3D Printing Air Emissions

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Industry use of 3D printing includes medical replacements, defense, architecture, and automotive. Automakers like GM and Ford use 3D printing to make prototypes of light-weight vehicle parts at a cheaper cost. Recent advancements in medical science have also allowed for the 3D printing of prosthetics and organs. Using scans of patients' diseased organs, scientists are able to reconstruct the same organ using 3D printing to print an artificial scaffold of the organ. They then cover the scaffold with the patient's own cells that will grow into the shape of the organ. So far organs such as kidneys, tracheas, and ears have been 3D printed. The materials used for 3D printing can range from plastics and metals to ceramics, paper and food. They also come in different material states such as powder, filament, pellets, granules, resin, etc. Acrylonitrile Butadiene Styrene (ABS), which is a plastic material, is commonly used because of its strength and ability to come in different colors. Its filament form that can be bought from non-proprietorial sources adds to its popularity.

The objective of this research was to determine the chemicals and particulates produced during 3D printing and determine expected effects from exposure at these levels. Other objectives were to collect particulate and volatile organic compound (VOC) measurements for compound specific exposures. In addition to that, engineering controls in place were evaluated and additional recommendations could be made based on room air changes per hour, occupancy factors, etc.

Since ABS (Acrylonitrile Butadiene Styrene) was the most common 3D printing material used in the labs included in this study, the hazardous combustion product of this material, styrene, was the focus of exposure sampling in this study. Styrene exposure limits are as follows from the NIOSH and OSHA regulatory agencies:

- NIOSH: 50,000 ppb TWA, 215 mg/m³ TWA
- 100,000 ppb STEL, 425 mg/m³ STEL
- 700,000 ppb 8-hour ceiling

Results shown first for the SidePak personal aerosol monitor, then for the ppbRAE photoionization detector, and finally for the compound specific air sampling with passive air sampling canisters.

Compound specific sampling from canisters placed near printers resulted in low styrene concentrations of less than 5.0 ppbv for both Knex and Potter labs, but did detect 40 ppbv of isopropyl alcohol.

**Discussion/Conclusion**

Preliminary results showed average chemical levels below regulatory limits with peaks sporadically throughout sampling periods. Therefore, 3D printing exposure does not appear to pose a hazard at printing labs at Purdue. More data collection should be performed in the future to determine the causes of peak chemical levels before recommendations to limit personal exposure can be made.

**Selected References**

1. BAAM | Big Area Additive Manufacturing. [Online]. 2019. [PDF].

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