APPLICATION HIGHLIGHT:

HVM 472: Testing of Waste Plastic Pyrolysis Oil (WPPO)

Introduction:

Thanks to its 70 years of experience in automated viscosity measurements, PAC Powered by Herzog is the benchmark in viscosity analysis. HVM 472 is designed to perfectly meet today's expectations on user convenience, quality, and safety.

The HVM 472 accurately detects viscosity for petroleum products, lube oils, used oils, gear oils, food & beverages, chemicals, and bitumen.

Reasons for choosing HVM 472 for your viscosity measurements include, but are not limited to:

- Fully automated kinematic viscosity determination
- Inclusion of two internal changers with 26-samples each
- Compact, double bath system, enabling user to work at two different temperatures
- Capable of performing both ASTM D455 tests, we well as fast test runs
- Viscosity Index (VI) calculations are possible in this single instrument

The HVM 472 Viscosity Analyzer comes with a bath with distinct features, including:

- Capillary test is visible from all directions
- Temperature range: 20° - 150°C with fixed oil volume
- Bath liquid: 2 x 5 liters of silicone oil
- High efficiency circulation system per bath with excellent temperature stability and uniformity
- Temperature control resolution of 0.0001°C
- Hot surface protection provided by the outer tube cover

Plastic Circularity and Increased Use of WPPO

Due to increased world population, higher standards of living, longer lifetime, increasing amounts of plastic packaging especially from food industry, growing concerns on environment, and new legal regulations, the rates of collections and recycling of waste plastics are soaring globally.

In addition to mechanical recycling, advanced recycling methods such as chemical recycling of waste plastics by pyrolysis are integral & complementary methods for achieving the sustainability targets worldwide. However, the nature of the WPPO is very different than the traditional hydrocarbons necessitating to develop new applications and equipments to reveal its chemical & physical properties.

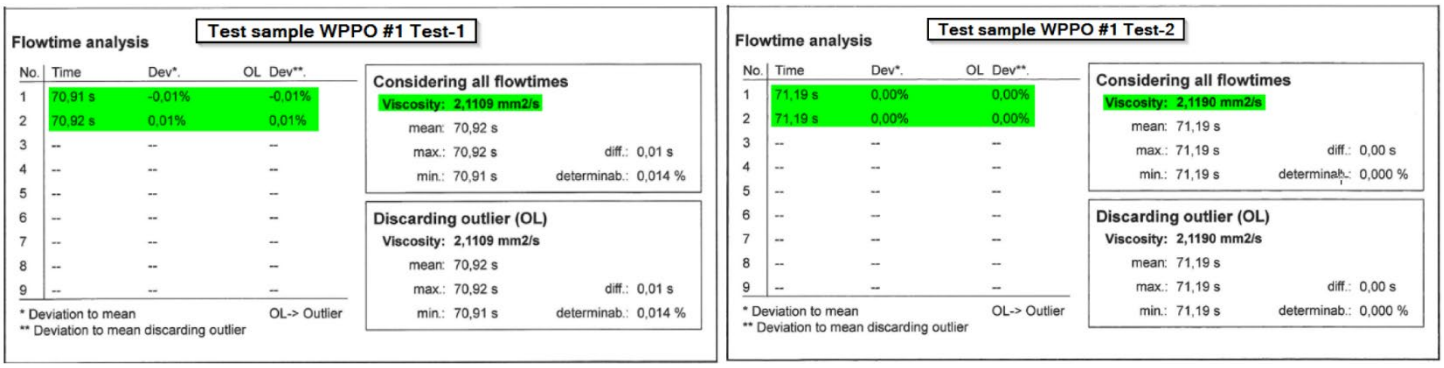
The viscosity measurement enables the producer & users of WPPO to optimize their processes and to sort & store & distribute & sell their products with a less downtime increasing throughput. HVM 472 is a strong analytical instrument to determine the viscosity of WPPO samples.

Instrument Preparation and Test Result Comparison:

The HVM 472 is designed specifically for testing samples that exhibit solid or waxy phases at room temperature. When the test begins, the HVM 472 utilizes its sample pre-heating system to liquefy the sample, effectively overcoming any waxy characteristics. This makes it particularly suitable for WPPO oils, which typically do not flow like liquids at room temperature.

The test results of the WPPO sample according to the ramp method ASTM D445 are shown in the Tables 1-3. Below. Very stable and precise results are obtained with excellent flow time and repeatability. Viscosity values ranged from 1.34 mm2/s to 2.35 mm2/s for 3 different WPPO samples demonstrating the strong capability of HVM 472 for the analysis of challenging WPPO samples. Measurements were performed at a temperature of °C Celsius.

