Comparison and Measurement of Swisstronics Twisters and PÖschl Twisters

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Using optical techniques approximately a thousand Swisstronics twisters and approximately a hundred and twenty five Poschl twisters were measured for concentricity and hole size.

Measuring Technique
Using an end plug to hold the twisters in place, the end plug is held in line with a light source, lens, and CCD Camera. The light source shines through the hole of the twister held in the end plug. The light then is passed through the lens and focused on a CCD Camera. Using the center point of the traced circle one can then measure the offset from the calibrated center of the system in one picture. This measures the concentricity of the twister. The size of the light spot is directly related to the intensity of the light passing through the twister. The intensity of the light passing through the twister is then dependent on the size of the hole in the twister. So the hole of the twister is directly related to size of the projected light spot.

Set Up
An Electrim CCD Camera was used to measure the image. A lens, with focal length of 7.63cm, was used to obtain a magnification of 5.57. The object length was set at 9cm, and the image distance was set at 50.1cm. The light source used was fiber optic illuminator (white light) that was fixed at approximately 3.5cm behind the end plug. The apparatus used to hold the end plug was specially made. A Newport scaled optics rail was used for the alignment.

Accuracy of the Measurement
Several systematic studies were done to test the accuracy and repeatability of the apparatus. Fifty separate measurements of the same twister (a P)schl twister) in the same orientation were measured to test the repeatability of the position and spot size measurement. The resulting standard deviation and maximum deviations are shown:

	X Position (um)	Y Position (um)	Distance from Origin (um)	X diam. (um)	Y diam. (um)	Avg. Spot diameter (um)
St. Dev.	1.2	3.0	2.7	1.6	2.8	2.2
Max. Dev.	6.4	15.0	13.1	8.0	16.0	12.0

The "X Position (um)" and "Y Position (um)" refer to the X and Y coordinates, in microns. The "Distance from Origin (um)" is simply the distance calculation from origin $(X^2+Y^2)^{1/2}$. The "X diam. (um)" and "Y diam. (um)" are simply the widths of the light spot according the X and Y profile of the light spot. The "Avg. Spot diameter (um)" is the average of the X and Y widths of the light spot and was 64.0um.

An initial calibration was done by rotating a twister in an end plug in 45-degree increments for the whole 360 degrees. This is usually done several times to get a good sample of data. In the initial calibration ten sets of data were obtained. The standard deviation and maximum deviation of the calibrated center position are:

	Avg. X Position (um)	Avg. Y Position (um)	Avg. Distance from origin (um)	Dist. From Center (um)
St. Dev.	0.4	0.4	0.4	2.3
Max. Dev.	1.3	1.1	1.1	9.6

The “Dist. From Center” is the calculated average off set of the twister.

Three twisters were also used to find the center point of the system as a redundancy check on the calibration method. Each twister was rotated two times (through 720 degrees).

Twister	X Position (um)	Y Position (um)
A	241.9	428.8
B	241.8	430.8
C	242.2	429.3

The offsets of these twisters were also measured at three different magnifications as a way to check our scale and magnification function.

Magnification	Twister A			Twister B			Twister C		
	Off set	St. Dev.	Max Dev.	Off set	St. Dev.	Max Dev.	Off set	St. Dev.	Max Dev.
5.6	9.8	1.9	6.5	12.7	2.3	7.9	17.4	2.7	7.7
3.2	13.0	1.0	4.4	14.8	1.3	4.5	10.7	1.6	5.9
2.3	9.0	1.7	6.6	16.9	2.0	12.3	17.7	1.7	7.7

Several other tests have yet to be performed. One is the absolute measurement of the hole size. The program directly measures the spot size of the twister but it is not obvious as to what hole size the spot size is related to. A fifty micron aperture was received after this study was begun. This aperture will be used to calibrate the program. There are plans to use a Rasnik mask as another test for the scale/magnification function of the program as well. A study on the consistency of the system is also planned.

