APPLICATION HIGHLIGHT:

OptiPMD: Analysis of Waste Plastic Pyrolysis Oil (WPPO)

Introduction:

Because of the rapidly growing world population, improved life span and increased standards of living, the petrochemical industry is growing fast. However, this brings an accumulated amount of plastic waste as well. Globally, since the invention of the first plastic early 1900s, the amount of the total accumulated global plastic waste has reached to 10 billion tones. More than half of it is still in the form of waste because the recycling rates are well below 10% today. Indeed, most of the recycling includes either dumping in the field or energy recovery (incinerations).

However, triggered by globally growing sustainability concerns, the companies & the nations started to take extra precautions to minimize the plastic waste together with improved recycling initiatives. One of the important technologies gaining ground is chemical recycling which includes the thermal pyrolysis of waste plastics.

The pyrolysis process provides an emerging, valuable but also a challenging feedstock, namely Waste Plastic Pyrolysis Oil (WPPO). Although WPPO can be used for fuel manufacturing or new petrochemical production purposes, its intrinsic chemical & physical properties bring its own challenges. Among the current needs of WPPO analysis, understanding the distillation properties is an important one which would enable the end customers to optimize their pyrolysis process, be in compliance with relevant guidelines & specifications as well as to perform fast screening studies of vast amounts of WPPO samples in a short period of time.

PAC has a complementary distillation portfolio starting with process offerings of MicroDist, covering GC solutions of SIMDIS and extending to innovative-true lab measurements made possible by OptiDist & OptiPMD. This app note provides details on method description and lessons learnt from WPPO analysis by OptiPMD according to ASTM D7345 providing an excellent correlation to D86 in just 10 minutes by using only 10 mL sample volume.

Method Description & Results

Mini-distillation analysis is performed by ASTM D7345 for WPPO samples. Experiments are run based on volume. Our OptiPMD solution can be used for product certification according to ASTM D7345 in the lab, for optimization support to engineers in the process, or for fast screening purposes with only 10mL sample to be finished in 10 minutes which can be successfully correlated to D86 method.

Since ASTM D7345 does not require to put the condenser to a specific temperature no clogging was observed even with samples having a higher paraffinic content. Main reason why there is no clogging problem is that the condenser tube temperature is not regulated, the sample increases the temperature of the condenser tube with its own energy during distillation and no clogging occurs. The distillation result curves and table of a waste plastic pyrolysis oil containing heavy naphtha for 2 different samples are provided in Table1-2 and Figures 1-2 below.

Table 1: IBP, FBP and corresponding distillation temperature data of the WPPO sample-1.

Volume	Temperature
IBP	61.4°C
5%	103.2°C
10%	121.8°C
20%	147.5°C
30%	177.5°C
40%	201.6°C
50%	222.3°C
60%	242.4°C
70%	263.0°C
80%	285.6°C
90%	309.5°C
95%	344.2°C
FBP	257.5°C

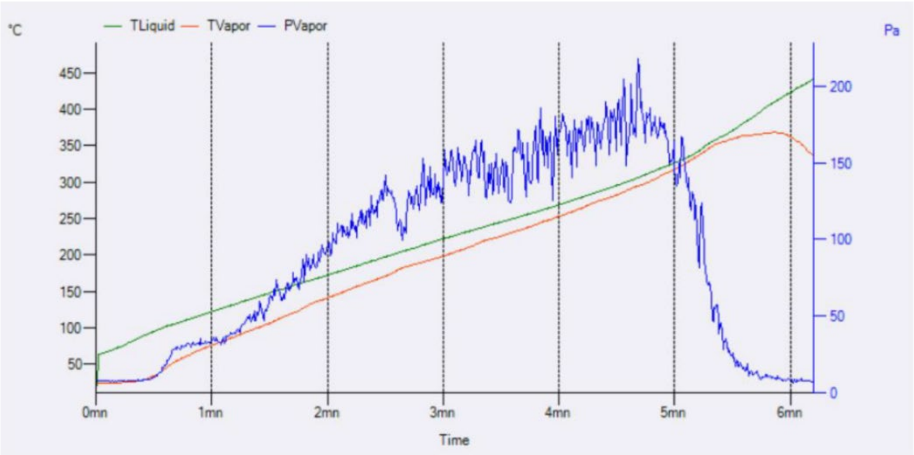

Figure 1: TLiquid, TVapor, and PVapor data of the WPPO sample-1 is given in the figure.

