A) Related Publications:


B) Others:


Appendix - II

REPRINT OF IMPORTANT PUBLICATION
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Abstract

Very few studies have been conducted to analyse physical and mechanical properties of fishing hooks. The present work is an account of a study carried out on five major brands of number seven round bent fishing hooks available in India, which are used to harvest tuna and medium sized fish resources. We have selected three imported and two indigenous brands of fishing hooks. The dimensional characteristics and unbending force as tensile load for deformation of the hook bend equal to its bite length were investigated. The mechanical strengths of the fishing hooks studied were highly varied and brand IB-1 recorded the highest unbending force of 275.9 N. It was found that the unbending test method employed to analyse the mechanical strength of fishing hook in this study is in agreement with the actual performance by the fishing hooks in the field and this test could be effectively used to evaluate mechanical strength of fishing hooks.

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Keywords: Mechanical properties; Fishing hooks; Metals and alloys; Unbending test; Deformation; High carbon steel

1. Introduction

Hook and line fishing is a highly selective low energy fishing method and is well suited for the exploitation of sparingly distributed fishes. It is one of the most ancient fishing techniques, which is still in use all over the world [1]. Fishing hooks form the indispensable part of any hook and line fishing system. Modern day fishing hooks are manufactured from high carbon steel wire [2,3]. The characteristic bend of fishing hook is formed by physically bending the wire to the desired shape and style. The most important step in hook manufacture is the tempering of the hook in which the hook is hardened to improve strength. This process hardens the metal and substantially increases its resistance to unbending, resulting in strong hooks with reduced brittleness. The resistance of fishing hooks towards unbending force is a very essential property as far as fishing hooks are concerned. But we have found that references of such studies are very limited. Most studies carried out were focused towards fishing efficiency of different fishing hooks [4–6].

Properties like hook shape, hook size and mechanical strength of the hook bend have a direct influence on the fishing performance of the hook. The fishing hooks available to the fishermen are not uniform in their physical and mechanical properties and a high degree of variation is seen between different brands. These variations could be attributed to difference in the steel wire used for manufacture of hooks and differences in hook manufacturing process [2,3]. Kitano et al. [7] studied the corrosion resistance of tuna long line fishing hooks. Ko and Kim [8] tested six types of fishing hooks for breaking and unbending due to plastic deformation of the material using dynamometer. They have also studied the dynamic forces acting on the fishing hook during hooking and hauling. Varghese et al. [9] studied the physical properties as well as corrosion resistance of fishing hooks from five indigenous hook manufacturing firms and that of one imported brand. It is difficult to compare between different brands of fishing hooks and there are no standard methods available to test the mechanical strength of fishing hook. Often fishermen have to depend on their experience while selecting a fishing hook. So a comparative study of these hooks would help the fishermen in selecting fishing hooks with better mechanical properties and performance. Here an attempt is made to compare the physical and mechanical properties of five different types of fishing hooks.
2. Experimental

Number seven size round bent fishing hook was selected for the comparative study, as it is commonly used by the fishermen for catching fishes like tuna and medium sized fishes. These are three imported brands, coded as FB-1, FB-2 and FB-3 and two indigenous brands, coded as IB-1 and IB-2. The physical dimensions of the hooks were measured as per IS: 9860 (Part I) — 1981 [10]. The general terminology used in fishing hook and different parts of a typical fishing hook is given in Fig. 1. The various parts of a typical fishing hook are eye, shank, bend, gape, bite, point and barb.

Wire diameter measurement of fishing hook was taken on the round unforged portion of the shank using a micrometer (Mitutoyo, $d=0.01$ mm). Microstructural observations of the samples were made after polishing and etching with 5% nital solution (using ‘Leica MZ16 A’ light microscope). Unbending resistance of fishing hook was taken as a measure of mechanical strength in their functional form. Unbending test is a modified form of conventional tensile test wherein the force required by the hook bend to develop a deformation equal to its bite length was measured using Shimadzu AG-I 10 kN Universal Testing Machine (UTM), with a cross head speed of 25 mm/min as per Varghese et al. [9] (Fig. 2). This test gives a measure of the force a hook bend can withstand. The deformation of hook bend equal to bite length was taken as the standard as any deformation beyond this point will render it useless for fishing. The results of the unbending test were verified with the feedback taken from fishermen about the mechanical performance of fishing hooks under use.

3. Results and discussion

Chemical composition and physical properties of studied fishing hooks are given in Table 1. No significant variation was observed among the five types of hooks studied with respect to total length, hook wire diameter, gape and bite (Table 1 and Fig. 3). However, significant variation was noticed in their unbending force.

