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DETERMINATION OF MESH BREAKING STRENGTH OF POLYAMIDE FISHING NETS UNDER THE EXPOSURE OF BENZINE, DETERGENT, SALT AND LIGHT

ABSTRACT

This study deals with the determination of breaking strength of polyamide cage fishing nets under the exposure of salt, light and varying environmental pollutants such as benzine and detergent. A series of experiments under varying conditions was carried out in order to determine breaking strength that is of a great importance in ensuring correct performance of a particular gear. Breaking strength values of the 39/14 fishing net samples which were held in benzine, detergent and dry salt at room temperature for 1 to 5 months are found to decrease with time. Loss of breaking strength values with detergent, benzine and dry salt resulted respectively as 10.09%>6.475%>3.39%. According to results, it can be generalized that detergent is the most abrasive pollutant. In laboratories conducting tests on fishing nets using detergent, benzine and salt the duration of the test should be lasted at least 5 months. No remarkable change with a slight loss of strength value of 0.36% observed in 36/18 fishing net samples which were exposed artificial sun light for 300 hours (Equals 2700 hours of sunlight exposure). It can be concluded that this result proved the fact of PA nets are very durable against sun light. The results of this study point out that the test conditions in laboratories duration and chemicals have a great impact on the results of tests. Pollutants such as detergent and benzine can noticeably decrease the strength of fishing nets and affect the productivity and Effectiveness of Fishing Operations.

Keywords: Fishing Net, Polyamide, Mesh Breaking Strength, Pollution, Detergent

1. INTRODUCTION

"Fisheries have developed continuously over the centuries, utilising improved and larger ships, more sophisticated fishing equipment and catch preservation techniques. Modern fishing has developed through three main technological revolutions such as development of mechanization, fish finding equipments and synthetic fibres." (FAO, 2005; Ramos, 1999; Sainsbury, 1996).

"Synthetic fibres are man-made from fibres, which have been produced entirely by chemical synthesis from simple basic substances. As compared with vegetable fibres they are of beter uniformity and continuity, have higher breaking strength and are more resistant to rotting. The chemical groups of synthetic fibres that are used in fishing gear are Polyamide (PA), Polyester (PES), Polyethylene (PE), Polypropylene (PP), Polyvinyl Alcohol (PVAA) and Dyneema" (Ramos 1999; Klust 1982).

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"Deterioration of a polymer is defined as embrittlement and/or loss of physical integrity of a polymer regardless of the mechanism which brings about these changes. The deterioration process might be the result of either a chemical or physical process. Degradation is deterioration which results from a chemical process. Degradation might be further subdivided, based on the agency causing the chemical change. Materials exposed to various elements of weather typically are degraded most often by sunlight, thermal effects, moisture. In addition other factors such as air contaminants, oxygen, salt etc can also contribute to degradation. Degradation due to slow oxydation of the plastic, especially at elevated temperatures is thermooxydative degradation while that due to the chemical action of water is hydrolitic degradation or hydrolysis. Polymers such as PC, Nylon, and acrylics are sometimes damaged by moisture through hydrolysis. The non-chemical deterioration processes might be subdivided. Dissolution or swelling in the water in which no chemical changes take place. In physical deterioration, a plastic loses strength due to purely physical phenomena. Rate of degradation at sea is different from that on land. High humidity is known to accelerate the rates of degradation of several classes of plastics. This may be brought about by the plasticizing action of small quantities of sorbed water leading to increased accessibility of the matrix to atmospheric oxygen or by the leaching out of stabilizing additives from the formulation. The higher temperatures generally result in an acceleration of light induced degradation and may even be high enough to induce significant thermooxidative degradation. Plastics at sea will not suffer from such heat buildup and may consequently undergo slower oxidative degradation and photodegradation. Many of the material failures are caused by the exposure of materials to the environmental conditions. The effects of weather on the properties of materials are of considerable technical and commercial importance. The main objectives for testing under simulated environmental conditions in laboratory instrumentation are to conduct the tests under more controlled and accelerated conditions as compared to outdoors exposure" (Andrady 1990; Wypych and Faulkner 1999; Boxhammer 1999a; Boxhammer and Scott 1999; Summers and Rabinovitch 1999; Boxhammer 1999b; Masters and Bond 1999)

