Viscosity Measurement of Raw Materials for Cosmetic Products

Cosmetic industry, pharmaceutical industry, clean oil producers, testing labs

Producers of oil-based cosmetic products receive pure and clean oils as raw materials which are further processed to the final product. For handling, processing, and transportation, viscosity is a crucial parameter. The Anton Paar SVM 2001 is the optimum solution for viscosity measurement throughout production.

Figure 1: From raw materials to cosmetic products

1 Why measure viscosity?

For producers of oil-based cosmetic products, the **viscosity** is an essential parameter to be determined. The pure oils are used as raw materials and further checked in quality control, transported, stored, and processed. Since many pure oils show a freezing point close to ambient conditions, their viscosity has a crucial influence on the handling and processing of the ingredients. Moreover, finished retail products, such as creams or balsam oils, require a convenient application by customers at any time.

This report describes how to test various types of pure oils used as ingredients as well as oil-based finished products at the following temperatures which are relevant for storage, transportation, processing and final application: 40, 25, 20 , and 15 °C (104, 77, 68 and 59 °F).

2 Which instrument is used?

For the test of oil samples, the SVM 2001 is used. The SVM 2001 features a viscosity measuring cell and a density measuring cell which are filled in one go.

The instrument's internal software provides single point measurements with or without automatic repetition in three different precision classes from ‘Precise’ to ‘Ultrafast’, while each class corresponds to defined stability criteria for temperature, viscosity and density.

For measurements with automatic repetition, the software features default deviation criteria for the repeatability depending on the selected precision class:

- for viscosity from 0.1 to 2.5 %
- for density from 0.0002 to 0.0010 g/cm³

3 Which samples are tested?

Oil-based cosmetic products have a curing effect for all skin types and help to protect the skin against harmful issues. Modern beauty oils are a combination of different types of oils and extracts mixed in such a way to trigger the desired effects of the finished product.

The scope of tested samples covers pure oil samples used as raw materials as well as oil-based finished products.

Pure oil products	Finished oil-based products
Sunflower oil	Body care oil
Olive oil	Make-up remover oil
Coconut oil	Body beauty oil
Shea butter	
Red palm tree oil	

Table 1: Tested samples

4 How to measure the samples?

4.1 Instrument preparation

For samples that are solid at ambient conditions preheating to 50 °C is necessary for proper filling. For these samples the accessory *Hot Filling Attachment* is used to ensure a stable temperature in the syringe and connections throughout the whole measuring and cleaning cycle.

The Hot Filling Attachment can easily be mounted on the instrument.

4.2 Instrument settings

- Measuring mode: ‘Repeated Mode’ (automatic repetition)
- Precision class: ‘Precise’
- Automatic prewetting: yes
- Filling temperature: yes
- Equilibration time: 180 s for preheated samples

Tip: Depending on the filling viscosity, the equilibration time has a crucial effect on the repeatability of viscosity measurement. A high filling viscosity requires a longer equilibration time for the results to become stable. In order to maintain a good repeatability, it is important to keep the equilibration time constant for measurements of the same sample.

4.3 Calibration

Before the measurement of the samples, it is advisable to perform a calibration. Use one or more standards in the viscosity range of your oil samples. This can be a certified standard or a house-internal standard with kinematic viscosity values. In any case you need reliable kinematic viscosity values at the measuring temperatures. If required, apply a calibration correction to improve the reproducibility. To perform a calibration, refer to the SVM X001 Reference Guide.

4.4 Sample preparation

If the sample is not freshly drawn from a production line or another reservoir, you can improve the repeatability by homogenizing the sample before taking the test specimen.

Any sample that crystallizes at ambient conditions should be preheated to a temperature at which the sample shows a homogeneous liquid phase.

4.5 Filling

Single-use syringes are recommended. Never use syringes with a rubber sealing, as the rubber is chemically not resistant and these syringes tend to draw bubbles. For preheated samples, always use syringes with a Luer-Lock connector. The typical sample volume is 5 mL.

4.6 Cleaning

4.6.1 Solvents

It is essential to use a solvent that dries up completely without residues even at low measuring temperatures. For most of the pure oils samples, cleaning with only one solvent is sufficient.

So-called petroleum benzine (hydrocarbon solvent, blend of mainly C7, C8, C9 n-alkanes) with a boiling range of 100 °C to 140 °C (212 °F to 284 °F) is the best choice and a universal solvent for cleaning over a wide temperature range. Since the cleaning effect is accelerated at increasing temperatures, the pre-set filling temperature of 50 °C (104 °F) for preheated samples enhances the cleaning speed.

For oil-based final products, it is recommended to use two cleaning agents: Isopropanol (Isopropylalcohol) to pre-clean and petroleum benzine for final cleaning and as drying solvent.

