SPECIFIC SURFACE AREA OF SOME STANDARD COTTON FIBER AND ITS RELATION TO PHYSICAL PROPERTIES

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Abstract

The specific surface area of 6 ICCS fibers, B-26, C-36, D-5, E-4, G-17 and I-26 was measured by means of methylene blue adsorption in liquid phase. The adsorption isotherm was hold at 25°C and during 24 hours. The concentration of methylene blue was in the range 0.004 - 0.18 g l^{-1} for each isotherm. The surface area of these standard cottons were found 32.32, 32.42, 34.48, 52.72, 43.96 and 29.91 m^2 g^{-1} respectively. Physical properties of these cottons such as crystallinity (determined by X-ray diffractoin) and fineness (measured by gravimetric method, FMT 3 and AFIS) were measured in order to establish the relationships between the surface areas of six standard cottons and their physical properties.

Introduction

The objectives of cotton fiber quality control are to apply the basic principles of physics, chemistry, biology and biochemistry to solve problems related to issues of cotton quality. Such objectives include : improvement of fiber propertie measurements, improvement in the methods of determining physical properties of fibers by high volume instrumentation (HVI) systems, better understanding of the relationships between structure/morphology to fiber and yarn strength and performances. In addition, the fibre quality is a major concern for all segments of the cotton industry. Physical prperties of cotton fiber serve as main predictors of performance. However, interpreting measurements have not always been successful when correlating fibre quality with results from processing. Specific surface area, which is defined as the accessible area of solid surface per unit mass of material, is one of the physical characteristics that is important for dyeing property.

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The purpose of this paper is to find, if exits, relationships between specific surface area measured by adsorption of methylene blue and the physical properties, including crystallinity, fineness, maturity, length of the fiber, tenacity.

Materials and Methods

The ICCS (International Calibration Cotton Standard) labelled B-26, C-36, D-5, E-4, G-17, and I-26 were used because their physical properties are quite different among them. All of the samples were conditioned at 21±1°C whith 65±2% of relative humidity (R.H.) during at least 24 hours, at the same conditions as for measurement of physical properties.

Specific Surface Area Measurement

Six standard cottons were measured for their specific surface area by the method of methylene blue adsorption at 25°C as described by Kaewprasit et. al., 1998. The concentration of methylene blue solution used is in the range 0.004-0.18 g l^{-1}. The concentrations of methylene blue solutions were calculated by measuring their absorbance at 660 nm on a Pye Unicam spectrophotometer.

Physical Properties Measurement

The fineness of cotton fiber were measured by gravimetric method, by FMT3 (Fineness Maturity Tester3, Shirley Developped. Limited) and AFIS (Advanced Fiber Information System from Zellweger Uster). Fibrograph was used to measure length parameters ; stelometer (1/8°) was used to measure strength or tenacity and elongation.

Crystallinity Measurement

X-ray diffractrometer, horizontal Goniometre Phillips PW1380 with Phillips PW1130/0 generator, was used to determine the percentage of crytallinity of cotton fiber. Ramie was used as a reference (Hermans 1949; Patil et. al., 1962 ; Khalifa et. al., 1991 ; Abdel-Rehim 1993). The preparation of cotton fiber sample and ramie was described by Kaewprasit 1997.

Results and Discussion

The value of specific surface area, measured by methylene blue adsorption in liquid phase, of six standard cottons, B-26, C-36, D-5, E-4, G-17 and I-26 are given in **table 1**. We note that there is a range of the values among the different types of cotton as the physical properties such as fineness, fiber length, maturity and tenacity.

The analysis of **table 1**, shows that there is a relationship between specific surface area and the fineness of cotton fibers.
The following numerical relationship of the form $S_{BM} = a + \frac{b}{H}$, was obtained where S_{BM} represents the surface area in m^2g^{-1}, H is the fineness of cotton fiber in mTex and a, b are the experimental numerical constants. Three

methods of fineness determination were realized. By gravimetric method, the numerical relationship obtained is : $S_{BM} = -6 + \frac{7112}{H}$, with R^2 = 75%.

