

Note 163 : Bouteille et jets d'eau

Voir pour plus de détail : PLANINŠIČ G., UCKE C. & VIENNOT L. (2011) *Holes in a bottle filled with water: which water jet has the largest range?* Muse project of the EPS-PED.

http://c.ymcdn.com/sites/www.eps.org/resource/collection/016775D4-8888-474D-887F-3E33AEA5E6D0/EPSPED_MUSE_bot_holes.pdf

Abstract

In some textbooks, a simple experiment is often presented about a jet of fluid streaming out of holes made in a vessel full of water. In this paper, we have chosen to discuss this topic partly because of erroneous assumptions that are prevalent in such treatments. Textbooks commonly ignore that the range of a water jet depends not only on the exit velocity but also on the time of flight until the jet reaches a horizontal surface. In addition, the connections made between this experiment and the dependence of hydrostatic pressure on depth often lead to erroneous explanations in both words and drawings. These errors seem to recur over extensive periods of time possibly through copying from one textbook to another. The authors' intention seems to be to illustrate that, in a fluid at rest, pressure increases with depth, whereas in this case the fluid is clearly not at rest. We clarify crucial aspects of this situation by applying the Bernoulli theorem in the case of water as an almost non viscous liquid and calculating the predicted trajectory of the jet as a projectile. Emphasis is placed on the fact that, in order to calculate the range of a given jet, the exit velocity is only one of the relevant factors. The duration of the free fall outside the recipient also needs to be taken into account. We also note that this analysis leads to the equivalence with water free fall and not with the hydrostatic situation. Our presentation here is restricted to the case of non-viscous incompressible fluids, jet streams from a container with a stationary free surface and geometrically perfect exit holes. For instance, hot and cold water behave differently due to the corresponding change in viscosity. All of these parameters present additional complexities some of which will be analyzed in a future paper.