Table 1: HVM 472 test results from sampler WPPO #1:



Flowtime analysis — Test sample WPPO #1 Test-1

No.	Time	Dev*.	OL	Dev**.
1	70,91 s	-0,01%		-0,01%
2	70,92 s	0,01%		0,01%
3	--	--		--
4	--	--		--
5	--	--		--
6	--	--		--
7	--	--		--
8	--	--		--
9	--	--		--

* Deviation to mean
** Deviation to mean discarding outlier
OL-> Outlier

Considering all flowtimes
Viscosity: 2,1109 mm2/s
mean: 70,92 s
max.: 70,92 s diff.: 0,01 s
min.: 70,91 s determinab.: 0,014 %

Discarding outlier (OL)
Viscosity: 2,1109 mm2/s
mean: 70,92 s
max.: 70,92 s diff.: 0,01 s
min.: 70,91 s determinab.: 0,014 %

Flowtime analysis — Test sample WPPO #1 Test-2

No.	Time	Dev*.	OL	Dev**.
1	71,19 s	0,00%		0,00%
2	71,19 s	0,00%		0,00%
3	--	--		--
4	--	--		--
5	--	--		--
6	--	--		--
7	--	--		--
8	--	--		--
9	--	--		--

* Deviation to mean
** Deviation to mean discarding outlier
OL-> Outlier

Considering all flowtimes
Viscosity: 2,1190 mm2/s
mean: 71,19 s
max.: 71,19 s diff.: 0,00 s
min.: 71,19 s determinab.: 0,000 %

Discarding outlier (OL)
Viscosity: 2,1190 mm2/s
mean: 71,19 s
max.: 71,19 s diff.: 0,00 s
min.: 71,19 s determinab.: 0,000 %

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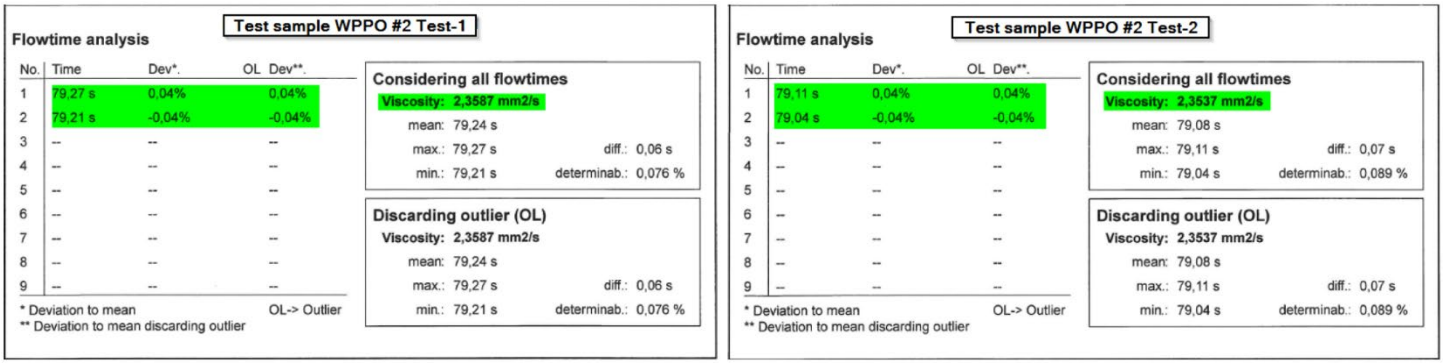
Table 2: HVM 472 test results from sampler WPPO #2:



Flowtime analysis — Test sample WPPO #2 Test-1

No.	Time	Dev*.	OL	Dev**.
1	79,27 s	0,04%		0,04%
2	79,21 s	-0,04%		-0,04%
3	--	--		--
4	--	--		--
5	--	--		--
6	--	--		--
7	--	--		--
8	--	--		--
9	--	--		--

* Deviation to mean
** Deviation to mean discarding outlier
OL-> Outlier

Considering all flowtimes
Viscosity: 2,3587 mm2/s
mean: 79,24 s
max.: 79,27 s diff.: 0,06 s
min.: 79,21 s determinab.: 0,076 %

Discarding outlier (OL)
Viscosity: 2,3587 mm2/s
mean: 79,24 s
max.: 79,27 s diff.: 0,06 s
min.: 79,21 s determinab.: 0,076 %

