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Snood Wire Attachment Enhances Corrosion in Fishing Hooks

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Abstract

Longlining is an important fishing method targeting sharks, tuna, seer fish etc. Fishing line is tied to high carbon steel hook using stainless steel snood wire in order to avoid large carnivorous fishes from biting off the hook. Corrosion is a major problem with hooks and often the hook fails at the eye region where the line is attached to the hook. How the attachment of metallic snood wire affects the hook in terms of corrosion is communicated here. Number 7, Round bent (J shaped) hook was used in this study. Corrosion rate of snood wire-rigged hooks was evaluated by exposing them to accelerated corrosion testing condition (salt spray as per ASTM B117-03-2003). The snood wire rigged hooks recorded substantial weight loss on exposure to salt fog for 300 h compared to control hooks (without snood wire attachment). Correspondingly, snood wire-rigged hooks displayed a corrosion rate of 109.316 mpy (mills per year) against the control hooks witha rate of 60.214 mpy ($p<0.05$).

Keywords: Corrosion rate, salt spray, fishing hooks, snood wire

Introduction

Hook and lines, the widely used fishing gear is considered to be the simplest among fishing gears. The catch from hook and line contribute about 2% of the fish landings in India (Radhakrishnan et al., 2016). Long lines are quite efficient for catching large predatory fishes, especially the deep water fishes (Olsen, 1995). As far as line fishing is concerned, among the different advantages it have, larger fishes of better quality are note worthy (JSogn-Grundvåg et al., 2020).

Fishing hooks have been found in many historic excavation sites indicating they are one of the first tools used by man to catch fish (Anon, 2004; 2005). Relatively advanced technology existed in hook and line fishing even in ancient India (Gaur & Sundaresh, 2004). Hardened and tempered high carbon steel wire of different sizes are used for making fishing hooks (Mathai, 2002; Anon, 2002; Thomas et al., 2007). Eye, shank, bend, point and barb are the important parts of a fishing hook (Fig. 1) which aid in suceesful hooking of the fish and the barb prevents escape of fish already hooked. Dimensions of gape and bite depend on the shape of the hook.

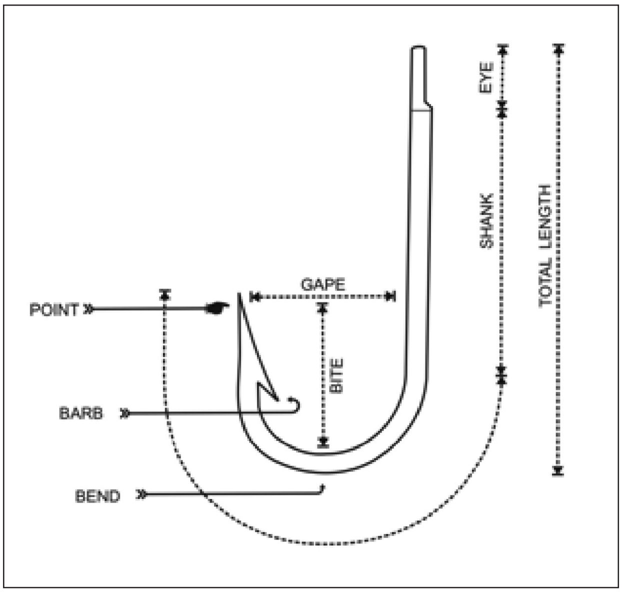

Fig. 1. Structure of a typical fishing hook

Corrosion of fishing hooks is a serious problem faced by the fishers, especially in the marine sector. Though modern hooks are constructed from high carbon steel wire and are protected by different types of surface coatings to prevent corrosion,

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corrosion is a problem affecting even such types of hooks (Edappazham et al., 2010). Studies on the nature of corrosion in fishing hooks and its effect on hook are very few (Baranov, 1976; Kenchington & Halliday, 1994). How the corrosion rate of tuna long-line fishing hook is influenced by tying the hook with nylon monofilament was reported by Kitano et al. (1990). Indigenously made hooks were evaluated by Varghese et al. (1997) in comparison to a popular imported brand (Mustad) with reference to physical properties, chemical composition of hook wire and corrosion behaviour.

Snood wire is an indispensable part in shark and tuna long line gears and it protects the hooked fish from loss due to fish bite. Snood wire or leader wire is usually made of steel and it connects the hook to sekiyamaor directly to the branch line proper through swivel. Sekiyama or secondary leader is constructed of three-strand twisted steel wire seized by cotton or nylon twine and it connects snood wire to the branch line proper through a swivel. Sekiyama together with the swivel prevents twists, kinks and entanglement. In shark long lines, short lengths of link chain is also used in place of steel snood wire (Mathai, 2002).

The corrosion performance of fishing hooks can be evaluated using accelerated corrosion tests. Accelerated corrosion test is beneficial in rapid evaluation of the corrosion characteristics of a product in the controlled conditions of a laboratory. Salt spray test is one such accelerated test by which different materials/products can be compared simultaneously and ranked based on the relative corrosion resistance by exposing them to identical conditions. It is considered as an appropriate technique for assessing general corrosion resistance (Basu et al., 1977; Natishan et al., 2000; Papadopoulos et al., 2007; Ito et al., 2020). A period of 98 h of salt spray exposure is reported to be comparable to one year of marine exposure (Varghese et al., 1997).

