TerranearPMC Safety Share

Week of June 8, 2015 – Respirable Particulate - PNOS

There are many types of particles that when they become airborne, represent a potential health hazard. Metals such as lead, magnesium, manganese, chrome (especially Chrome VI) can be quite toxic to the human system. And when they are used in such processes as welding and grinding, these materials can become airborne and create a significant likelihood that persons in the area will inhale them. While our bodies have some very intricate and subtle defense mechanisms to filter out such materials and to even capture and remove them from our bodies, our defense mechanisms are not 100% effective – especially as the particle sizes get smaller.

When airborne particles have a diameter of 10 micrometers (microns or µm) they are referred to as “respirable” (I have found that *spellcheck* does not like this word). Airborne particles of this diameter or less have the ability to defeat our defenses and reach into the deepest and most sensitive regions of our lungs: the alveoli. Alveoli are typically described as tiny sacs located at the very terminal ends of our lungs. Their function is to interface with blood vessels that directly contact the lungs and allow the transfer of oxygen that we breathe via diffusion into our blood stream. From here, oxygen is transported throughout our bodies where it is used within cellular interactions for their designed function. Meanwhile as oxygen is entering into our blood stream, carbon dioxide (CO_2) is leaving; going from our blood stream into our lungs (through the alveoli); also via diffusion. From here, CO_2 leaves our bodies (or lungs) via exhalation. The actual driving mechanism that assists with the transfer of oxygen from our lungs into the blood stream and CO_2 from the blood stream to the lungs is *partial pressure*. That is, because the pressure of oxygen is greater in our lungs than in the blood stream, oxygen can diffuse or travel in this direction. This same principle holds true for CO_2, where its pressure is greater in the blood stream and therefore moves from the blood to the lungs (followed by exhalation).

While we need to protect ourselves from toxic particles, severe damage to our lungs can occur when we are exposed to respirable particulate; even when such substances are considered to be non-toxic; even dust. These non-toxic particulate are referred to as “particulate not otherwise specified or PNOS. When respirable particulate enters into the deepest regions of our respiratory system, there are a number of things that can happen. These materials can be removed through such defenses as coughing or coming into contact with the body’s many biologic active defenses as microphages and antigens and something called the mucus-cilia escalator that forces foreign materials out of the body (eventually leaving as sputum or mucus). Particulate can even get dissolved into the blood stream and thereby leave the respiratory system. This mechanism requires that the particulate is soluble in water (or blood); otherwise, such as uranium, which is not water-soluble, it just remains and causes a continuous assault on the immediate location where the substance has been deposited. Another possible scenario for particulate in the alveoli region is that it remains lodged and acts as a barrier to stop oxygen/CO_2 transfer. Respirable particulate can even cause physical abrasions, resulting in scaring of the tissue, thereby rendering the specific-affected alveoli ineffective, thus reducing the overall lung surface area to perform the vital function of gas exchange.

Occupational exposure limits for respirable particulate – PNOS have been established by both the Occupational Safety and health Administration (OSHA) and the American Conference of

Governmental Industrial Hygienists (ACGIH). Depending on the project location or organization where the exposure to respirable particulate exists, either OSHA permissible exposure limits (PELs) or ACGIH threshold limit values (TLVs) will apply.

The OSHA PEL for respirable particulate is 5 milligrams per cubic meter (mg/m3) for an 8-hour time-weighted average (TWA). In the past, ACGIH established a TLV of 3 mg/m3. However, in recent years, ACGIH has slightly altered this by applying additional stipulations. Such limitations for a material to be considered a respirable particulate – PNOS now include:

- The particulate material does not have a specific TLV;
- The material is insoluble or poorly soluble; and
- Has a low toxicity (other than causing inflammation or overload the lungs) or does not emit ionizing radiation, or cause immune sensitization.

If all three of the criteria exist, then such airborne particulate (particles that are biologically inert), then ACGIH recommends that airborne concentrations should be kept below 3 mg/m3 for an 8-hour TWA.

Industrial hygiene practices have been established to assess worker exposures to respirable particulate. The most popular and widely used is real-time monitoring, where an instrument continuously measures the airborne particles in the air through the principle of scattering light in a sensing chamber that is linearly proportional to the particulate concentration. While many manufacturers of dust monitors have developed refined sensing to focus on respirable particulate, the reliability to be specific to only respirable particulate is not 100%; therefore there is a tendency to underestimate their measurements. Traditional sampling methods are considered to be much more reliable as well as acceptable by OSHA and NIOSH. One method, NIOSH 0600, uses a cyclone that has the ability to collect only the respirable fraction of PNOS.

Respirators can be a very effective method to protect persons from airborne respirable particulate. Of course if engineering controls, such as localized ventilation or wetting methods can be applied, these control methods should be considered before donning a respirator. However, if such controls are not feasible, using an air purifying respirator with the appropriate filters/cartridges should properly protect persons, providing they are medically qualified to wear a respirator and have been fit tested for the specific unit to be worn. This includes knowing the respirator manufacturer, model and size. Appropriate cartridges of non-toxic particulate would be high efficiency particulate air (aka HEPA) or even N95 filters. The difference between HEPA and N95 is that HEPA offer greater protection (99.95% efficiency for 0.3 µm particle size), while the N95 is 95% effective for the same particle size).

Choosing the right control method for airborne particulate should be the responsibility of the project/company industrial hygienist. Through appropriate assessment methods this person can offer the best protective methods based on the type of contaminant, concentration and location where such exposures may exits.

We delight in the beauty of the butterfly, but rarely admit the changes it has gone through to achieve that beauty - Maya Angelou