Flowtime analysis — Test sample WPPO #2 Test-2

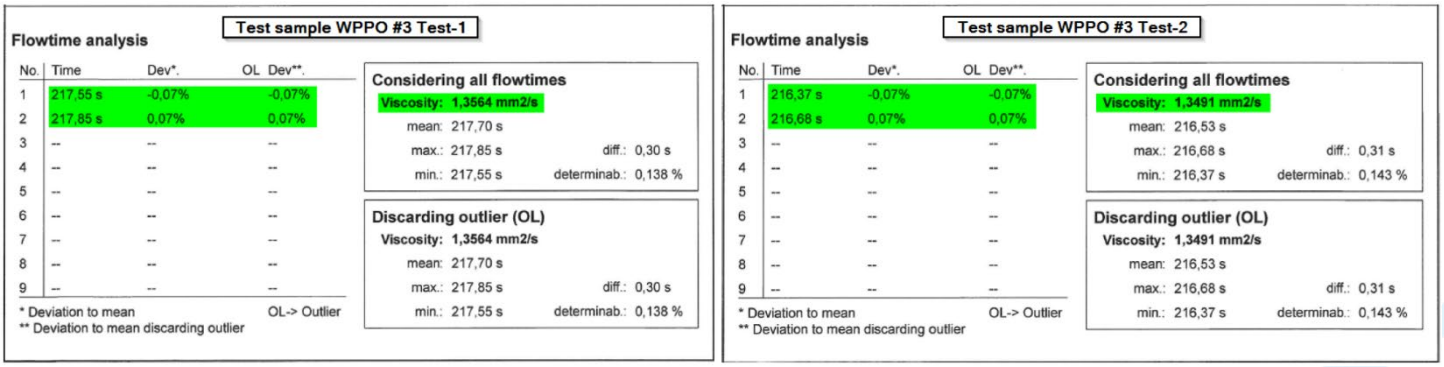
No.	Time	Dev*.	OL	Dev**.
1	79,11 s	0,04%		0,04%
2	79,04 s	-0,04%		-0,04%
3	--	--		--
4	--	--		--
5	--	--		--
6	--	--		--
7	--	--		--
8	--	--		--
9	--	--		--

* Deviation to mean
** Deviation to mean discarding outlier
OL-> Outlier

Considering all flowtimes
Viscosity: 2,3537 mm2/s
mean: 79,08 s
max.: 79,11 s diff.: 0,07 s
min.: 79,04 s determinab.: 0,089 %

Discarding outlier (OL)
Viscosity: 2,3537 mm2/s
mean: 79,08 s
max.: 79,11 s diff.: 0,07 s
min.: 79,04 s determinab.: 0,089 %

Table 3: HVM 472 test results from sampler WPPO #3:



Flowtime analysis — Test sample WPPO #3 Test-1

No.	Time	Dev*.	OL	Dev**.
1	217,55 s	-0,07%		-0,07%
2	217,85 s	0,07%		0,07%
3	--	--		--
4	--	--		--
5	--	--		--
6	--	--		--
7	--	--		--
8	--	--		--
9	--	--		--

* Deviation to mean
** Deviation to mean discarding outlier
OL-> Outlier

Considering all flowtimes
Viscosity: 1,3564 mm2/s
mean: 217,70 s
max.: 217,85 s diff.: 0,30 s
min.: 217,55 s determinab.: 0,138 %

Discarding outlier (OL)
Viscosity: 1,3564 mm2/s
mean: 217,70 s
max.: 217,85 s diff.: 0,30 s
min.: 217,55 s determinab.: 0,138 %

Flowtime analysis — Test sample WPPO #3 Test-2

No.	Time	Dev*.	OL	Dev**.
1	216,37 s	-0,07%		-0,07%
2	216,68 s	0,07%		0,07%
3	--	--		--
4	--	--		--
5	--	--		--
6	--	--		--
7	--	--		--
8	--	--		--
9	--	--		--

* Deviation to mean
** Deviation to mean discarding outlier
OL-> Outlier

Considering all flowtimes
Viscosity: 1,3491 mm2/s
mean: 216,53 s
max.: 216,68 s diff.: 0,31 s
min.: 216,37 s determinab.: 0,143 %

Discarding outlier (OL)
Viscosity: 1,3491 mm2/s
mean: 216,53 s
max.: 216,68 s diff.: 0,31 s
min.: 216,37 s determinab.: 0,143 %

Conclusion:

HVM 472 is a method in full compliance with ASTM D445 & provide a suitable testing for samples with paste and waxy characteristics. Since WPPO samples are mostly rich in waxy paraffines, they possess solid-like flow patterns at room temperature. Due to this behavior, WPPO samples require a pre-heating system, and with HVM 472, such analysis is possible. Thanks to the highly efficient & user-friendly design, HVM 472 can test 52 different test samples by loading them into the sample carousel for a complete analysis during the night time creating higher efficiency, uptime and throughput.

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