According to the data in Figure 1, it is conclused that there is a chemically dissolved water in sample due to a decrease in PVapor ~100°C.

On the other hand, we observe no deviation in Tvapor temp profile at the same point; thereby it is anticipated that this is not the “free water in sample” but a chemically dissvoled one. Therefore we suggest our customers to perform dehydration in the lab prior to the analysis.

Table 2: IBP, FBP and corresponding distillation temperature data of the WPPO sample-2.

Volume	Temperature
IBP	67.5°C
5%	105.0°C
10%	121.8°C
20%	144.9°C
30%	174.8°C
40%	202.4°C
50%	229.7°C
60%	257.3°C
70%	284.9°C
80%	315.1°C
90%	348.0°C
95%	392.3°C
FBP	393.0°C

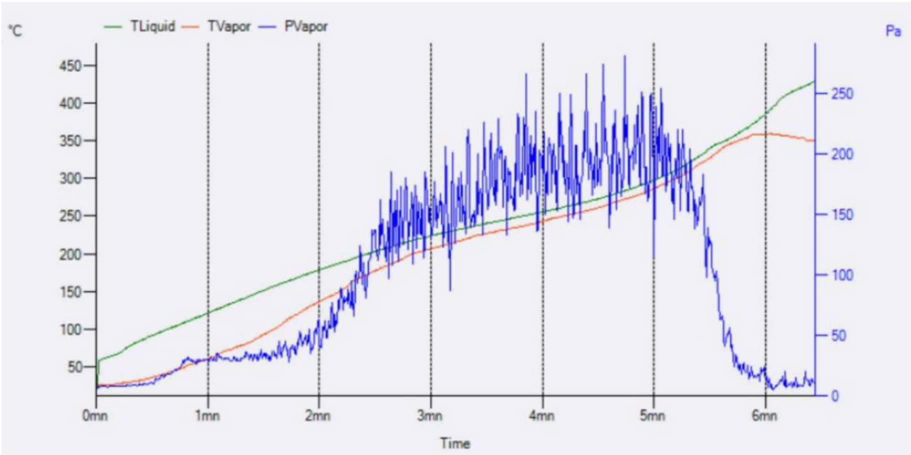

Figure 2: TLiquid, TVapor, and PVapor data of the WPPO sample-2 is given in the figure.

Similar sets of data for sample-2 is provided in Table 2 & Figure 2. The experiment is successfully run without any clogging although the FBP values close to 400 C is observed. No chemically dissolved water is detected.