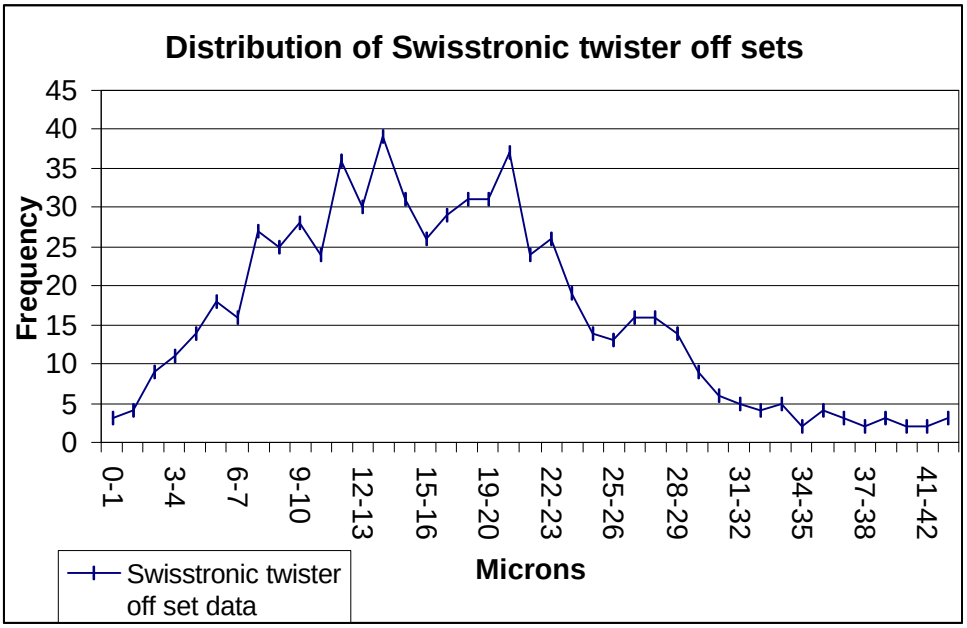
Comparisons between the Swisstronics twisters and Poschl twisters are more concrete than any absolute conclusions because of the lack of tests of the scale calibrations. A report on these tests will be made when these tests are complete.

Results of Swisstronics twister measurements

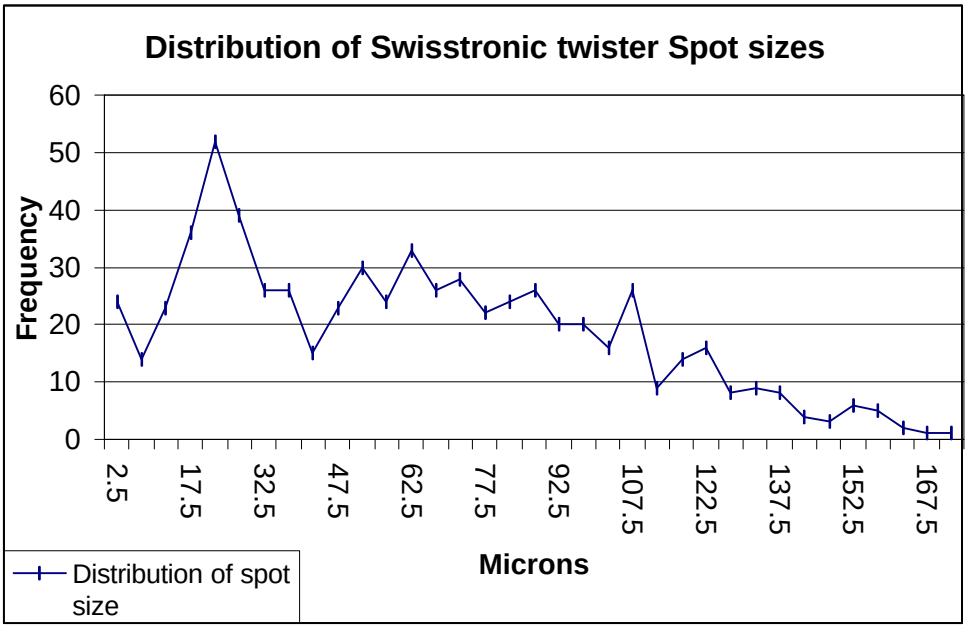
Of the 1000 twisters that were received all were measured, but 52 measurements weren’t recorded due to a mistake by the operator. So the data analyzed were of a set of 948 twisters. Each measurement was done at the same magnification. Of the 948 twisters 287 did not project a light spot intense enough to register any light spot on the CCD. The reason for this is not entirely obvious. When visually checked in the apparatus there is some light coming through, but it is definitely not as bright at the light that comes through a twister that does project a spot. So after comparing twisters that don’t register a light spot and those that do, it appears that the twisters that don’t register light spots are blocking the light path. So the light that does come through is simply reflections. The results are:

Swisstronics Twisters (661 measurements)		
	Off set of Twister (um)	Spot Size (um)
Average	16.3	62.8
St. Dev.	8.0	40.1

This is the distribution of the off sets.



Here is the distribution of the spot size from Swisstronic twisters.