2. RESEARCH SIGNIFICANCE

Since research work on the effects of salt, light and varying environmental pollutants such as benzine and detergent on the fishing net material is very limited, this study may light the way for future research works. Results of this study can be benefited by testing and research laboratories in their testing and method validation activities and in practice, by the users of fishing nets.

3. EXPERIMENTAL METHOD-PROCESS

3.1. Materials

In this study, fishing nets made of polyamide were exposed to various factors such as detergent, regular benzine, dry salt and light in order to determine the effects on the breaking strength of meshes of nets. The tests were carried out in Turkish Standards Institution (TSE) Denizli Regional Directorate Textile Laboratories. 39/14 (Netting yarn 3.9mm in diameter and 14mm mesh) and 36/18 (Netting yarn 3.6mm in diameter and 18mm mesh, for only artificial sun light test) knotless multiflament Polyamide 6.6 (PA) fishing nets produced for the containment of farmed fish has been used. The mentioned material was imported by the Turkish firm "Delta" from "Remer S.r.l." in Italy. 39/14 type netting material was used for tests conducted by salt, benzene and detergent and 36/18 type netting material was used only for Xenon arc light test. Tests on the breaking strength of meshes were conducted at a temperature of 20°C±2°C and a relative humidity of 65±2%, which are required for the testing of textile products and specified in the TS EN ISO 139 Standard (Turkish Standards Institution 2006). In the TSE Denizli Textile Laboratory, where the tests were made, is a conditioning room where the conditions in question are maintained and recorded 24 hours a day. The tests were carried out using the breaking strength device available in this room. The test results were obtained by carrying out tests of the breaking strength of individual meshes within a certain area of netting with minimum 10 mesh measurements and calculating the mean values. The fishing nets used in the tests were split carefully with scissors without any damage to the meshes.

3.2. Measurement of Dry/Wet Mesh Breaking Strength

Dry mesh breaking strength has been defined as the maximum force measured during a tensile test on meshes of netting in standard atmosphere. The principle of the method is extending a mesh until it ruptures under the applied load (Turkish Standards Institution 2004, British Columbia Ministry of Agriculture, Food and Fisheries 2002). In case of testing wet mesh breaking strength, netting material has been immersed the liquid and surplus water shall be shaken off at the end of test period. The tests were conducted using a load cell with a maximum load capacity of 1000 N (with the serial number UK 225) in an INSTRON-England branded 4465 model breaking strength test device having a fixed elongation rate, in accordance with the TS 6246 EN ISO 1806/2004 standard and mesh breaking strength method. The tests were carried out by adjusting the jaw speed of the device in such a way that the breaking time would be 20±3 seconds. The meshes were tied to the jaws of the device using rings. The mesh was placed in the rings in such a way the mesh would not come into contact with the buttons. As required by the standard, the values obtained from the testing of meshes that do not break at the knots were not included in the calculation. The results were read digitally on the display of the device and recorded.

3.3. Holding in Benzine

Samples in the form of meshes of netting kept as soaked in normal leaded benzine at room temperature in the borosilicate conical flask were taken out at certain times and subjected to testing. The samples to be taken out and tested last remained in benzine for periods of 1 to 5 months. The samples were taken out of benzine and then tested.

3.4. Holding in Detergent

Samples in the form of meshes kept as soaked in LAB (Linear Alkyl Benzene) based liquid dish-washing detergent at room temperature in the borosilicate glass beaker were taken out at certain times and subjected to testing. The samples to be taken out and tested last remained in detergent for periods of 1 to 5 months. The samples were taken out of detergent and then tested.