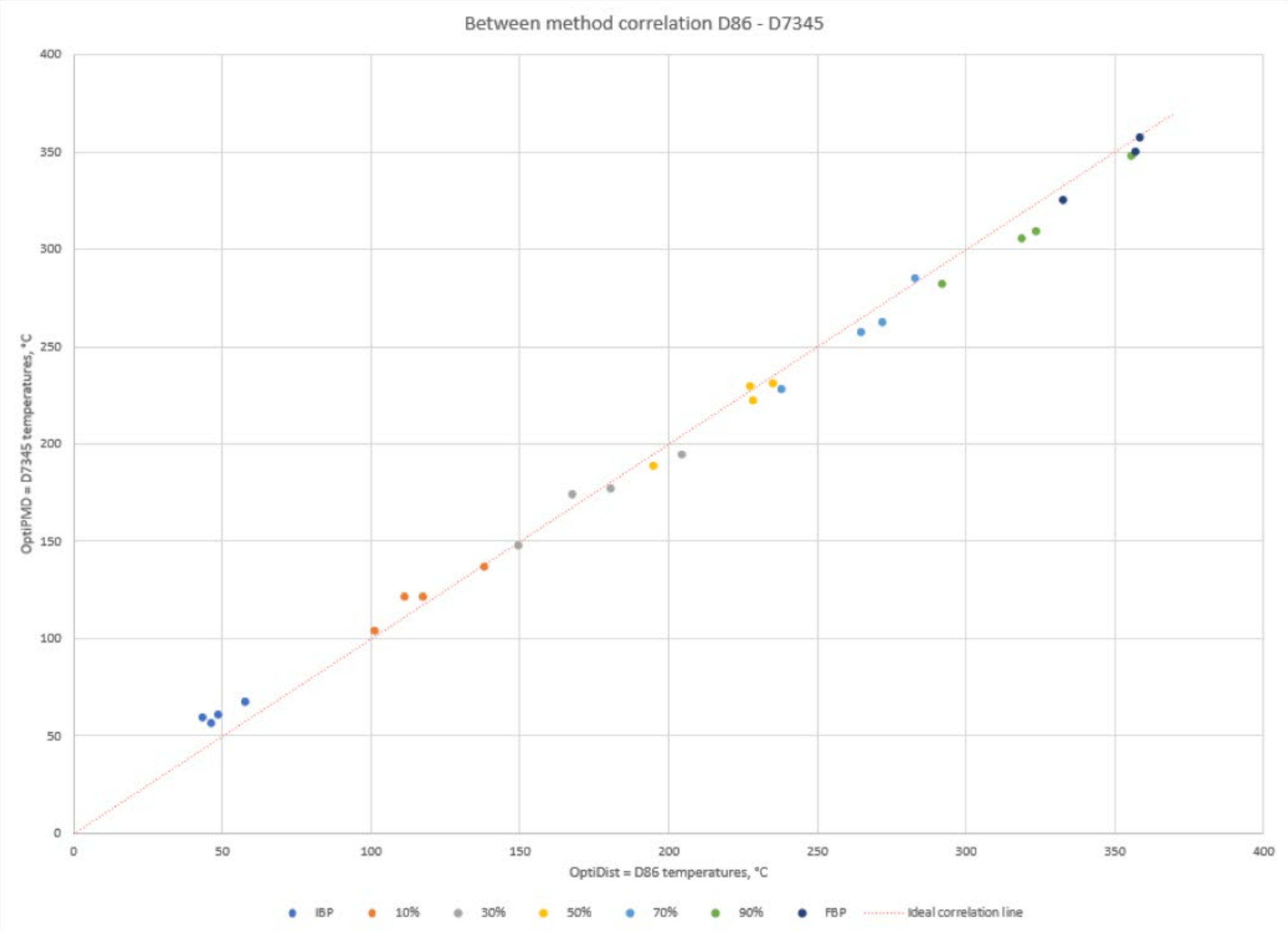

Figure 3: The correlation of the D7345 vs. D86 data for rhe collected WPPO sampled with an R2 value of 0.9973.

Conclusion:

As for the analysis of challenging WPPO samples, our OptiPMD solution can be used for product certification according to ASTM D7345 in the lab, for optimization support to engineers in the process, or for fast screening purposes with only 10mL sample to be finished in 10 minutes which can be successfully correlated to D86 method with R2 of 0.9973.

Collected results clearly implies that the use of OptiPMD can be recommended to our customers for the analysis of WPPO reliably. Even with challenging samples showing huge variations between IBP and FBP values during the analysis of WPPO samples having high paraffinic content, OptiPMD successfully analyzed and provided satisfactory results.

The OptiPMD offers an excellent combination between speed and a reliable correlation to ASTM D86 or EN/ISO 3405 for the user, meaning much higher sample throughput and a faster response to the specific analysis requests.

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