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Durometer

With all the rubber products made these days, roller coverings probably have more ranges of hardness than any other elastomer based products. Hardness is usually the fundamental property used in specifying a compound for a roll. Measuring the hardness of rubber is not entirely scientific, and in fact is quite subjective. The purpose of this paper is to define standard tolerances and testing procedures to help clarify what is and is not possible in defining specified hardness on roller coverings. There are many instruments used for measuring the hardness of rubber, but there are two that are most commonly used in the roller industry. One is the durometer and the other is the Pusey & Jones (P&J) plastometer. Each of these instruments measures the resistance of a cover to indentation.

The durometer is the most widely used instrument for measuring the hardness of rubber for the roller industry. Although the P&J plastometer has wide spread use in the paper industry, the durometer has the advantage of being small, easy to use, and gives quick readings. Unfortunately its very simplicity leads to misuse and possible disagreements, but when used in accordance with *The American Society for Testing and Materials* (ASTM) D 2240 procedure readings are reproducible with reasonable consistency. The durometer uses many different scales for different materials and hardness. The two that are used for rubber roller industry are Type A and Type D. The durometer Type D is used for measuring much harder materials than the basic rubber on rollers. Hence the Type A durometer is the more widely used scale

The durometer measures the resistance of the covering to the indentation of a shaped pin, indentor, against a calibrated spring. The spring is attached to an indicating hand that will point to a number on a graduated scale. The graduated scale is from 0 to 100, and the number decreases as the material gets softer. The difference between the types of durometers is the calibrated spring load and the shape of the indentor. Because of the difference in the shapes and spring there may be no simple relationship between the results obtained from one type of durometer to another, and for that matter, between another kind of measuring instrument. It is generally accepted that 60 Type D is somewhere in the range of 100 Type A for general comparisons only.

Even though Type A and D are different durometers the testing procedure is the same. To get an accurate reading one must follow the ASTM D 2240 testing procedure. The following is a brief highlight of the procedure and further information can be obtained from ASTM book of standards. The sample of rubber to be tested needs to be at 70 F +/- 5 degrees and must be at least 0.250” (6mm) think and the indentor must be at least 0.500” (12mm) from any edge. To obtain a measurement, apply the presser foot, the flat part of the durometer, to the roll as rapidly as possible without shock, keeping the foot parallel to the surface. Apply just enough pressure to obtain firm contact with the surface of the roll. Read the scale within one (1) second after the presser is in firm contact with the surface. Then repeat the above procedure in four more places on the roll at least 0.250” (12mm) apart to obtain a median value. It is this value that is reported as the hardness of the rubber.

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Due to varying factors in materials and processes it is necessary to specify a plus or minus tolerance. Many factors influence the reading obtained using a durometer even if the durometer is properly calibrated. Some of these factors are: the rate of application of load, the amount of pressure used, and whether or not there is an other-than-vertical force component. It has therefore been necessary for many independent tests to be conducted to determine what the actual range is for these variations. One such test was conducted by Rubber Manufactures Association, Inc. (RMA) using specialized independent laboratories. The first variable noted was with one operator using the same durometer at different times on different places across the specimen. The results of the test showed an average of two (2) points variance. The next variable they wanted to test was the range of variance many people got using calibrated durometers across many different days and labs. The results from that test showed an average of four (4) points variance. Many other studies have been conducted including one by ASTM with similar results.

With these studies in mind the question then becomes what is an allowable tolerance for rubber hardness when specifying a cover. Over the years there has been a great debate on this subject. It has been generally accepted that a tolerance of +/-5 points is allowable. As you can see from the results of the above mentioned test anything under this tolerance would be hard to achieve on a repetitive basis. With this in mind one needs to be careful when specifying anything closer than the +/- 5 point tolerance. Although it might be able to be achieved once there is no guarantee that it could be hit the next time due to the variance in testing.

In addition to the variances of durometers there are also several other factors that influence the hardness of rubber when measured on a roll. One of these factors is temperature. Rubber, even when properly cured, will change with the variations in temperature. In most cases as the temperature rises the hardness of the rubber will go down. The opposite is also true. As previously stated the standard testing temperature 70 F +/-5 degrees. If tested at any other temperature great care must be taken is being that the entire mass of the rubber be at the same temperature. It needs to be noted that rubber has a low coefficient of heat transfer; therefore it is difficult to obtain the exact temperature of a covered roller. Another factor that influences the hardness of rubber is the age of the cured rubber. Elastomeric products tend to become harder with age. So if a roll has been in storage or has been in service for a period of time, one can expect that it be harder than it was when it originally was covered. Although there are many more factors that could influence the hardness, temperature and time are some of the more common.

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Being one of the easiest properties of rubber to obtain, hardness is often the main focus when specifying a rubber cover. One has to remember that hardness is the resistance to indention. While hardness is important when trying to decide what is best for your application, properties such as dynamic modules, chemical resistance, and hysteresis of the material also need as much if not more focus. These properties can be controlled better than hardness because they don't have the high amount of variables that rubber hardness testing has. At Rolls Incorporated we are committed to supplying our customers with the highest quality materials and services available. If you have any questions concerning rubber hardness or would like further information on testing procedures please feel free to contact one of our helpful customer service representatives or your sales engineer.

Sources

RMA Roll Covering Handbook. Washington DC: Rubber Manufacturers Association, 1989.

"Standard Test Method for Rubber Hardness – Durometer Hardness." ASTM D 2240, American Society for Testing and Materials, 1986

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