4.6.2 Procedure

- To avoid spillage, remove the sample from the cell by drawing it back into the syringe.
- Fill approx. 2 mL of solvent(s) with a disposable syringe. Mix solvent and sample residues in the viscosity using the motor speed button  . Fill approx. 1 mL more solvent, move the plunger several times forth and back, and remove the sample from the cell. The generated air bubbles improve the cleaning action. Repeat this procedure once.
- Flush the cells with approx. 3 mL of fresh solvent.
- Connect the air pump hose respectively clean compressed air to dry the cell.

5 Results

For each temperature, up to three measurement cycles with automatic repetition are conducted. Based on the valid results (n), the mean value and standard deviation is calculated and displayed in the tables below.

5.1 Pure oils as raw materials

5.1.1 Sunflower oil, olive oil and coconut oil

As their freezing points are below 0 °C (32 °F), olive oil and sunflower oil do not require any preheating. Viscosity measurements show a standard deviation between ± 0.01 % to ± 0.27 % for all measuring points.

Since coconut oil has a freezing point between 23 to 26 °C (73 to 79 °F), the sample is preheated to 50 °C (122 °F) to ensure a homogeneous, liquid sample. Due to the long solidification time of coconut oil, the SVM 2001 gives stable measuring results for 25 °C and 20 °C (77 °F and 68 °F) at precision class ‘Precise’. For measurements at 15 °C (59 °F), the enhanced crystallization does not allow valid viscosity measurement any more.

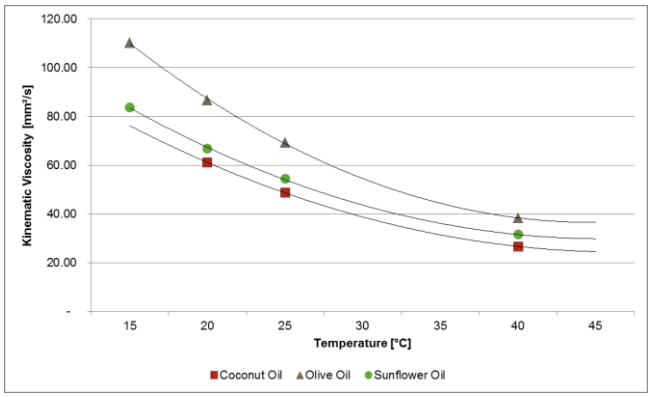

Figure 2: Kinematic viscosity of natural oils versus temperature

Sample	Measurement Mode	Temp. in °C	Kinematic Viscosity in mm²/s
Sunflower Oil	Repeated Mode, n = 3	40	31.50 ± 0.01 mm²/s (± 0.04 %)
Sunflower Oil	Repeated Mode, n = 3	25	54.35 ± 0.01 mm²/s (± 0.01 %)
Sunflower Oil	Repeated Mode, n = 3	20	66.82 ± 0.04 mm²/s (± 0.05 %)
Sunflower Oil	Repeated Mode, n = 3	15	83.66 ± 0.22 mm²/s (± 0.27 %)
Olive Oil	Repeated Mode, n = 3	40	38.34 ± 0.01 mm²/s (± 0.02 %)
Olive Oil	Repeated Mode, n = 3	25	69.27 ± 0.10 mm²/s (± 0.15 %)
Olive Oil	Repeated Mode, n = 3	20	86.65 ± 0.01 mm²/s (± 0.01 %)
Olive Oil	Repeated Mode, n = 3	15	110.0 ± 0.04 mm²/s (± 0.04 %)
Coconut Oil	Repeated Mode, n = 3	40	26.66 ± 0.03 mm²/s (± 0.11 %)
Coconut Oil	Repeated Mode, n = 3	25	48.64 ± 0.02 mm²/s (± 0.04 %)
Coconut Oil	Repeated Mode, n = 3	20	61.12 ± 0.09 mm²/s (± 0.15 %)

Table 2: Kinematic viscosity of sunflower, olive, and coconut oil at different temperatures

5.1.2 Red palm oil

The sample is preheated to 50 °C (122 °F) before filling. At 40 °C (104 °F) the sample is still liquid, but the crystallization process begins already and the sample is not ideally homogeneous anymore. Measurements with precision class ‘Precise’ and measuring mode ‘Repeated Mode’ do not deliver results within the predefined repeatability range. Consequently, this sample can only fulfill precision class 'Ultrafast'.

Due to enhanced crystallization in the measuring cell and syringe at 25 °C (77 °F), refilling out of the syringe is not possible anymore. Therefore, the measurement mode ‘Standard’ is selected. After filling at the same filling temperature of 50 °C (122 °F), the sample is cooled down to the 25 °C (77 °F).

For measurements at 20 °C (68 °F) and 15 °C (59 °F), the advanced solidification process significantly limits the repeatability of measurements.

