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Optimization of Thermal Behavior and Mechanical Properties of Green Shade Nets at Constant Temperature

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***Abstract* - To cover agricultural structures and living for protecting plants and peoples from high solar radiation in hot and sunny regions different types of shading nets are used. In summer, the amount of photosynthetically active radiation (PAR) transmitted through these nets usually fulfills plant growth requirements. However, the life of shade nets is still unknown. It is very important to find out the life time prediction of shade nets for its economical and efficient use. This paper presents a simple method to estimate the life time prediction by calculating the different parameter (like haze bursting pressure, dimensions, mass etc.) at 70^{0}C for 23 weeks, since atmospheric temperature in India always below 70^{0}C. All experiment work done on universal testing machine (UTM). Experiment is done on the five small samples of shade nets. Hot Air oven is used to maintain this constant temperature during experiment. Some loss of dimensions, mass and bursting pressure of shade nets is found.**

Keywords - Universal Testing M/C, Hot Air Oven Force Convention Type, Weighing Balance (Accurate) etc.

I. INTRODUCTION

Shade nets in the form of covering materials are widely used for different purposes in the agricultural sector. Like they are used to protect crops from hail, strong wind, snow, heavy rainfall, insects, birds and animals [1]. In common language, the term "shade" can be generalized to furthermore encompass any varieties of a particular color, whether technically they are shades In summer seasons, the photo synthetically active radiation(PAR; 400–700 nm) that is transmitted through net-covered structures(e.g., shade-houses) usually fulfils crop growth requirements because outside incident PAR is high. However, utilization of shade-houses for growing crops in winter is limited because the suitability of these nets for winter season applications is still unclear. Obviously, the amount of PAR inside the shade-house is one of the most important parameters related to protected cultivations at any time of the year. Thus, knowledge and exploitation of the Plastic net performances related to the incident PAR should be of great interest to growers, horticulturists, and agricultural engineers. However, very few studies were found related to PAR transfer through plastic nets or net-covered structures.

Fig. 1.1 – Shade Net

II. LITERATURE SURVEY

Castellano et al. [4] measured spectral transmittances of 12 different plastic shading nets under artificial direct and diffuse R. They used a large integrated sphere (1 m in diameter) and halogen lamps to simulate the normally incident direct PAR and fluorescent lamps to simulate the diffuse PAR. Also Kittas et al. [5] ed the integrating sphere-halogen-lamp technique to measure e spectral transmittance of four different plastic shading nets. Though the transmittance is strongly related to the incidence gle of the radiation, transmittances are often measured in laboratories at normal incident light. Sica and Picuno [6] measured spectral transmittance and reflectance of samples (200mm × 200mm) of different plastic nets in a short and a long-wave

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spectrum using o spectrophotometers. However, nets are non-homogeneous terials and it is often difficult to measure a small net sample using a spectrophotometer. This is because the light source in e-spectrophotometer is a concentrated ray with cross sectional mensions comparable to the mesh size of the net. Castellano et [7] measured the shading factor for 12 plastic shading nets by ng the Italian UNI10335 National Standard, which is the only tional standard in Europe providing a methodology to evaluate e shading factors of plastic nets. Revision of different types and applications of agriculture plastic nets [8] emphasized the need methods to measure and evaluate the radiometric properties of stic nets.

III. EXPERIMENTAL WORK

The properties evaluated using the guideline ASTM D 3045-1992 (Reapproved 2003). The various properties were evaluated with the heat exposure to 70°C for 23 Weeks. The Dimensions, Breaking Strength to Materials to Artificial Light, UV Resistance Test was observed before and after heat aging. The sample was drawn in the B-1,3,6,12,23 Weeks interval to evaluate the above properties. The schedule for the exposure and properties evaluated was given in Table 2.1 and Table 2.2.