3.5. Holding in Salt

Samples in the form of meshes kept as soaked in dry salt in the borosilicate glass beaker at room temperature were taken out at certain times and subjected to testing. The samples to be taken out and tested last remained in salt for periods of 1 to 5 months. The samples were kept in the conditioning room for a period of at least 1 day after they were taken out of salt and then tested.

3.6. Holding Under Effect of Light (Xenon Arc Lamp)

This test was carried out on fishing net samples in the form of netting placed in the testing chamber of the device by suspending them on test apparatus using a Heraeus/Germany branded Xenotest 150 S model air-cooled test equipment under exposition to normal light conditions in accordance with the TS 1008 EN ISO B02:2001 standard (Turkish Standards Institution 2001). The samples placed in the device for certain periods were taken out and subjected to test. At the end of the test period, the samples were kept in the conditioning room for a period of at least 1 day and then tested for breaking strength. One-hour xenon arc lamp effect is equal to the effect of remaining under daylight for 9 hours.

4. FINDINGS AND DISCUSSIONS

Related data obtained from the experiments are given in the Tables 1-4 and Graphics 1-4.

Table 1. Mean values of breaking strength of 39/14 fishing net samples holding in glass containers after exposure of benzine at room temperature for 1 to 5 months (N, Newton; Number of measurements, n=18), (Mean breaking strength of untreated 39/14 samples is 409.88 N±33,693 n=25)

	1 Month	2 Months	3 Months	4 Month	5 Months
Mean	406.0944	410.20556	410.3263	402.6611	383.3444
±Std. Dev	42.746	49.269699	30.28929	37.62471	77.28555

Table 2. Mean values of breaking strength of 39/14 fishing net samples holding in glass container after exposure of detergent at room temperature for 1 to 5 months (N) (n=18), Mean breaking strength of untreated 39/14 samples is 409.88 N±33.693 (n=25)

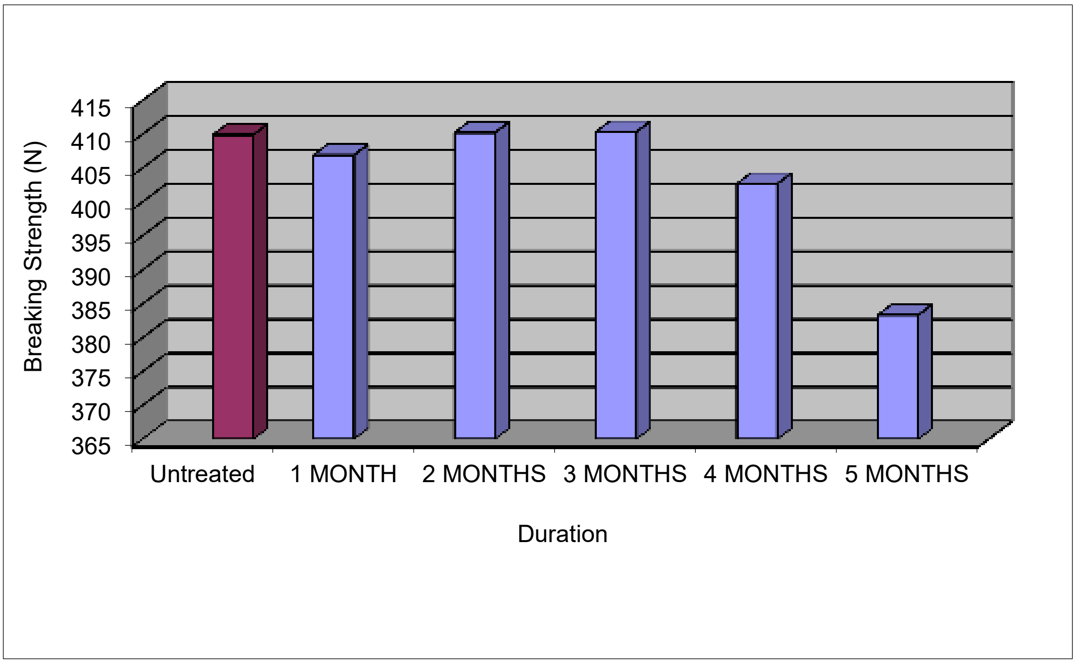
	1 Month	2 Months	3 Months	4 Month	5 Months
Mean	410.2722	399.62222	384.7294	384.0765	368.5118
±Std. Dev	30.12771	27.591998	31.66277	35.18266	61.33246