In the present study, how a snood wire attachment influences the corrosion behaviour of a fishing hook was assessed through salt spray test.

Materials and Methods

Round bent (J shaped) flatted fishing hook of No. 7 size made of high carbon steel was selected for the study. The physical measurements of the hooks were made as per IS: 9860 (Part I) – 1981. Wire diameter was measured at the round shank portion of the hook using a micrometer (Mitutoyo, d = 0.01 mm). Before weighing, dirt and oil if any present on the surface of the hooks were removed by degreasing using acetone and were weighed individually using an electronic balance (Sartorius BP211D, d = 0.01 mg).

Hooks selected for the study were made of wire diameter 1.82 mm, have a total length of 40 mm, gape 15.90 mm, bite 17.50 mm and weighed 1.398 g.

Snood wire made of stainless steel (SS) wire (grade 304 H) of 0.20 mm diameter was twisted into an eight stranded wire of 200 mm length, in an identical way as followed by the commercial hook and line fishers and it was tied to the eye of the fishing hook (Fig. 2).

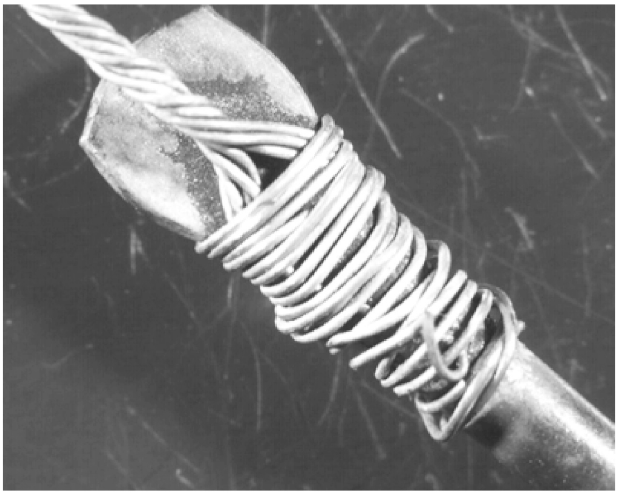


Fig. 2. Snood wire tied to the eye of fishing hook

Test samples consisted of two sets of hooks *viz.,* first set with snood wire attached (n=6) and the second set without snood wire which formed the control (n=6). Immediately before exposing to salt fog, the samples were again degreased using acetone and dried.

A salt spray chamber of 90 cm length, 72 cm width and 72 cm height was used for the experiment. The hooks were exposed to salt fog (salt spray) as per ASTM B117 -03 (2003). A 5% NaCl solution (pH between 6.5 and 7.2 at 35°C) was used; and the pH and temperature of which were measured using pH tester 30, Eutech Instruments. The temperature inside the chamber was maintained at 35±1°C throughout the experiment. The samples were suspended from thin plastic strings inside the cabinet and a uniform saturated salt fog was maintained throughout the test. The hooks were exposed to 300 h of salt spray and at an interval of 100 h, the extent of corrosion was observed visually. The optimum period of exposure was arrived as 300 h after a preliminary study with 500 h of salt spray exposure. Moreover, considering that salt spray exposure of 98 h was equivalent to one year of sea water exposure (Varghese et al., 1997) and that average life span of commercial fishing hook was reported by fishers as less than three years, 300 h was finalized as the optimum exposure period for this study.

After 300 h of exposure, the hooks were washed with clean running water to get rid of salt deposits if any, adhered to the surface. After removing the snood wires, the corrosion product buildup on the surface of hook was removed following ASTM G1 specifications (ASTM G1 – 90, 1994). The dried specimens were then weighed. The weight loss of fishing hooks was calculated as:

$$\omega = \frac{M_0 - M_c}{M_0} \times 100$$

ω = percent weight loss, M_0 = initial weight of specimen and M_c= weight of the corroded specimen, after cleaning.

Exact estimation of the surface area of fishing hook was difficult by virtue of their irregular/complex geometrical shape. Since the hooks used for the investigation were of the same type and size, the percentage weight loss over the exposure period in salt spray could also be taken as the measure of their corrosion resistance.

Corrosion rate was calculated as:

$$\text{Corrosion rate (mpy)} = \frac{K \times W}{D \times A \times T}$$

K = A constant *

W = Weight loss in gram

D = Density in g cm^{-3}

A = Surface area in cm^2

T = Time in hours.

*K is taken as 3.45 x 10^6 for calculating corrosion rate in 'mils per year' (mpy).