All the five types of hooks had almost uniform hook wire diameters and variation was insignificant. The unbending force of the five types of hook is shown in Fig. 3. Out of the five types of hooks, the indigenous brand IB-1 recorded the highest unbending force, 275.9 N while IB-2 recorded the least (Fig. 3). On statistical analysis, brand FB-1 is found to be significantly different from brands FB-2 and IB-2 in terms of unbending force. Similarly brand FB-2 is significantly different from FB-3 and IB-1, brand FB-3 is significantly different from IB-2 and brand IB-1 is significantly different from IB-2. It was found that the unbending force of fishing hooks is positively correlated with their wire diameter (Fig. 3).

The fishing hooks were classified as ‘excellent’, ‘good’ and ‘poor’ with regards to their mechanical strength based on the feedback collected from fishermen who are using these hooks. According to this, brands FB-1 and IB-1 were excellent, brands FB-2 and FB-3 were good and brand IB-2 was poor in their mechanical performance in the field. This is in agreement with the unbending test results with exception of FB-2 which showed poor mechanical strength in unbending test.

The deviations in mechanical strength among the five types of fishing hooks studied could be due to the different material compositions and heat treatment given during manufacturing process. In light microscopy we found that the hooks with high mechanical strength had a uniform fine grain-sized microstructure when compared to IB-2 (Fig. 4). Mechanical strength of a fishing hook bend is very critical for successful fishing. This is more important in the hook and line fishing of large fast moving fishes like tuna. These fishes will transfer lot of kinetic energy to the fishing hook while hooking and this could lead to hook failure, which ultimately results in loss of the catch. Varghese et al. [9] carried out the unbending test of fishing hooks by recording the load required for deformation of the hook bend. Varghese et al. [9] reported that indigenous fishing hooks were fragile and could be easily deformed under load when compared to imported brands of fishing hooks.

<table>
<thead>
<tr>
<th>Chemical composition (wt.%)</th>
<th>FB-1</th>
<th>FB-2</th>
<th>FB-3</th>
<th>IB-1</th>
<th>IB-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manganese (Mn)</td>
<td>0.51</td>
<td>0.62</td>
<td>0.64</td>
<td>0.76</td>
<td>0.65</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>0.02</td>
<td>0.04</td>
<td>0.06</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>0.01</td>
<td>0.08</td>
<td>0.07</td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>0.02</td>
<td>0.02</td>
<td>0.04</td>
<td>0.10</td>
<td>0.01</td>
</tr>
<tr>
<td>Carbon (C)</td>
<td>0.57</td>
<td>0.76</td>
<td>0.69</td>
<td>0.83</td>
<td>0.76</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical properties</th>
<th>FB-1</th>
<th>FB-2</th>
<th>FB-3</th>
<th>IB-1</th>
<th>IB-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total length (mm)</td>
<td>41.70</td>
<td>40.00</td>
<td>39.00</td>
<td>39.50</td>
<td>40.30</td>
</tr>
<tr>
<td>Gape (mm)</td>
<td>15.00</td>
<td>15.90</td>
<td>15.40</td>
<td>15.10</td>
<td>15.10</td>
</tr>
<tr>
<td>Bite (mm)</td>
<td>16.90</td>
<td>17.50</td>
<td>17.30</td>
<td>17.00</td>
<td>16.10</td>
</tr>
</tbody>
</table>

Fig. 1. Parts of a typical fishing hook.

Fig. 2. Unbending test of fishing hook using UTM.

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fishing hooks. But the present study indicates that indigenous brands are equally good in mechanical strength.

The imported brands of fishing hooks are costly, compared to the indigenous brands of the same size. However, fishermen are more inclined towards the imported brands, apparently due to the brand loyalty acquired over the years, much before the indigenous brands came into the market. It is clear from the study that indigenous brands are comparable with imported brands of fishing hooks with respect to their physical and mechanical properties. Since unbending test results were in conformance with the mechanical strength performance observed in the field, unbending test could be used for the selection of most suitable fishing hook from different types of hooks as per the requirements.

4. Conclusions

After analysing the physical and mechanical properties of the five types of fishing hooks, we have made the following conclusions:

(1) Unbending test could be used as an effective tool in analysing the mechanical properties of fishing hooks.
(2) In unbending resistance, the indigenous brand IB-1 is found to be comparable with the imported brands FB-1 and FB-3. Moreover, IB-1 showed higher unbending resistance than brands IB-2 and FB-2.

(3) The wire diameter and the unbending force of fishing hooks are positively correlated.

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References


