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Effect of dyeing on PA monofilament yarns used for Fishing Nets- A preliminary study

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ABSTRACT

Fishermen often dye their fishing nets to camouflage with water and also to increase sinking speed, abrasion resistance and knot stability. At present the natural dyes have been almost completely replaced by synthetic dyes. The effect of these synthetic dyes on the net properties has been reported less in India. This paper presents the results of a study on the effect of dyes on the polyamide monofilament (PA) yarns used for fishing net construction. PA monofilament yarn of 0.16 mm diameter, the most common material used for gill nets and cast nets is selected for the study. Six dyes popular among fishermen are selected for this study. The mechanical strength properties of dyed and un-dyed yarns are measured and compared. It is seen that the presence of dyes brings about perceptible changes in the properties of dyed yarns.

Keywords: Polyamide, Monofilament yarn, Breaking load, Elongation, Dyes

INTRODUCTION

Fishermen often dye their nets with different colours. In earlier days the net fibres as well as dyes used were natural. Cotton, sun hemp, Italian hemp, sisal, manila and coir were used for making gear and often natural preservatives were used which also attributed colour to the nets. Kuriyan and Nayar (1959) and Nayar and Naidu, (1962) studied the indigenous preservatives used by fisherman in India and their application to natural gear materials. The preservatives mainly selected for study were coal tar, Tannin, Garnols, Cuprinols, Cuminine.

The present day situation is different. The biodegradable natural gear materials are replaced by synthetic netting yarns and the natural dyes have been replaced by synthetic dyes. Presently nylon is the most common synthetic material used in gill netting. The main dyes that are applied on nylon are disperse, acidic and vat class of dyes. The natural colour of nylon is shiny white, visible in clear water (Carrothers, 1957). Nylon monofilaments are mainly used in monolining, gill nets and cast nets. Fishermen often dye their fishing nets to camouflage with water, to increase sinking speed, abrasion resistance and knot stability. However, the effect of dyeing on the properties of those materials is not much studied (Al-Oufi et al., Suganuma, 1979). The life of netting material treated with dyes is more compared to the untreated ones (Al-Oufi et al., 2004).In the Indian condition only few studies have been conducted on these lines (Gulrajani et al., 1980). The breaking load and elongation are important properties which have a direct influence on the durability as well as retention of gear configuration and mesh size. This communication deals with a preliminary study undertaken on the effect of acidic and alkaline dyes on the breaking load and elongation of PA monofilament yarn of 0.16mm diameter.

Materials and methods

Dyes were collected from different regions of India. The collected dyes were the most popular ones among the fishermen communities. Their colour and P^H were noted. A total of 17 dyes were collected from and were classified according to their pH values into acidic and alkaline dyes. Of these six important dyes, three each from acidic and alkaline category were selected for this study. Nylon monofilament of 0.16 mm diameter is selected for study. Each sample is scoured in water and dried. The dye bath was prepared using a 100:1 water-dye ratio following Gulrajani, et al., (1980). One gram of the selected dye is mixed with 100 ml of water. Dyeing was done by immersing the material for 1.5 hours at 70-80°C in the dye bath prepared. No additives were added during the dyeing process. After the required period of immersion the material was washed in flowing water. Then the material is dried at room temperature. The dyed, reference and undyed (control) samples were subjected to mechanical strength tests. The breaking load and elongation of the samples were measured as per IS: 5815:1993-part 4, using the Universal testing machine (AG-I, SHIMADZU Co.) of 10 kN capacity. The tests were conducted at standard atmospheric conditions. A reference sample was run in each case of dyeing viz., the samples were treated under conditions identical to the dyeing process except for the omission of the dye. A minimum of ten replicate tests were conducted on each sample. The data was analysed using SPSS Software for analysis of variance (ANOVA) to find out whether the dyes have any significant effect on breaking load and elongation.

Results and Discussion

The linear density of the PA monofilament yarn of 0.16 mm dia. taken for the study is 25.52 tex, breaking load 13.03 N and elongation 24.88 %. **Table 1** gives the properties of the dye and also the breaking load and elongation of the dyed materials along with the control and reference samples. Irrespective of the pH, all dyed samples showed change in breaking strength and elongation from the control. Except acidic I sample all the dyed samples showed an increase in breaking load from 1% to 8.3%. Acidic I had a 4.4 % decrease in breaking load. Reference sample also showed a 5.6% decrease in breaking load. In the case of elongation, all dyed samples showed increase in percentage elongation compared to control **(Fig: 1)**. Dyed samples showed 53.7% to 71.7 % increase in percentage elongation compared to control. Reference sample also showed 66.8% increase in elongation. However, no difference was observed between acid and alkaline dyes. There is significant difference between control and all the dyed materials with reference to elongation ($p<0.01$). This shows that dyeing bring about appreciable change in elongation.

