Importance of Peak Flow Rates

Arthur T. Johnson
University of Maryland
Biological Resources Engineering
College Park, MD 20742-5711
E-mail: artjohns@umd.edu

By now everyone knows that peak respiratory flow rates can be considerably higher than average flow rates. The question remaining is what importance do they have? We have measured peak flows up to 442 L/min and have seen that peak flows are 2.7 times average flow rates for work rates up to 100% of maximum. We have also seen a large variation in average flow rates from person to person, but this variation is not presently drawing attention.

Peak flow rates are very short-lived, existing for less than 1% of the time. This means that there is some element of chance in their detection because they typically exist for only one or two measurement intervals. They can also be influenced by electrical or mechanical noise in the measurement system. The volume of air inhaled for such a short time is also small.

No one knows actual peak flow rates in the work place. All measurements of peak flow thus far have been in the laboratory or in simulated situations. Thus, we do not know how high they are or how often they occur in real life.

I am not an expert on filter design, so I cannot speculate with assurance on what would happen if cartridge filters were or were not designed to handle peak flow rates. I do know, however, that protection is more than just concentration of contaminant times the time of exposure. Also involved is dead volume of the respirator face piece, dead volume of the respiratory system, respirable fraction of particulate matter, respiratory flow rates, inhalation times, and times for work/rest cycles. The contaminant must reach the wearer in order to be toxic, and our flow visualization work has shown that respirator dead volume can be very protective.

What is of interest to me is the effect of peak flow on the wearer, the person behind the respirator. The respirator with its resistance and compliance acts as a low-pass filter, removing high frequency respiratory components. Rapidly changing peak flow rates are in this category, as are rapid increases at the beginning of exercise breathing waveforms and rapid decreases at the end. If breathing flow rates are filtered toward a sinusoidal wave shape, what are the consequences? Can the wearer detect the difference and what if he/she does feel it? We do know that there are small, rapid changes in respiratory flow rates that occur all the time. No one pays them any attention. We also know that a sinusoidal flow wave shape is about 10% less efficient than is the normal exercise flow wave shape. This should make wearing a respirator more tiring than not wearing a respirator.

One thing is certain: the wearer is not a passive entity. The respirator is mostly passive, but the wearer adjusts. Sometimes the adjustment might be beneficial, but, usually, an adjustment by the wearer to a respiratory device comes at a cost, and the cost is likely to be that work cannot be performed as long nor as hard as without the respirator. Protection comes at an economic and subjective cost. It is time to recognize that respirators should be made to minimize their burden on the wearers. Accommodating peak flow rates is just one step toward this goal.