Sample	Measurement Mode	Temp. in °C	Kinematic Viscosity in mm²/s
Red Palm Oil	Rep. Mode, n = 3	40	56.55 ± 1.90 mm²/s (± 3.37 %)
Red Palm Oil	Standard, n = 3	25	149.27 ± 7.84 mm²/s (± 5.25 %)
Red Palm Oil	Standard, n = 3	20	508.24 ± 86.4 mm²/s (± 17.0 %)
Red Palm Oil	Standard, n = 2	15	13288 ± 12803 mm²/s (± 96.4 %)

Table 3: Kinematic viscosity of red palm oil at different temperatures

5.1.3 Shea butter

The sample is preheated to 50 °C (122 °F) before filling. For analysis of shea butter with a freezing point in a range from 35 to 42 °C (95 to 108 °F), measurements with the precision class ‘Precise’ are only possible at 40 °C (104 °F).

Sample	Measurement Mode	Temp. in °C	Kinematic Viscosity in mm²/s
Shea Butter	Repeated Mode, n= 2	40	90.97 ± 0.07 mm²/s (± 0.08 %)
Shea Butter	Repeated Mode, n = 3	25	187.46 ± 9.23 mm²/s (± 4.92 %)
Shea Butter	Standard, n = 3	20	1269.1 ± 363.1 mm²/s (± 28.6 %)

Table 4: Kinematic viscosity of shea butter at different temperatures

For 25 °C (77 °F), the precision class is changed to ‘Ultrafast’. Whereas at 25 °C (77 °F) measurements with measuring mode ‘Repeated Mode’ are completed, the increasing crystallization limits repeatable results at 20 °C (68 °F) and doesn’t allow any valid determination at 15 °C (59 °F).

5.2 Oil-based finished products

For all tested cosmetic products, measuring results with measuring mode ‘Repeated Mode’ at highest precision class ‘Precise’ are obtained. The standard deviation of kinematic viscosity results for the tested beauty oil, the make-up remover oil as well as the body care oil range from ± 0.04 % to ± 1.50 % at maximum.

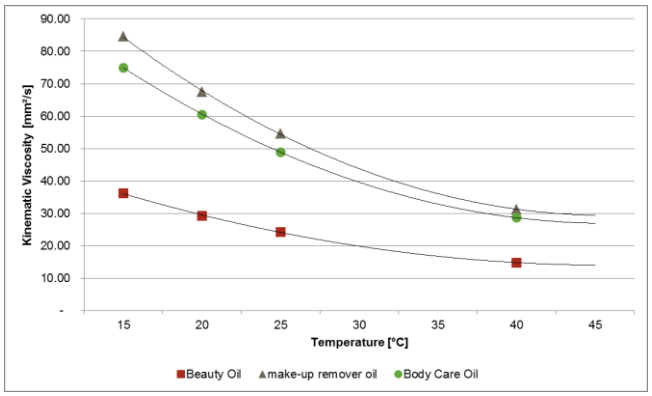

Figure 3: Kin. viscosity of finished cosmetic products vs. temp.

Sample	Measurement Mode	Temp. in °C	Kinematic Viscosity in mm²/s
Beauty Oil	Repeated Mode, n = 3	40	14.81 ± 0.01 mm²/s (± 0.04 %)
Beauty Oil	Repeated Mode, n = 3	25	24.26 ± 0.02 mm²/s (± 0.07 %)
Beauty Oil	Repeated Mode, n = 3	20	29.28 ± 0.01 mm²/s (± 0.04 %)
Beauty Oil	Repeated Mode, n = 3	15	36.15 ± 0.23 mm²/s (± 0.63 %)
Body Care Oil	Repeated Mode, n = 3	40	28.64 ± 0.12 mm²/s (± 0.41 %)
Body Care Oil	Repeated Mode, n = 3	25	48.94 ± 0.41 mm²/s (± 0.84 %)
Body Care Oil	Repeated Mode, n = 3	20	60.46 ± 0.63 mm²/s (± 1.05 %)
Body Care Oil	Repeated Mode, n = 3	15	74.97 ± 1.12 mm²/s (± 1.50 %)
Make-up Remover Oil	Repeated Mode, n = 3	40	31.26 ± 0.06 mm²/s (± 0.20 %)
Make-up Remover Oil	Repeated Mode, n = 3	25	54.64 ± 0.12 mm²/s (± 0.22 %)
Make-up Remover Oil	Repeated Mode, n = 3	20	67.45 ± 0.15 mm²/s (± 0.22 %)
Make-up Remover Oil	Repeated Mode, n = 3	15	84.47 ± 0.03 mm²/s (± 0.03 %)

Table 5: Kinematic viscosity of finished cosmetic products at different temperatures

6 Conclusion

The SVM 2001 is perfectly suited for determining the kinematic viscosity of pure oils used for the production of cosmetic products as well as for finished oil-based cosmetic products, provided that equipment and settings are in accordance with this report (see 4 “How to measure the samples?”). Results are obtained at highest precision class and show good repeatability.

Figure 4: SVM Family – The viscosity measurement solution

For the viscosity measurements close to a known freezing point, the SVM 2001 gives successful measuring result as single point measurement with or without automatic repetition. If an automatic temperature scan is desired for measurements at various temperatures, consider also the SVM 3001, as it offers a specific measuring mode as well as fast heating and cooling rates.

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