Table. 1 Properties of Dyes and breaking load & elongation of dyed, reference and control samples

Colour of the dye	Nature of dye	pH	Code of the material	Breaking Load (N)	Elongation (%)
----	----	----	Control	13.03	24.88
----	----	----	Reference	12.30	41.51
Pink	Acidic	3.35	Acidic I	12.46	40.61
Brown	Acidic	5.85	Acidic II	13.21	38.25
Green	Acidic	4.35	Acidic III	14.11	41.53
Orange	Alkaline	10.25	Alkaline I	13.15	42.71
blue	Alkaline	9.93	Alkaline II	13.56	42.25
Yellow	*Alkaline*	9.9	*Alkaline III*	13.85	42.73

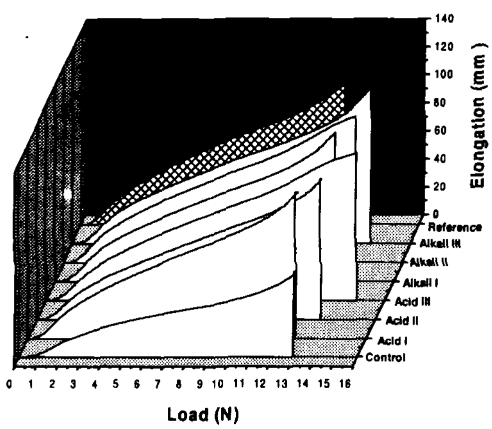

Fig:1 The load elongation studies of the dyed materials along with the control and reference