By using the FMT3 instrument, the following relationship is found : $S_{BM} = 4 + \frac{5432}{H}$, with R^2 = 79%.

And finally by using AFIS systems, we obtain : $S_{BM} = -40 + \frac{10971}{H}$, with R^2 = 67%.

The relationship between specific surface area and the fineness seems very interesting since it enables us to propose a new reference method to calibrate specific surface area measurements obtained from a double compression air-flow instrument.

In addition, this relationship is comparable to that one determined by Lord in 1961, whith the advantage that it does not take the other parameters such as perimeter, diameter or thickness (which are not easy to evaluate) in account.

Further investigation is necessary before establishing a relationship between surface area and fineness. We investigated firstly all the parameters that could affect the value of specific surface area. Therefore, we decided to study the effect of percentage of crystallinity on the surface values. **Table 2** gives the specific surface areas in m^2g^{-1} and the percentages of crystallinity (% cryst.) of six standard cottons.

Figure 1 shows that it may exist a trend in the relationship specific surface area against crystallinity. As water molecule are adsorbed on amorphous region of cotton, there is an increase of degree of crystallinity when the amount of adsorbed water increase. The increase of surface area with the percentage of crystallinity increase could be ascribed to an increase of adsorbed water on each cotton fiber as estabiliched by Kaewprasit et al. 1999.

Concerning the other technological properties such as fiber length, maturity or tenacity, unfortunately, from this study there is no significant correlation.

Conclusion

Methylene blue adsorption was proposed to use as a method to estimate the specific surface area of cotton fibers. This specific surface area may be used as a direct characteristic for cotton fiber quality, since there is relationship between these surface area and its fineness.

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Table 1 : Specific surface area in m^2g^{-1} and the values of its physical properties.

	Cottons					
	B-26	C-36	D-5	E-4	G-17	I-26
S_{BM}	32.32	32.42	34.48	52.72	43.96	29.91
H						
gravimetric	139	165	153	134	144	216
FMT3	207	154	160	122	138	229
AFIS	151	138	137	126	135	165
Fibrograph (mm)	24.64	28.96	33.78	33.53	24.38	27.18
2.5%SL	24.64	28.96	33.78	33.53	24.38	27.18
50%SL	11.94	13.97	15.49	14.99	11.43	12.95
50/2.5 (%)	48	48	46	45	47	48
Maturity						
im	4.45	3.48	3.75	3.09	2.7	4.97
mr (M)	0.81	0.80	0.84	0.88	0.63	0.85
Tenacity						
stelometer	17.1	22.0	32.7	30.3	17.7	19.1

Table 2 : Specific surface area in $m^2 g^{-1}$, the percentage of crystallinity in %.

	Cottons					
	B-26	C-36	D-5	E-4	G-17	I-26
S_{BM}	32.32	32.42	34.48	52.72	43.96	29.91
%Cryst	76	75	77	79	75	70

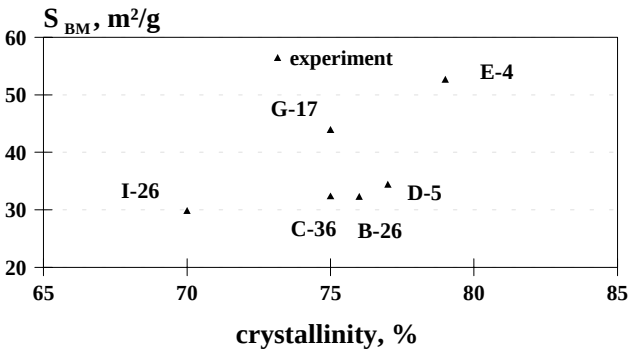

Figure 1. Relationship between specific surface area and crystallinity.