

## Review

Fekhar Bahmed

### **On the PhD dissertation entitled „Improving in corrosion, transportation and storage properties of real waste derived pyrolysis oil”**

A very actual topic with high practical significance was chosen by the Candidate, because the handling of polymer (and other) wastes is still a very serious and growing problem. Any process, which can reduce the amount of these wastes and therefore reducing the pollution of the environment is very important. One of these processes is the chemical recycling of the polymers with pyrolysis, which converts them into gaseous and liquid products. But the quality of the pyrolysis oils are poor (for storage and transportation too), in the aspect of using them as fuels. In his work, the Candidate investigated the opportunities of in situ catalytic upgrading of these oils.

The structure of the thesis is as expected: it starts with a literature summary in 32 pages, and the experimental circumstances are presented in 11 pages. After that the results and a conclusions are presented in 63 pages finished with a conclusion chapter, the number of the references are more than 290. The thesis fulfills the general expectation of 1/3 part literature, 2/3 part experimental rule.

Regarding formal things: I am not native in English but as I understood the professional language of the thesis is acceptable and clear. There are a few mistypings and interesting usage of words, but these did not affected the reading and understanding of the thesis. The grammar improved significantly compared to the previous version. The applied tables and figures are also clear and professional. My only specific note is that putting references in chapter- and figure/table titles is not elegant

The abstract summarizes well the significance of the topic and the experimental results of the Candidate. Also in the Introduction section shortly the base theoretics and directions of the work is summarized. This is followed by the 32 page literature summary, which is logical. For the literature summary more than 290 references were used, which is extraordinary. This chapter collects the relevant informations about the topic of wastes and their pyrolysis. The literature part of the thesis is logical and clear, and my suggestions for the previous versions were taken into consideration.

My questions and notes regarding to Literature summary:

- what is the biggest accumulation points of waste plastics?

- in Chapter 1.4.1.1 the experiments described in text do not present in Table 1.5., why?
- is there any literature about co-pyrolysis of plastics with paper?
- how the water content of pyrolysis oil can affect the corrosion properties?
- what are the usual olefin and aromatic content of pyrolysis oils from thermal-only processes? How do these values change with in-situ catalytic upgrading?
- does the pyrolysis oil fulfil the European diesel fuel standard (Figure 1.8)?
- how could the producing of pyrolysis oil be economically viable?
- what are the quality limits of pyrolysis oil regarding using it as transportation fuels?

The Experimental part (11 pages) is summarizing the raw materials, the catalysts, the processes for pyrolysis and aging, the analytical methods and the research plan. The applied machines and methods are modern and effective.

My questions and notes regarding to the Experimental part:

- what are the origins of the wastes which are the raw materials, and why they are the chosen ones?
- what were the inspirations for using these catalysts, especially the red mud?
- based on what experience were the catalyst treat rates 5% in every case?

The Results and discussion part is 63 pages long, which presents the experimental results. The presentation of the results are logical, the discussion is correct.

My questions and notes regarding to the Results and discussion part:

- if the TAN are not applicable to unique polymers, can it be used generally in aging tests?
- if the solid deposition measurement is correlates on the 3rd day already, is the 7 day/80 °C aging is good for forecasting storage properties?
- comparing the batch and tubular reactor product yields: residue equals heavy oil+char?
- if the red mud and the  $\text{Ca}(\text{OH})_2$  are reducing the catalytic active sites, why are they needed?
- light oil means two very different fractions in case of only thermal and in case of thermo-catalytic results: could the different chain length enviroment had any effect in corrosion and accelerated aging tests?
- based on accelerated results does any light oil need filtering?
- did the water cause any problem during paper-plastic pyrolysis?



- is the forming of  $\text{CO}_2$  during paper-plastic pyrolysis a problem regarding the environment? Is hydrogen forming positive or dangerous?

There are a lot of valuable results in the Experimental part of the thesis, and the new Conclusions chapter shows it clear that based on the aim, with the flexible selection of reactor types, catalysts and parameters the wanted product fraction can be produced.

The Summary chapter is about describing the significance of the topic together with the main results of the Candidate. My questions and notes regarding to this part:

- where can the pyrolysis oil of this research be applied based on its quality?
- is it possible to use medical wastes in polymer pyrolysis processes?

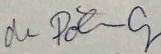
Regarding to theses of the dissertation, the following ones are **accepted** as a scientific novelty by me:

- 3.1. b) c)
- 3.2. all
- 3.3. all
- 3.4. a)

I miss the own references, in which these theses were published, they should have to be put beside the theses. To summarize my opinion: there are enough new scientific results in the dissertation to achieve PhD degree. The publication work of the Candidate is very good, and supports this statement.

Summarizing my opinion regarding the whole dissertation: the level of the work complies with the expectations about a PhD dissertations, I suggest it for **acceptance**. After a successful final defence, the PhD degree is recommended to the Candidate.

Herceghalom, 2021 January 19th.

  
dr. Pölcsmann György  
product development expert