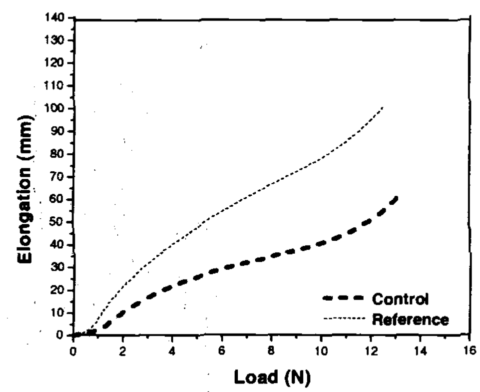

Fig:2 Load- elongation behaviour of the control and reference

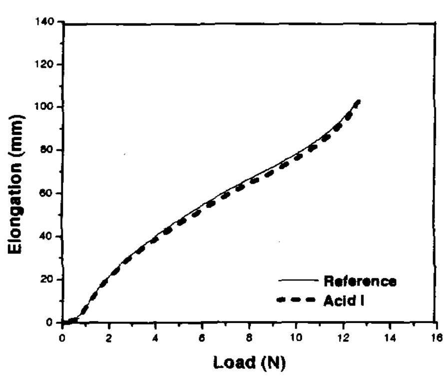

Fig:3 Load- elongation behaviour of the reference and acid I dye

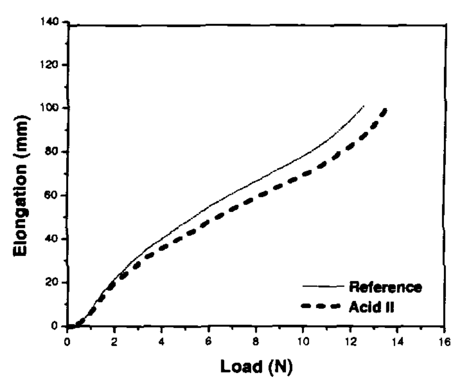

Fig:4 Load- elongation behaviour of the reference and acid II dye

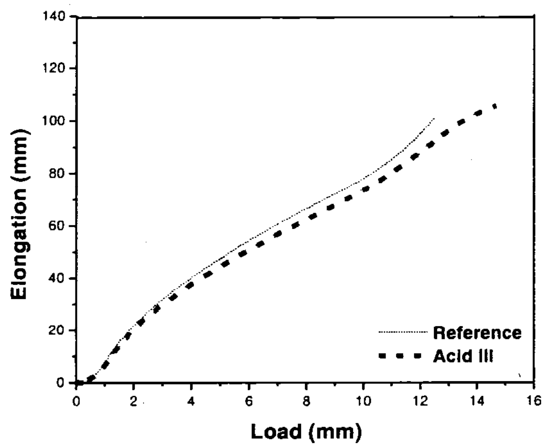

Fig:5 Load- elongation behaviour of the reference and acid III dye

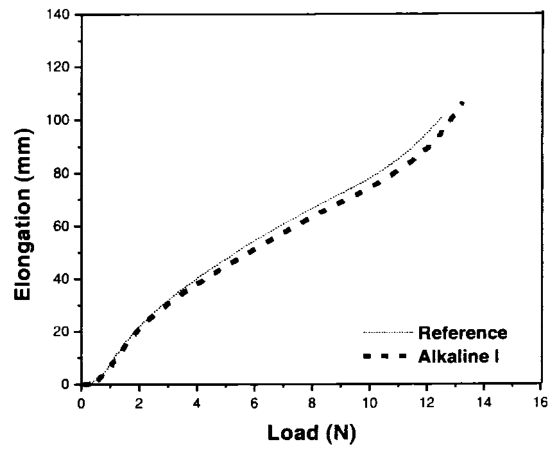

Fig:6 Load- elongation behaviour of the reference and alkaline I dye

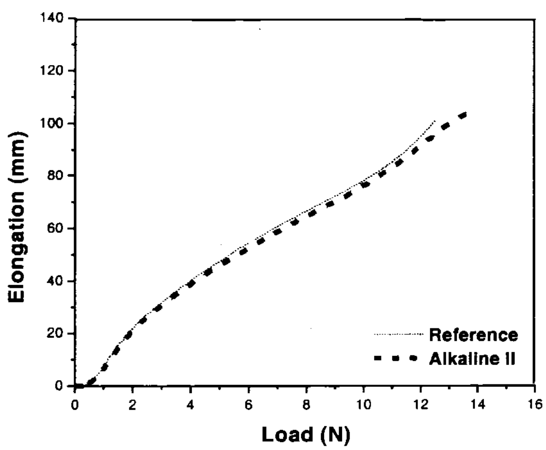

Fig:7 Load- elongation behaviour of the reference and alkaline II dye

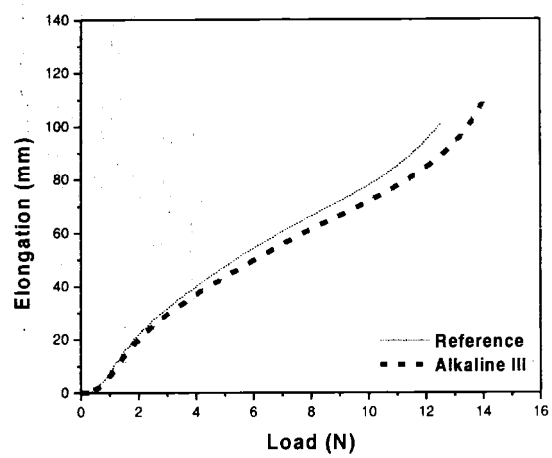

Fig:8 Load- elongation behaviour of the reference and alkaline III dye

A comparison of the control and reference sample showed significant difference between control and reference sample with reference to breaking load ($p<0.05$) and elongation ($P<0.01$). This shows that the dyeing process itself had a significant influence on both breaking load and elongation. **Fig: 2** also indicate the difference in the load elongation curve of the control and the reference. To find out whether the dye had any significant influence on the material in addition to the dyeing process, ANOVA between reference and dyed samples was carried out with reference to the breaking load and elongation. In the case of breaking load, significant difference between reference and dyed samples at 5% level was observed in the case of Acidic II and Alkaline I and at 1% level in the case of Acidic III, Alkaline II and Alkaline III. Figures 4 to 8 clearly shows the deviation of the load elongation curve from the reference. However Acidic I showed no significant difference. Load elongation curve of reference and Acidic I showed no appreciable difference from the reference **(Fig: 3).**

In the studies conducted by Suganuma (1979), there is no marked difference between the disperse dyes and acid dyes in the case of breaking load. But Gulrajani et al., (1980) reported that there occurs a change (either increase or decrease) in the breaking load of the dyed material. In the present study also there is a change in the breaking load in the case of dyed and undyed material as reported by Gulrajani et al., (1980). As suggested by Gulrajani et al., (1980), the change in breaking load by alkaline dyes may be due to the physical hindrance by the dye molecules to the movement of molecular chains of the fiber and for acidic dyes this is due to the strong ionic bond between the fiber chain and the dye molecule. There is a change in elongation between the dyed and undyed fibres. Also elongation increased significantly in the case of reference sample too. Thus it can be concluded that dyeing process brings about more effect on the elongation of PA monofilament yarn than the dye itself. Even though Gulrajani et al., (1980) did run a reference sample, finding similar to the present study was not reported. The results from the present study have prominent significance as a far as fishing gear is concerned. When a gear made of PA monofilament is dyed and there is change in the elongation then it affects the performance of the net during its use. But the heat setting which is done during the manufacturing of PA monofilament nets can reduce the impact on elongation that occurs during dyeing. Since the classification of dyes based on the pH value is only at the preliminary stage, further study is needed on the chemical properties of the dyes. Studies are also required to assess the effect of dyeing on other properties of the material.

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