Table 3. Mean values of breaking strength of 39/14 fishing net samples holding in glass container after exposure of dry salt at room temperature for 1 to 5 months (N) (n=18), Mean breaking strength of untreated 39/14 samples is 409.88 N±33.693 (n=25)

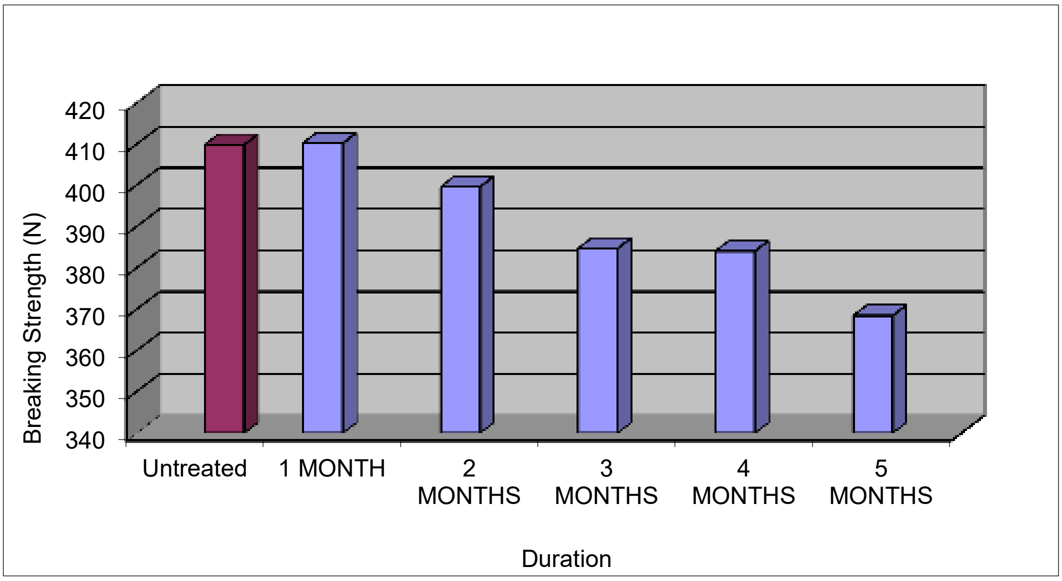
	1 Month	2 Months	3 Months	4 Month	5 Months
Mean	413.4211	410.47778	410.7526	399.7556	395.9611
±Std. Dev	44.98887	31.749717	27.5756	33.07215	41.82947

Table 4. Mean values of breaking strength of 36/18 fishing net samples after exposure of artificial sun light for different periods (N) (n=10), Mean breaking strength of untreated 36/18 samples is 461.45 N±22.900 (n=50)

