

# Review of: "[Commentary] On Heated Tobacco Products and the Importance of Science-Based Assessments and Product Classification"

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Potential competing interests: No potential competing interests to declare.

The work presented is a commentary addressing the comparison of traditional cigarettes to heated tobacco products (HTP). I see the following main arguments: a) the aerosol resulting from HTP is fundamentally different from tobacco smoke, and b) should not be called smoke as it does not contain solid particles; c) HTP and cigarettes should be compared considering the typical quantities used, on a per unit basis, rather than on the basis of tobacco mass.

The paper is reasonably written, with dozens of relevant works cited. It does not provide much background; rather, the reader is given references to a review paper as well as different studies, the approaches and results of which are compared and discussed.

Regarding the first argument, I don't think anyone suggests that cigarette and HTP aerosols are the same. HTP aerosol does contain much less incomplete combustion products compared to cigarette smoke, but, as the authors themselves say, is not harmless. With HTP being a relatively new product, and with epidemiological studies and findings lagging, sometimes considerably, behind the introduction of new technologies, the relative toxicity and difference in health effects is still an open question.

Regarding the second argument, the authors do not provide a reference to any universally accepted definition of the standard of smoke, and I am not aware of any either. Further, it is my opinion that "smoke" is a common language word rather than a scientific term. There is no universally accepted definition of smoke in the common language, either. The American Heritage Dictionary, in its definition of smoke, explicitly allows both solid and liquid particles (<https://www.wordnik.com/words/smoke>), as does Wikipedia. The Cambridge dictionary defines smoke as "the grey, black, or white mixture of gas and very small pieces of carbon that is produced when something burns" (<https://dictionary.cambridge.org/dictionary/english/smoke>). This definition is contrary to the current state of knowledge, according to which small pieces of (elemental) carbon are of black color, while white, grey, and brown tones are a result of organic compounds. It is my opinion that one cannot expect the common citizen to assess whether particles they are observing are solid or liquid, and whether they are a result of combustion, pyrolysis, or vaporization of material; therefore, any aerosol (solid or liquid or a combination of the two – often solid particles are coated with semivolatile organics) that appears to be related to thermal processes (combustion, pyrolysis, vaporization) can be viewed as smoke.

The authors do not suggest a more appropriate alternative name for the visible effluent from HTP. It is my opinion that, at

the present time, there is no practical synonym for "smoke" for a cloud of visible particles originating from a high-temperature process, be it a traditional or electronic cigarette, or a frying pan or a grill, the latter featuring primarily liquid particles originating from the thermal decomposition of cooking oils and fats. The synonym "mist," describing liquid aerosols, is typically not used in conjunction with high-temperature processes.

Further, I am not convinced that all visible aerosols from HTP use are liquid droplets of volatilized material, typically an oily substance, used as a carrier to deliver the active components to the lungs. Many fatty acids are known not to have a boiling point at ambient pressure in air, as, when heated, they start to decompose before they have a chance to vaporize. This is consistent with the argument that HTP aerosol contains pyrolysis products. Here, I see a distinct possibility that while the goal might very well be to vaporize the carrier substance (humectant), in reality, varying levels of pyrolysis and combustion products might be present, depending on the quality of design, manufacture, calibration, maintenance, and usage of both HTP and associated smoking devices.

As far as PAH formation is concerned, cooking studies report increasing PAH levels with increasing temperature, while in diesel engines using the same vegetable oil, PAH levels decrease with temperature; both low temperatures (no pyrolysis) and high temperatures (complete combustion) favor low PAH production, with a peak in intermediate temperatures featuring incomplete combustion.

Regarding the third argument, I agree with the authors that cigarettes and HTP should be compared on a typical usage basis. This reflects the equivalent dose principle, as well as fundamental differences between cigarettes, where a large part of the tobacco is used to generate the high temperature needed to deliver the "active" substances to the lungs, and HTP devices, which use electric power for this purpose, with far lower losses of active substances to combustion.

The authors clearly disclose they are employed by Philip Morris. If the motivation is to point out that HTP and their side effects should be treated objectively and compared with cigarettes on a fair basis, I see this as a legitimate argument, and the authors have a full right to present it.

The work addresses a topic that is current and of scientific and public interest, and such discussion has a legitimate place in scientific literature.

Overall, the authors made a fair attempt at presenting their opinions in a logical manner, using a reasonably objective selection of literature; I recommend some revisions and improvements, as detailed above.