Suggested Exposure Temperature °C	Reciprocal Temperature Degrees Absolute $1/TX10^3$	Estimated Limiting Temperature ^{A} t1, °C										
		40	55	70	85	100	115	135	155	180	210	240
50	3.09	A										
70	2.91	B	A									
90	275.	C	B	A								
105	2.64	D	C	B	A							
120	2.54		D	C	B	A						
130	2.48			D	C	B	A					
155	2.34				D	C	B	A				
180	2.21					D	C	B	A			
200	2.11						D	C	B	A		
225	2.01							D	C	B	A	
250	1.91								D	C	B	A
275	1.82									D	C	B
300	1.74										D	C
325	1.67											D

Table 2.1 - Suggested Temperature and Exposure Times for the Determination of Heat Ageing of Plastics

Estimated Limiting Temperature – The best estimate of limiting temperature available prior to the testing program. This may be based on prior knowledge of similar materials and many subsequently be amended on the basis of described short term data suggested exposure time:A-3,6,12,48 Weeks, B-1,3,6,12,23 Weeks,C-6,12,24,48,96day;D-2,4,8,16,32 days.

S.No.	Name Of The Property Evaluated	ASTM /IS Method	1 week	3 Week	6 week	12 week	23 week
1.	Dimensions	IS-14887					
2.	Mass	IS-1964:2001					
3.	Breaking Strength	IS-1969:1985					
4.	Bursting						
5.	Haze						

Table 2.2 - Properties Performance Evaluation and schedule

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MASS

GSM in Woven sack means grams per square meter it refers to the quality of material used in production. This can be calculated with average of five results.
Following equation is used to calculate the "GSM".

GSM = Mass per unit Area
Sample size: 200×200 (Unit: - mm)

DIMENSION

The tarpaulins shall be made to the shade and dimensions as specified in the contract or order. The following tolerance shall be permissible for length, width and mass.

BREAKING STRENGTH

The mass was done in accordance with the IS 1969 (1985). The greatest stress especially in tension that a material is capable of withstanding without rupture. Tensile strength measures the force required to pull something such as rope, wire, or a structural beam to the point where it breaks.

Sample size: 450×70 (mm)
TESTING M/C DETAILS
1 Universal Testing M/C
2 Hot Air Oven Force Convention Type
3 Weighing Balance (Accurate)

IV. RESULT AND DISCUSSION

In the present investigation the Breaking Strength was determined as a function of time with the constant exposure to the plastic product at 70°C for 15 week. The sample was initially determined the above properties and considered as 0 days sample or base property of the material. The sample was drawn in the interval of B-1, 3, 6, 12 and 15 Weeks. And show the haze chart in figure 4.1.

The regression analysis was conducted on the above test data and the prediction of the life span of the products was made as per ASTM. Use the regression equation to determine the exposure time necessary to produce a predetermined level of property change. An acceptable regression equation must have an r^2 of at least 80%.

Haze Obtained values						
TEST RESULTS OF PRODUCT AGEING @70^{0}C FOR 5 SAMPLE AS PER ASTM D3045-92						
S..no	Week	HAZE (%)				
1	Day 0	19	20	21	20	19
	Average			19.8		
2	week 1	20	19	19.5	20	20
	Average			19.7		
3	week 3	19.5	20	19	20	19
	Average			19.5		
4	week 6	19	20	19	19.5	18.5
	Average			19.2		
5	week 12	18	19	19	18	17
	Average			18.2		
6	week 23	17	18	16	17	18
	Average			17.2		

Table 4.1 – Product ageing at 70 ^{o}C for 5 samples.

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REGRESSION ANALYSIS OF HAZE

Prediction of time period for 80% deterioration Haze to the Average Haze values calculated for 23 weeks

Sl No	Xi	Yi	xi-x	yi-y	$(xi-x)^2$	(yi-y)2	(x-xi)(y-yi)
1	0	19.8	-7.5	0.866666667	56.25	0.751111111	-6.5
2	1	19.7	-6.5	0.766666667	42.25	0.587777778	-4.983333333
3	3	19.5	-4.5	0.566666667	20.25	0.321111111	-2.55
4	6	19.2	-1.5	0.266666667	2.25	0.071111111	-0.4
5	12	18.2	4.5	-0.733333333	20.25	0.537777778	-3.3
6	23	17.2	15.5	-1.733333333	240.25	3.004444444	-26.86666667
Sum	**45**	**113.6**	**0**	**-3.553E-15**	**381.5**	**5.2733333**	**-44.6**
Avg	**7.5**	**18.933333**					