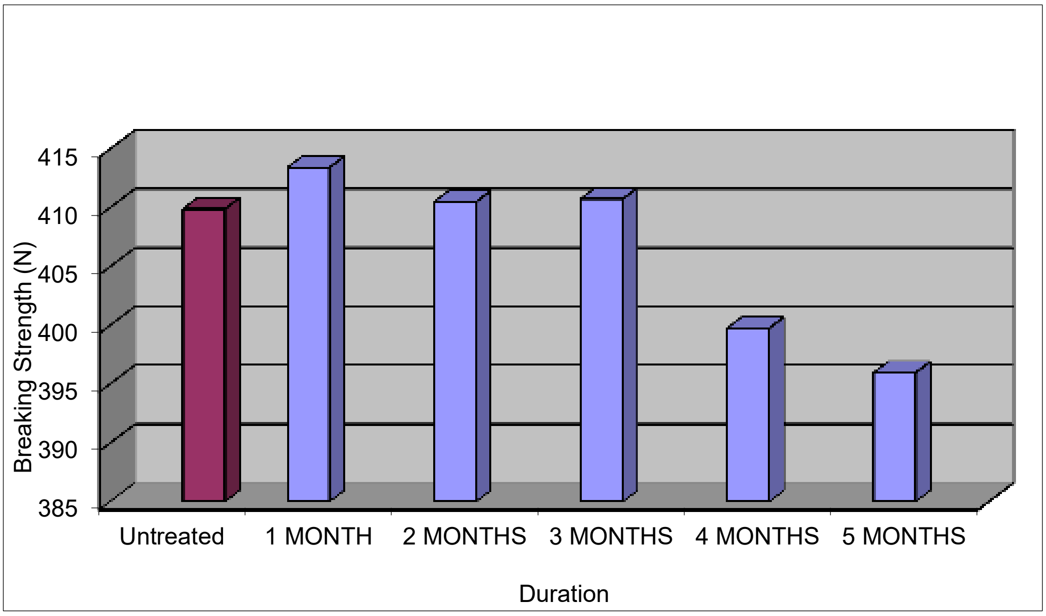
	40 Hours	160 Hours	200 Hours	300 Hours
Mean	461.23	459.76	462.5	461.66
±Std. Dev	28.63828	21.74336	22.63326	21.70173



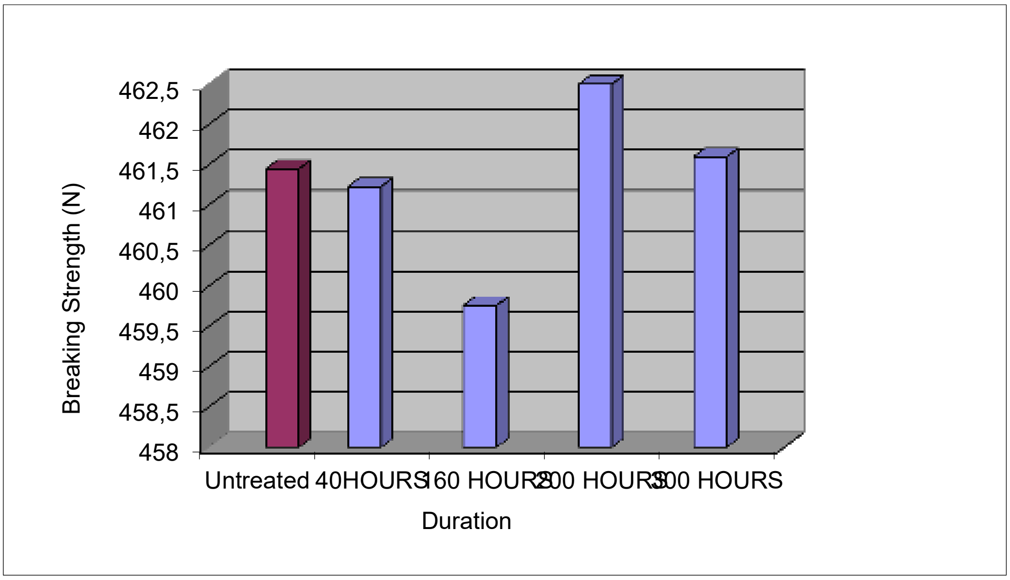
Graphic 1. Mean Values of breaking strength of 39/14 fishing net samples holding in glass containers after exposure of benzine at room temperature for 1 to 5 Months (N)



