

Packing Optimization of an Intentionally Stratified Sorbent Bed Containing Dissimilar Media Types

The Fire Cartridge is a packed bed air filter with two different and separate layers of media designed to provide respiratory protection from combustion products after a fire event on the International Space Station (ISS). The first layer of media is a carbon monoxide catalyst made from gold nanoparticles dispersed on iron oxide. The second layer of media is universal carbon, commonly used in commercial respirator filters. Each layer must be optimally packed to effectively remove contaminants from the air. Optimal packing is achieved by vibratory agitations. However, if post-packing movement of the media within the cartridge occurs, mixing of the bed layers, air voids, and channeling could cause preferential air flow and allow contaminants to pass. Several iterations of prototype fire cartridges were developed to reduce post-packing movement of the media within each layer (settling), and to prevent mixing of the two media types. Both types of movement of the media contribute to decreased fire cartridge performance. Each iteration of the fire cartridge design was tested to demonstrate mechanical loads required to cause detrimental movement within the bed, and resulting level of functionality of the media beds after movement was detected. In order to optimally pack each layer, vertical, horizontal, and orbital agitations were tested and a final packed bulk density was calculated for each method. Packed bulk density must be calculated for each lot of catalyst to accommodate variations in particle size, shape, and density. In addition, a physical divider sheet between each type of media was added within the fire cartridge design to further inhibit intermixing of the bed layers.