equation can be rearranged as follows:

Compare this equation to the momentum balance for flow in a tube, from section II.B.1:

The Bernoulli equation in effect says that pressure and gravity forces lead to a change in kinetic energy. It allows for a change in kinetic energy, which was excluded in the momentum balance we derived earlier (where we assumed that the velocity in equals the velocity out). A change in velocity could happen if, for instance, the cross-section of the conduit changes along its path. But the Bernoulli equation as written in Eq. 5.9 *excludes* any mention of drag on the walls of the tube. Our momentum balance, and the equations that follow from it (including Eq. 5.30 in *FTI*) assumes that the change in kinetic energy is negligible; pressure and gravity forces provide the momentum that is lost in drag.

Eq. 5.9 would be appropriate to a case where the change in velocity is large and the drag negligible: e.g., a pinhole leak in a pressurized tank. Eq. 5.30 and the derivation we follow this term assumes the change in velocity is not important and focuses on drag along a relatively long pipe.

A fuller form of the Bernoulli equation could include both terms. We don't cover that in ta3220, but you could easily derive it yourself.