Results of Pöschl Twisters

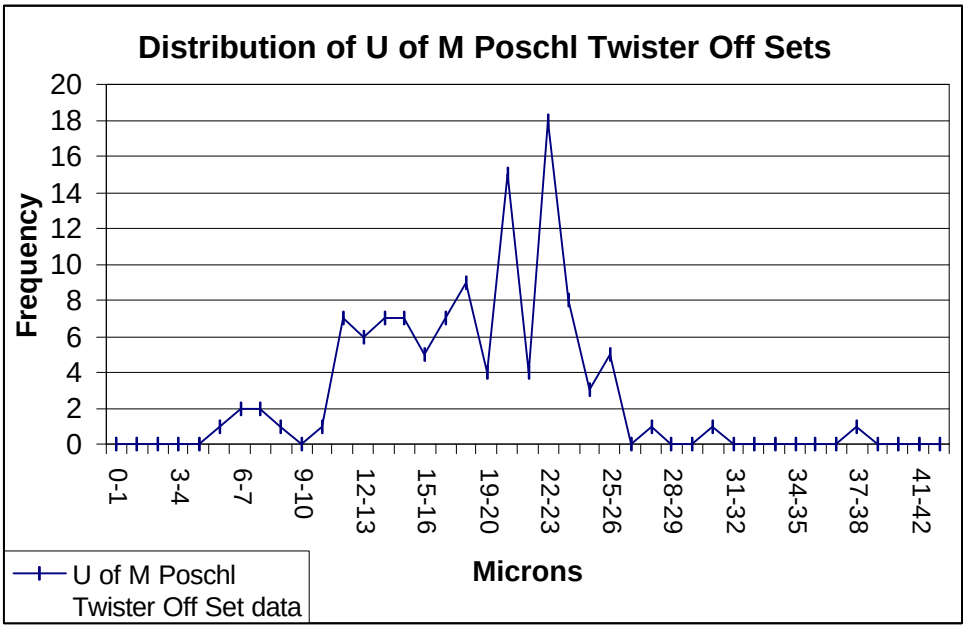
Ten Poschl twisters were sent along with the Swisstronic twisters. All ten were measured and recorded along with 115 UM Poschl twisters. The system had to be recalibrated in the middle of the U of M Poschl twister measurements. The results of the ten twisters are:

Data from Ten sent Poschl Twisters		
	Off Set (um)	Spot Size (um)
Avg	19.0	75.0
St. Dev.	3.1	3.8

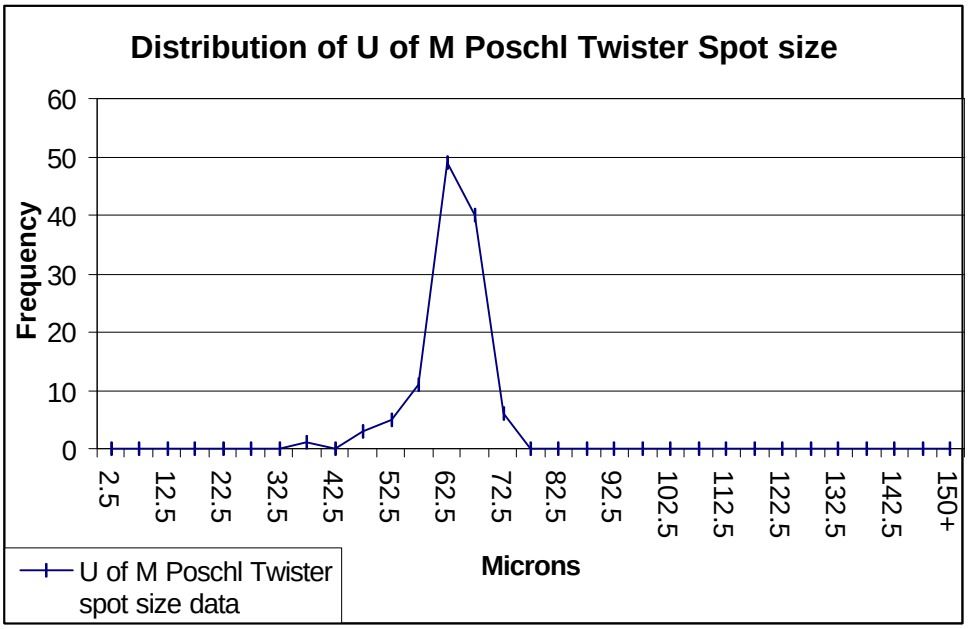
The UM Poschl twister data is:

U of M Poschl Twister data (115 Measurements)		
	Off set of Twister (um)	Spot Size (um)
Avg.	17.9	63.4
St. Dev.	4.9	5.6

The distribution of the U of M Poschl twisters is:



The distribution of spot sizes of the U of M Poschl twisters is:



Comments

It seems that the Swisstronics twisters are slightly smaller in outer diameter, nominally, than the Poschl twisters. The Swisstronics twisters were able to slip into the end plug a lot easier than the Poschl ones. I measured, with a micrometer, the outer diameter of five Poschl twisters and got an average of 5.00mm, and the Swisstronics measured at 4.97mm. After visually inspecting the twisters, it seems that the Swisstronics twisters have been tumbled longer, in other words the deburring process for the Swisstronic twisters was longer or more intense than for the Poschl twisters, and that the tool used to create the hole was not as sharp. This is because of apparent tool marks and discoloration on the inside of the twister. The Swisstronics twisters are also shinier, and the edges more rounded, than the Poschl twisters, which are smoother on the inside. The Swisstronics twisters also appear to be squeezed. This is a possible reason for the many twisters not projecting a light spot (making them unable to be measured by this technique).