Graphic 2. Mean values of breaking strength of 39/14 fishing net samples holding in glass containers after exposure of detergent at room temperature for 1 to 5 months (N)



Graphic 3. Mean Values of breaking strength of 39/14 fishing net samples holding in glass container after exposure of dry salt at room temperature for 1 to 5 months (N)



Graphic 4. Mean values of breaking strength of 36/18 fishing net samples after exposure of artificial sun light for different periods (N)

Related data obtained from the experiments conducted in order to determine the mesh breaking strength of fishing net samples under varying laboratory conditions were statistically evaluated by using the technique of Repeated Measurement Multi Factor Analysis of Variance (ANOVA) (Düzgüneş, et. al., 1999; Zar, 1999). The results of statistical analysis applied on data obtained from the study are as following:

In the experiment which conducted in order to determine breaking strength of 39/14 fishing net samples holding in glass containers after exposure of benzine, detergent and dry salt at room temperature for 1 to 5 months, there are 3 levels of the factor of method which are consisting of benzine, detergent and salt. The factor of duration has 5 levels which are consisting of 1, 2, 3, 4 and 5 months. Repeated measurements have been conducted on the levels of the factors of duration. The Duncan's Test has been used in order to determine the differences among the means of groups. According to the results of Analysis of Variance, the interaction between the factors of duration and method and differences of the means of the factor of duration were not found statistically significant.

There is no difference among the mean value of untreated sample and mean values of samples treated with benzine and salt for different periods. On the other hand, difference has been detected among the mean value of untreated sample and mean values of samples treated with detergent for 3 months, 4 months and 5 months ($P<0.05$).

Related data obtained from the experiments conducted in order to determine the breaking strength of 36/18 fishing net samples after exposure of artificial sun light (Xenon arc lamp) for different periods were statistically evaluated by using the technique of Repeated Measurement Multi Factor Analysis of Variance (ANOVA). According to the results of Analysis of Variance, the differences among the mean levels of duration factor were not found statistically significant. Similarly, there is no difference among the mean value of untreated sample and mean values of samples treated with Xenon arc lamp for different periods.

5. CONCLUSION AND RECOMMENDATIONS

Taking the data obtained from the experiments into consideration, it can be inferred that; breaking strength values of the 39/14 fishing net samples held in benzine, detergent and dry salt at room temperature for 1 to 5 months, decrease depend on the duration. Loss of breaking strength values with detergent, benzine and dry salt resulted respectively as 10.09%>6.475%>3.39%. According to results, it can be generalized that detergent is the most abrasive pollutant. Laboratory tests conducting on fishing nets by using detergent, benzine and salt should be lasted at least 5 months in order to observe abrasive effects of these pollutants. These results also agree with that reported as high humidity is known to accelerate the rate of degradation (Andrady, 1990; Wypych and Faulkner, 1999; Boxhammer, 1999a; Boxhammer and Scott, 1999; Summers and Rabinovitch, 1999; Boxhammer 1999b; Masters and Bond 1999).

The possible cause for detergent is more abrasive than benzine is detergent's accessibility to stabilizing compounds in the net yarn and leaching out them. Since netting yarn is a derivative of petroleum, benzine has more consistent chemical composition with it. Dry salt has had the weakest abrasive effect since it's more inert and simple nature and its low water content.

No remarkable change with a slight loss of strength value of 0.36% observed for 36/18 fishing net samples which were exposed artificial sun light for 300 hours (Equals 2700 hours of sunlight). It can be concluded that this result proved the fact of PA nets are very resistant to sunlight.

In the light of the results and discussion, pollutants such as detergent and benzine which are also currently present in aquatic environments, can substantially decrease the strength of fishing nets and affect the productivity and effectiveness of fishing operations. In the light of results, it is advisable that fishing nets are not stored unless they are cleaned and aerated properly following their usage.

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