



# Electronic Cigarettes: Truth or Toxic?

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32.06	18.99	74.91	238.03

## Abstract

With the increasing research on the hazards of cigarettes, people are looking for a safer alternative to smoking. Electronic Cigarettes were introduced in the early 2000's to serve this purpose, and they are gaining increasing popularity. Many e-cigarette companies claim that the use of e-cigarettes is completely harmless because of combustion of the organic liquids would cause the inhalation of only water vapor and carbon dioxide along with the flavors and nicotine. Companies also advertise their products to help smokers quit smoking. Recently, "vaping" has grown increasingly popular especially with minors since several states still allow the sale of e-cigarettes to minors. Studies have shown that more teenagers are vaping, and that it may lead to the use of real cigarettes. In more recent news there have been reports of respiratory problems arising from e-cigarette use, as well as the cigarettes exploding during use causing harm to the user. There are two main concerns that individuals may have concerning e-cigarettes. Most users are concerned about the compounds absorbed by the body, while non users are concerned with the compounds present in the vapors exhaled by users. To address the concerns of e-cigarette users, the vapors were analyzed using simultaneous thermal analysis infrared spectroscopy (STA-IR) and the results indicate that the vapors released after heating are not simply carbon dioxide and water, so the liquids do not undergo combustion and may not be as harmless as claimed by e-cigarette companies. Further investigation using gas chromatography mass spectrometry (GC-MS) is being performed to determine the compounds formed as a result of heating the e-liquids. To address the concerns of non users, a device similar to a hookah was created to capture the vapors on clothing material (to simulate second hand smoke) before extracting the compounds captured on the material and analyzing the chemical content in the GC-MS.



<http://abcnews.go.com/Health/facts-cigarettes/story?id=20345463> (Accessed 3/1/2016)

## Recent News & Major Concerns

- Recent studies have found compounds in the vapors that have been linked to the COPD-like disease called Popcorn Lung.
- Also, there have been reports of e-cigarettes exploding during use causing severe injury to the user

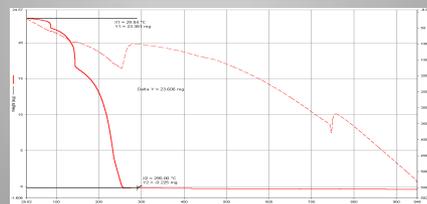
## Objectives

- Address the concerns of both users and non-users by analyzing the vapor produced by the e-cigs and the compounds found in the second hand smoke.

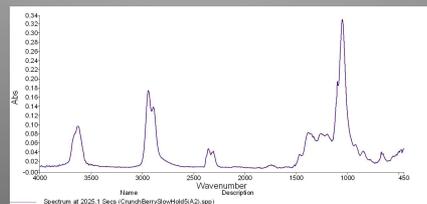
## STA-IR Analysis

The STA-IR simulates the heating that occurs in the e-cig and analyzes the vapors immediately produced to address the concerns of the "users."

The individual components of the e-liquids were analyzed with the STA-IR. The e-liquids may contain varying concentrations of propylene glycol, vegetable glycerin, and nicotine. The heat curve below displays the mass loss as a function of temperature as the e-liquid was heated.



The e-liquid appears to be 100% vaporized by 260 °C. However, the process did not occur all at once, but rather in three distinct steps. The method was adjusted unsuccessfully in attempt to separate the different stages.

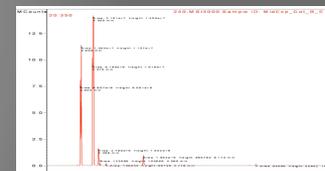


This is the IR spectrum taken when the e-liquid was vaporized in the STA. It was determined that the vegetable glycerin and propylene glycol components were in such high concentration that other compounds produced could not be seen on the spectra. However, it is clear that the vapors are not only carbon dioxide and water as claimed by the e-liquid companies.

## Hookah and GC-MS



In order to simulate second hand smoke, a "hookah" was set up to draw the vapors onto a piece of cotton soaked in a 2:1 Benzene:Ethanol mixture to extract the compounds for GC-MS analysis



The GC-MS data above shows the presence of all of the pure components along with several compounds that could not be identified with our current spectral libraries.

## Conclusions and Future Plans

- E-cigarettes are not all they claim to be (or not to be) because they are vaporized not combusted as claimed. However, they still do not contain the number of toxins as cigarettes
- Semi-micro bomb calorimetry will be used to analyze the chemical energy of the compounds in the e-liquids in order to determine the cause of the device explosions
- Also we are trying to obtain the KnowItAll software from BioRad in order to help separate the IR data and identify compounds found in the GC-MS

## Acknowledgements

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