RTI INTERNATIONAL

Research Snapshot

Electronic Cigarette Emissions Characterization

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RTI International recently completed an internally funded project that investigated the physical, chemical, and toxicological characteristics of vapors produced by electronic nicotine delivery systems, commonly known as electronic cigarettes or e-cigs. Given the recent public pressures and perceptions reported in the media, RTI recognized the lack of available data on electronic cigarette emissions needed to inform policy decisions. The goal of the research was to develop experimental procedures and collect data characterizing the aerosol, chemical and toxicological properties of electronic cigarette emissions.

RTI developed a sampling and collection system to representatively characterize e-cig vapor and aerosol emissions. We realized that a conventional tobacco smoking machine could not be modified to transport aerosol particles from the machine to the aerosol instrumentation without significant changes in the concentration and size distribution. We also wanted to realistically mimic a person's respiratory system which was best achieved using a custom-apparatus. The automated system also eliminated human factors that could affect the generation of the e-cig emissions. Our system generated repeatable particle size (error of 1.6%) and mass output (error of 18%). RTI evaluated two types of e-cig liquids using a cartomizer style device.

Our data found that a significant quantity of aerosol particles and vapors are produced. The average mass concentration was 3.3 milligrams per cubic meter for both e-cig liquids. However, the aerosol size distribution varied with the type of e-cig liquid. The median particle diameter was 184 nm for the one e-liquid and 270 nm for the other. Most interestingly, we observed a decrease in the median diameter under humid conditions because of the activation of condensation nuclei that coalesced e-cig vapors into particles with diameters near 100 nm.

The chemical characterization of the e-cig liquids and the generated vapors and aerosol found a variety of chemicals. Not surprisingly, the main constituent in both e-cig liquids were glycerin and glycol ethers. Commonly used preservatives, flavorings, and fragrances were also easily identified. The preservatives BHA and BHT were found. Chemicals that exhibit caramelized sugar and citrus aroma and taste profiles were also found. Nicotine was found equally distributed in both the aerosol and vapor phase.

RTI assessed the dosimetry of the electronic cigarette during the final phase of the research. We used published smoking pattern data for a 14 year-old adolescent male and our collected e-cig emission particle size distribution data as inputs into a lung deposition model. The model results predicted 47% of the inhaled emissions were deposited in the lungs. Almost all of the inhaled emissions, 40%, were deposited in the alveolar region, the deepest part of the lungs. The 53% of the e-cig emissions exhaled are potentially a source of second-hand exposure by nearby individuals.

This preliminary research has led to some initial conclusions regarding e-cig emissions, including the following:

- The aerosol and vapors produced by electronic cigarettes have different properties than those produced by combustion processes. These differences will result in potential changes in how the emissions impact exposures to both the "smoker" and to those exposed to secondary emissions as compared to conventional cigarette use.

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- Chemical constituents of different electronic cigarette liquids present unique exposure potentials to both primary and secondary emissions.
- E-cigarettes may cause or worsen acute respiratory diseases, including asthma and bronchitis, among youth because chemicals contained in the particles emitted may irritate airways or worsen pre-existing conditions.
- Understanding the physical and chemical, and toxicological properties of myriad e-cig products will require standardized approaches to their testing so that reliable comparisons can be made.