



Letter to the editor

Update and rebuttal of Benavides et al. (2017) Life-cycle analysis of fuels from post-use non-recycled plastics



Dear Editor,

A paper published in Fuel in 2017 is frequently cited to support claims that plastic-derived fuels are carbon neutral. Specifically, its abstract states that these fuels had “96% lower fossil fuel consumption than conventional ULSD [ultra-low sulphur diesel] in the base case” [2]. Here we explore what this statement means exactly, analyse the findings in terms of the study's methodology, and compare the results with peer reviewed literature and regulatory filings both of which contradict the claims.

It is fair to say that the paper is a difficult read, with some befuddlement, none more so than the “96% lower...than base case” claim. The text which refers to this 'base case' (§4.1) actually describes “more than 80%”, but there is also “89%” (in Fig. 3), and when the actual numbers (from Fig. 3) are calculated the value is found to be 86%! Elsewhere, a different statement of “around 83% (on average)” is made. This type of imprecise and unscientific language is commonplace in the manuscript, as we illustrate later. Crucially, the above values appear to include emissions from combustion of conventional fuel but omit them from the plastic derived fuel. To further illustrate the confusion, the ‘96%’ value is not in the Conclusion and only appears once in the Results under a different section (§4.2.2) where it does NOT relate to the base case at all, rather ‘case 2’. The abstract statement is clearly wrong.

Plastic to fuel technology remains at the concept stage, and acquiring an accurate dataset is troublesome. Benavides et al. [2] use unverifiable, self-reported survey responses from five unidentified plastic to fuel operators, and this is problematic for two fundamental reasons: With no independent confirmation of the dataset and without elementary disclosure, the claims cannot be supported: the study is not reproducible. Secondly, the paper fails to distinguish between design specification and actual plant performance data such that in some cases the data provided by these companies may be no more than a marketing exercise. Such lack of disclosure may be due to commercial restrictions (though no explanation is given) but it does not justify why the authors have chosen to present what they describe as only “median” and “aggregate” values throughout (i.e. Tables S3, S4, 1). ‘Aggregate’ is not defined, and there is no explanation why the median has been used for five data points. Neither have they discussed the range in results; indeed there is no statistical analysis whatsoever, again most unorthodox for an academic publication. To illustrate how far this has put the results in error, in §4.1 the authors state that life cycle GHG emissions from waste derived ULSD are predicted to be 6 g CO₂/MJ fuel. Regulatory filings have now enabled what is believed to be the first independent energy audit of a plastic to fuel plant – Agilyx, Tigard [3]. From this audit it can be calculated that the emissions intensities for 2019 and 2018 were 169 g and 1307 g CO₂/MJ fuel respectively (assuming all product and by-product is burned), thus evidencing that the estimate by Benavides et al [2] is out by a factor of between 28 and 218.

The second significant limitation of the paper's methodology is its

use of hypothetical scenarios, no doubt again no due to lack of technology deployment. One of these scenarios is the theoretical 'base case' which represents the hypothetical use of pyrolysis products to heat the process, i.e. §3.3 (main paper and supplementary information). “... combustion of the co-produced fuel gas supplies all the energy needed in the process; no external electricity or natural gas is consumed”. This is a common claim made by technology providers which has recently been shown to be a false premise based on both case studies and thermodynamic principles [5]. Of course, this publication supersedes the work of Benavides et al. but there is still no evidence from their survey respondents to support such a conjecture and indeed there is no provision of data sufficient to reproduce such an energy balance. Under real conditions, the greenhouse gas savings from plastic to fuels are at best effectively zero, for if the gas is used as fuel, then diesel or natural gas must be used to heat the pyrolysis retort and hence extra GHG emissions must be added to the budget on top of which will be electricity necessary to operate the plant along with pre-and post- processing energy [4]. It has been stated that no chemical recycling technology can offer a net-positive energy balance [1].

Finally, the comparator - GHG emissions from petroleum ULSD - is also obviously an important parameter as it puts the claims in context. Yet, the provenance of this parameter, or how it was determined, is not explained in Benavides et al., [2], thus giving the claims no verifiable support. It caps the major limitations as explored above.

In partial mitigation, the landscape with respect to plastic to fuel technology is very difficult with much pressure to substantiate claims made by those with vested interests. We write to illustrate why authors should err on the side of caution where claims of plastic to fuel sustainability are concerned.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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