Measurement of Specific Length, Width and Curling Index of Fibers in Paper & Pulp

Introduction

Paper & Pulp

The shape of pulp fibers is an important property of fibrous raw material. The strength of the finished paper sheet and of paper-machine runability depend highly on the fiber's shape parameters. The standard method for measuring fiber length is a microscopic procedure, which is tedious and inaccurate.

Another solution for measuring the fiber length involves the passing of the fibers through a narrow capillary at constant speed between a source of polarized light and a detector. This method suffers from clogging problems and the elimination of curved fiber from passing through the capillary which then prevents them from being counted and measured.

Furthermore, additional analysis of e.g. the particle size distribution of additives in the pulp require an additional analyzer since these particles are not measured.

The Ankersmid CIS-100 is the answer to this application by using a different approach.

CIS-100 – Particle Size, Shape and Concentration Analyzer

The Ankersmid Particle Size, Shape and Concentration analyzer, CIS-100, is a complete characterization system for particles in motion. Comprehensive particle analysis is obtained through the unique combination of two measuring channels employing Time-Of-Transition and Dynamic Shape Analysis (see Figure 1).

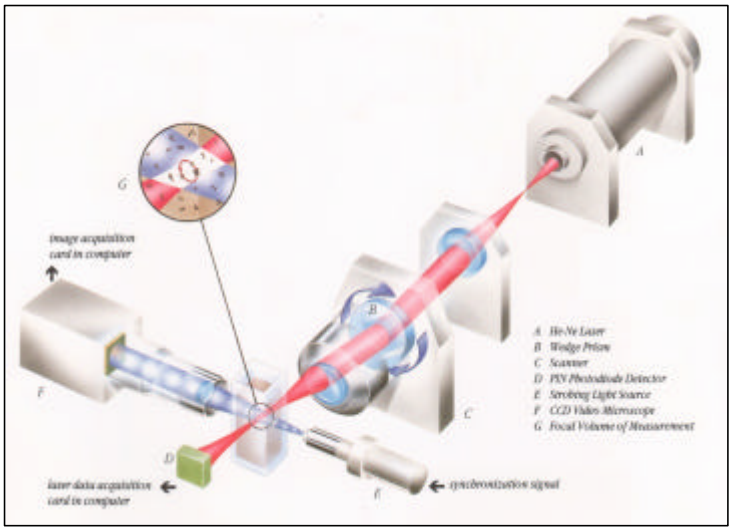

Figure 1 – Schematics of the two measuring channels

Time-Of-Transition is based upon the obscuration of a rotating laser beam by a passing particle. Because the velocity of the rotation is exactly known the time of obscuration is directly correlated to the particle's diameter.

Because most particles have irregular shapes this technique is combined with a microscope camera synchronized with strobe light capturing "still" images and analyze them by a strong image analysis software package. The images are enhanced, processed, and analyzed automatically to ensure full representation of the sample. Accurate results are produced in a fraction of the time normally required for microscopic observation. This way the particles can be described by their shape parameters like aspect ratio, shape factor, Feret diameters, specific length, width, etc.

An automatic flow controller (LFC-101) is used to flow the particles through the measuring cell. continuously while particles are in dynamic flow.

A special sample cell orientates fiber-shaped particles in flow direction. Special strategic shape filters are used in order to discriminate fibers from the complete matrix.

Table 1 - Measurement set-up configuration

Illumination	Synchronized strobe light with adjustable intensity and duration.				
Video camera	High resolution B&W CCD camera, 768x493 pixels.				
Shape range	**Lenses**	**Objective magnification**	**F.O.V**	**µm/Pix**	**Range [µm]**
	Lens DW	6x	1500x1200µ	2.3	10-600
	Lens EW	1.4x	6200x4500µ	9.5	20-3000

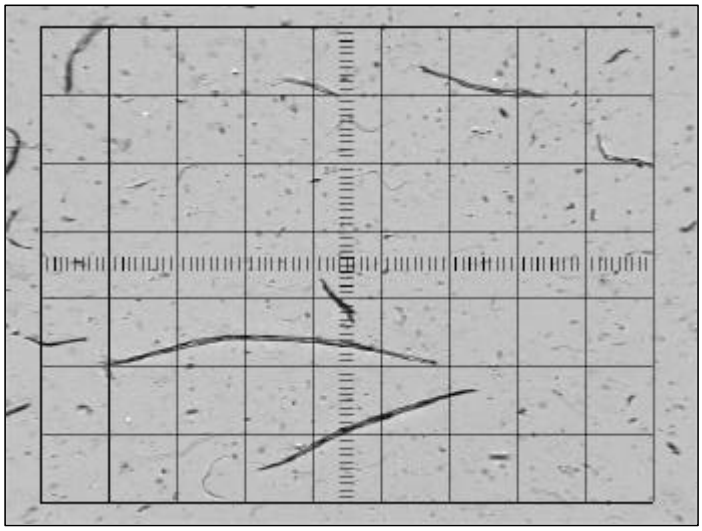

Figure 2 – Image of fibers in paper pulp

Summary

The CIS-100 produces variety of output presentation: Tables, Graphs, as shown in the figures below:

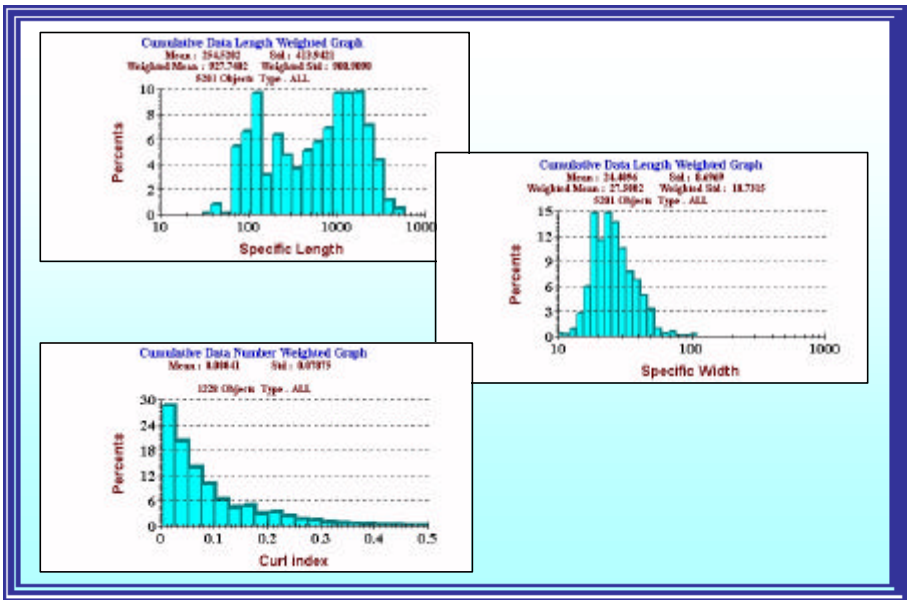

Figure 3 – Distributions of the Specific Length, Width (in microns) and Curling Index of fibers in paper pulp.

Undersize(%)	Specific Length(µm)
5.00	70.82
10.00	89.91
15.00	110.06
20.00	134.34
25.00	166.59
30.00	216.72
35.00	286.22
40.00	402.67
45.00	522.64
50.00	658.93
55.00	804.17
60.00	938.80
65.00	1079.32
70.00	1245.99
75.00	1426.57
80.00	1665.89
85.00	1906.30
90.00	2193.06
95.00	2690.65
97.00	2856.02
99.00	4033.57
100.00	5744.37

Undersize(%)	Specific Width(µm)
1.00	12.94
3.00	14.66
5.00	15.53
10.00	17.33
15.00	18.46
20.00	18.87
25.00	19.88
30.00	20.85
35.00	22.06
40.00	23.15
45.00	24.20
50.00	25.09
55.00	26.08
60.00	27.38
65.00	28.62
70.00	30.34
75.00	32.09
80.00	34.71
85.00	37.50
90.00	41.33
95.00	46.85
97.00	50.43
99.00	64.52
100.00	108.90

Undersize(%)	Curling Index
75.00	0.0018
80.00	0.013
85.00	0.035
90.00	0.066
95.00	0.13
97.00	0.18
99.00	0.26
100.00	0.44

Figure 4 – Various table outputs

Conclusion

Dynamic Shape Analysis is a very strong tool to characterize Fibres. Besides yielding information about fibre-length and fibre-width, Dynamic Shape Analysis provides information about fibre condition through additional parameters such as the Curling Index.

References

1. Aharonson; Karasikov, N.; *J. Aerosol Science,* ***1986****,* 17, 530-536

2. Karasikov, N.; Krauss, M.; Barazani, G., In *Particle Size Analysis,* Lloyd, P.J Ed.; John Wiley & Sons: New York **1988.**

3. Weiner, B. B.; Tscharnuter, W. W.; and Karasikov, N.; *Improvements in Accuracy and Speed Using the Time-of-Transition Method and Dynamic Image Analysis for Particle Sizing,* Theodore Provder, American Chemical Society, **1998**