Y=	b0+b1X
b1=	(SUM(X-Xi)(Y-Yi))/SUM(Xi-X)2
b0	Y+b1X
b1	-0.11691
b0	18.05653124
Y	**18.05653124-0.11691X**

Where

X-Time period

Y-Haze values for particular time period

Hence by above equation, the decrease of 80% of Avg. Haze values Predicted for 0-23 week is 5.6% per years appx.

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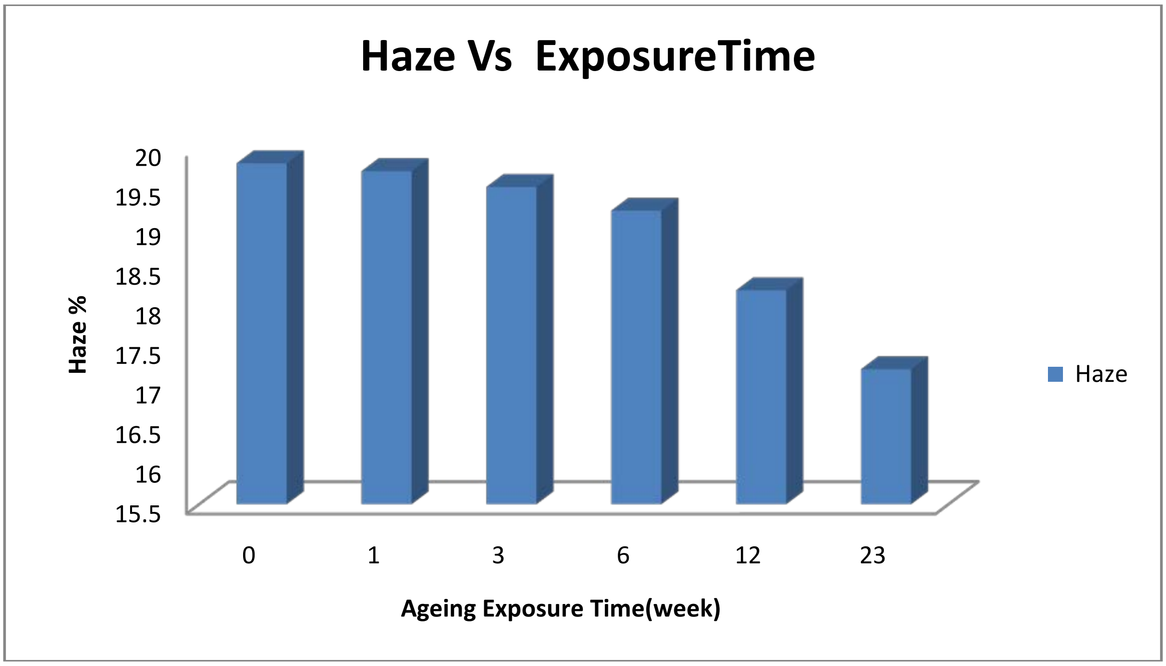

Fig. 4.1 – Haze Chart

V. CONCLUSION

The above studies have been done based on the **ASTM D 3045** and regression analysis was conducted on the properties obtained in the interval of time duration of B-1,3,6,12,15 Weeks. The analysis was shown the below prediction of the life time of the product:

S.No.	Property	Life span of the calculated regression analysis (Years)
1.	Haze	5.6%

The above properties are not directly affect the product life with respect to the time and hence can be omitted to predict the life time of the product.

Based on the above regression analysis and data interpretation generated after exposure to the product for the 70°C B-1,3,6,12,15 Weeks it was concluded that the Breaking Strength, haze can be considered for the prediction of life time of the product.

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