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Velocity

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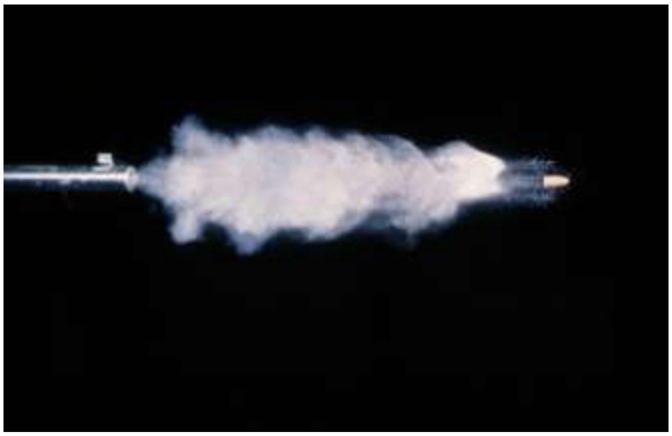

Extreme Velocity

Aeronautical engineers talk about velocity of planes in terms of "Mach" speed. The highest air speed record ever measured for a jet-powered plane was about Mach 3.3, or 3.3 times the speed of sound (768 mph) which is over 2500 mph. At this speed, the engines of the aircraft have so much force and resistance on them that they start to shut down. The sonic booms from the nose cone essentially un-start the engines. It is believed that jet-powered planes tested and built for speed could achieve Mach 7, but not in Earth's atmosphere.

Air Flow

Velocity is a measure of how long it takes a body to travel a distance. You're probably most familiar with miles per hour (mph, m/h). In most laboratory settings and within most facilities, velocity becomes relevant in a few areas and is typically measured in ft/s or m/s. One area is the air flow throughout a building. The circulation of air in buildings is important to keep workers breathing clean air. Another common area where velocity of air is important is when using fume hoods or biological safety cabinets. Sometimes facilities will use dryers and other machines where large amounts of warm air must be evacuated so that bacteria won't cling to the duct work.

The chemical composition of air lends itself to being combustible and as such is half the reason our internal combustion engines get us to where we need to go. Your car has an air intake system that pulls in air from outside the engine and is mixed with gasoline to form a combustible ratio that ignites and runs an engine. Without the proper amount of air flow, the ratio would be either too lean or too rich and the performance of the engine would suffer.

Velocity and the Lab

As discussed previously, most velocities in the lab are measured in ft/s or m/s. This is because those quantities are meaningful when talking about air circulation. Measuring the air flow of a fume hood in mph is not helpful because of the relatively small distances that the air will have to travel once it is evacuated from a room. For instance, let’s say a fume hood or a biological safety cabinet had a velocity profile test at a certain sash height that produced 100 ft/s of air movement out of exhaust port. This means it can move through 100 feet of ductwork every second, whereas if it were measured in mph, we would be talking about an air speed of 68 mph. Those two quantities are easy to work with, but you probably aren’t going to be evacuating the air for any number of miles, and not nearly for any length of time such as an hour.

Sometimes it’s necessary to actually do a duct traverse. This is a profile of a section of ductwork to see what the average evacuation of air is. The final measurement is a measure of the volume of air evacuation rate typically reported in cubic feet per minute (cfm). This is a good way to tell if a volume of air is moving quickly through a ductwork system and see if there are any obstructions or leaks that might be affecting the safe evacuation of air. If the air through duct work isn’t moving at a sufficient enough speed, any airborne contaminants that are present will cling to the sides. If that happens, then they can build up and spread throughout a facility and contaminate good air.

Terminal Velocity

Many people have heard the term “terminal velocity”, but most don’t know what it means. This term is typically discussed when talking about jumping out of airplanes, but can be applied to anything moving through a medium such as air or liquid. When talking about skydiving, it refers to the maximum speed a body can fall due to the acceleration of gravity.

We all know gravity is constant force that keeps us “grounded” to the Earth. And as I mentioned it is an acceleration force. If you drove into work today, you hit the accelerator pedal in your car to get you going faster and up to speed. The acceleration of your vehicle allowed you to go from 0 mph to say, 55 mph. Once you hit 55 mph, you stopped your acceleration (it became zero) and you then cruised at a constant velocity. The acceleration due to gravity never becomes zero until you are out of the atmosphere into outer space (hence you being able to float, and hence the term “zero gravity”). Since we are land dwellers, gravity is constantly pushing down on us. With that said you might think that if you jumped out of a plane you would fall faster and faster and faster until you hit the ground and your velocity would keep increasing, right? The fact is, at some point you would reach a constant velocity and you would stop accelerating. Confused? Think about the jet-powered plane I mentioned earlier that is limited to Mach 3.3 because of air resistance and the sonic forces coming off the nose cone. When we free fall from high in the air, the drag (resistance) of our body through the air will eventually equal the force of gravity on our body. When those two forces are equal and opposite, we have reached terminal velocity, and it’s the fastest we can fall to the Earth.