

Rheology and Processing of Paints, Plastic and Elastomer based Composites
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Lecture 20

Practical demonstration on Mooney viscometer, ODR and MDR

Welcome back to NPTEL online certification course on rheology and processing of plastics, paints and elastomeric composites. Today I will give a demonstrating using ODR, MDR, Mooney Viscometer which are the most basic instrument in our rheology lab. This is the Mooney Viscometer from Prescott instrument standard ISO 289 or ASTM D1646. Here this machine consists with two types of die, one is smaller and another is larger. Rotation speed is variable speed Mooney Viscometer. So we can change the speed of rotation from 0.

1 to 20 rpm. Fully automatic temperature ambient to 2 to 5 degree centigrade, temperature controller 3 terms PID, accuracy 0.03 degree centigrade. This is a pneumatic controlled machine, pressure always maintain 60 psi.

You can see this is the rotor like ODR this is not biconical, this is a flat surface rotor. So that is why here we have to put two piece of sample, one in upside and another is downside. Again it will cover the rotor like sandwich this type. It is not flash the sample from upside to downside, and it is always rotate not oscillate it rotates 2 rpm fixed as per ASTM. You can see the grooves.

This is the sample cutter. The instrument comes with the sample cutter. This type of rubber sheet we can cut. Two pieces required, one for upper and another for lower pretends. The cavity volume 25 cc.

After cutting the two pieces, PET sheets is applied for stickiness of natural rubber. This is the software portion. You can see the rotation. It is always fixed as per ASTM 2 rpm. It is not oscillating, it is rotating.

After instrument start, it is some time for preheating the upper and lower pretends. It set temperature 100 degree centigrade. Finally we can do Mooney for 4 minutes for natural

rubber. Now temperature is almost 100 degree. After temperature come, we put the sample for testing.

The machine is now ready. This is 100 degree centigrade right now. Two pieces are sample placed like that. Now machine is ready for testing. Now machine is testing mode.

It will take 5 minutes, 1 minute for preheating time and then the rotor is start rotating. This is the graph. After finish the 1 minute for preheating, you can see the torque is rise. A Mooney unit is equivalent to a torque of 0.735 pound inch.

The pressure is applied pneumatically on the top platen which moves downward and closes the button stationary platen. One uptime for this instrument 1 minute is given already. For NR the reading is taken after 4 minutes and butyl rubber 8 minute. For low viscous rubber, the rotor diameter is large which for high viscosity is low. The ratio of viscosity of two rotors large by small is 1.

8. So it depends on the types of rubber too. The delta Mooney is a expression of the Mooney used as an induction processability for non used as an induction processability for non pigmented oil extended emulsion SBR. The measure is difference between viscosity reading at two different times. After complete 5 minutes, the test is completed. The platen automatically goes up.

If we set the accepted value of this rubber, then passed, fell and forced 3 moves is here. It has user defined 3 quantity control gates based on which passes criteria can be implemented. Actually, Mooney is used for quality control of the raw material. So you can say this is quality is good or bad. Now I am starting with ODR oscillating disc rheometer.

This is oscillating disc rheometer from Monsanto. Its model number rheometer 100S. Oscillating disc rheometer is efficient, simple and reliable testing equipment. It is measured cure characteristic of vulcanizable rubber compound. In our facility, we have Monsanto 100S rheometer.

This is having the look of the instrument. Now I am discussing about the specification of the instrument. You can see there is a pneumatic pressure applied for this instrument. It is always maintained 60 bar. The upper and lower platen working through this pneumatic pressure.

This instrument having oscillating frequency 100 cycles per minute equals to 1.67 hertz. Oscillating amplitude plus minus 3 degree for half cycles. Sample volume approximately

8 cc. Temperature microprocessor control calibrated range 100 to 200 degree centigrade.

Independent upper and lower platen control. Pneumatic frequency control temperature within 0.5 degree centigrade. Torque transducer directly sub mounted in the line of oscillating disc. Four arms temperature compensated straight gate switch recording and display directly on line display VGA monitor.

Automatic computational graph with result. And compressor air supply always maintain 60 psi. Now I am discussing about the main instrument or basic part of the instrument. This is the main part. The rheometer is designed in compliance with ASTM 2084 and ISO 3417.

It is a tabletop model for using friendly operation. The body of the machine is molded of 16 gauge stainless steel. A test piece compound is contained in a sealed test cavity under the positive pressure and maintained at a specific elevated temperature. This is the upper platen and this is lower platen. Inside the lower platen a rotor biconical disc is embedded in the test sample which can oscillate through a small specific angular arc plus minus 3 degree.

You can see the oscillating of this rotor. It is rotate, it is oscillate in 3 degree. Generally for rubber sample we can do in 3 degree and for plastics hard metal 1 degree and semi liquid type for 5 degree. The torque required to oscillate the disc depend upon the stiffness of rubber compound which increases with the increase in cross linking during cure of the compound.

You can see the rotor. The rotor is designed in grooves. From one grooves to another is maintained at an angle 10 degree. This is oscillate like that. A sample test piece is just put on the rotor then pneumatic lock and motor is start. You can see the motor is oscillating.

Now I am showing the temperature controller part. This is the temperature controller part. The temperature is controlled by PID controller with PTE 100 RTDS temperature sensor. Monsanto uses low wattage heater in direct contact with dies so that recovery and maintenance of temperature is precise. The machine houses dedicated CPU to capture analysis and send data.

Now I am showing the temperature controller part. This is the temperature controller part. This controller part is to fix with this temperature controller part. This is for upper plate end and this is for lower plate end. You can see this 150 set temperature controller temperature 150 generally we can do for in a natural rubber 150 and for sulphur system and peroxide system it can be higher than sulphur system it will 160 to 170 degree

centigrade.

This is the set temperature and this is the temperature actual at that moment in instrument. Now I am showing the software part. The instrument comes with a complete computer system loaded with custom built software. This is the software CompuGraph. And after filling this parameter user name, test type, operator, compound ID just click on ok and then write the compound name says testing 1.

It is already fixed with 30 minute for 150 degree centigrade. Now we can start the test. You can show the peak is coming. For the complete test it will take 30 minutes. One peak already came and now graph is slowly slowly rising.

After complete the test you can show this type of graph is displayed on the screen. This is the torque curve red one and this is the tan delta. After complete the test you can see this type of graph is displayed on the screen. After complete the test the field will open motor off first one motor off pneumatic pressure off and then this open.

This is a biconical rotor. If we put the sample just upside of this rotor the material is flash and catch the rotor like that like sandwich. After finishing you can see this type of sample is removed from this rotor. This is Monsanto MDR 2000 moving die rheometer. The instrument is complied with ASTM D5289.

Biconical close system sealed die. Die gap 0.5 mm nominal sample volume approximately 4.5 cm square cube. Drive system mechanical brushless DC electric drive. Losing system pneumatic with soft close with preventive foil rips.

Oscillating frequency 1.67 hertz. Oscillating spray 0.1 degree to 30 degree. Torque range 0.01 to 250 DC Newton. Like ODR there is no rotor it is called rotorless rheometer.

You can see two platens there one is upper platen and another lower platen. The die is placed in lower platen. You can see the oscillate it oscillating 0.

5 degree R. If we put the sample here. The instrument is running. Now I am showing the software portion like ODR this is also same software operating software is same compo graph and this user name test type operator compound ID after fill up this parameter putting the sample name. After complete that is similar like ODR as the curve is displayed on the screen.