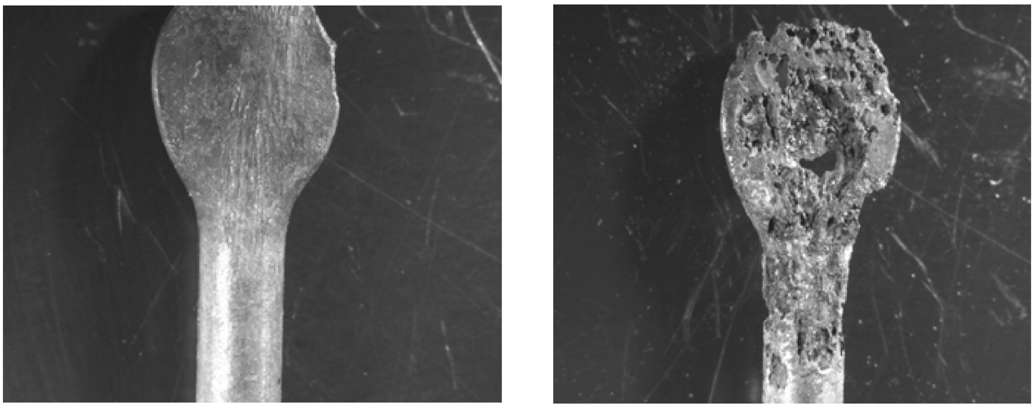
Surface characteristics of the exposed hooks were examined by optical microscopy (OM) (Leica MZ16 A). Significant difference between the control hooks and snood wire rigged hooks in terms of weight loss and corrosion resistance was analysed by analysis of variance (ANOVA) at P=0.05 levelusing SPSS 12.0.

Results and Discussion

Both sets of hooks, control and snood wire-rigged, showed marks of corrosion within seven days of exposure to salt fog. Rust stains developed on the hook surface increased with the advancement of exposure period. At 100 h of exposure, corrosion spread across the entire surface of the hooks. At 200 h, the corrosion product was mainly concentrated at the eye portion of hooks where the snood wire was tied. At 300 h, snood wire rigged hooks were either broken at the eye orwere at the verge of a breakage. Corrosion attack was more at the eye portion (Fig. 3). Snood wire attachment gave adequate harbouring space for the corrosive medium and that seems to have enhanced the corrosion attack at that area. Kitano et al. (1990) also reported similar enhanced corrosion at the point of attachment in tuna hooks tied with nylon monofilament. Though they used comparatively less aggressive immersion test using artificial sea water, intense corrosion attack was detected at eye portion of hook and by six months immersion, eye portion was completely corroded (Kitano et al., 1990).

There was significant difference between control and snood wire-rigged hooks in terms of weight loss ($p<0.05$). The control hook had a mean weight loss of 6.16% while the hooks with snood wire had a weight loss of 10.08% at 100 h of exposure. At 300 h, this was 11.53% and 20.93% respectively in control and snood wire-rigged hooks indicating that due to corrosion, loss of weight almost doubled from that at 100 h of exposure in both the cases. According to Kitano et al. (1990), corrosion induced weight loss of fishing hooks immersed in artificial sea water for six months was in the range of 5 to 11%. In fishing hooks, loss of core metal will result in reduction of their mechanical strength which would lead to hook failure making the hook unusable.

Similar to weight loss, the snood wire-rigged hooks showed significantly higher rate of corrosion ($p<0.05$) than the control hooks. In the initial stage of salt spray test, higher corrosion rates were recorded compared to the later stages. At 100 h of exposure, the control and snood wire rigged hooks respectively had corrosion rates of 96.557 and 157.92 mpy



(a) Control hook (b) Hook with snood wire.

Fig. 3. Eye portion of fishing hooks after 300 h exposure

(Fig. 4). Subsequently, the rates showed marginal reduction with corrsion rates of 60.785 and 79.051 mpy respectively at 200 h. At 300 h, corrosion rate was only 60.214 mpy in the case of control while snood wire rigged hooks had a significantly higher value of 109.316 mpy. Similar to the present study, Montgomery et al. (2012) in a study conducted on low carbon steel panels subjected to seawater spray test, reported that the corrosion products formed aggressively in the initial period.

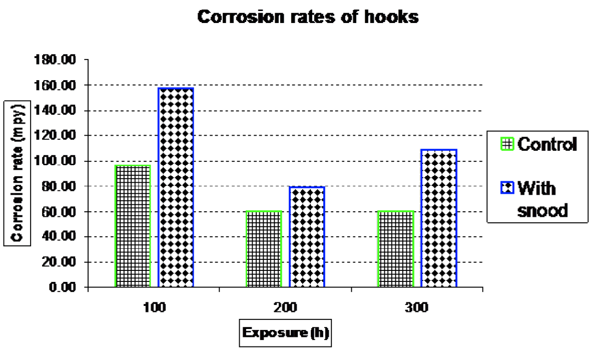


Fig. 4. Corrosion rate of fishing hooks exposed to salt spray

The higher rate of corrosion in snood wire-rigged hooks might be either due to the crevices formed on the surface of the hook at the point of snood wire attachment or due to the bimetallic couple formed between the snood wire and the hook. The crevices/ gaps developed at the point of attachment of snood wire at the eye portion of hook must have facilitated more corrosive medium and that too for a prolonged period. Similar observation was made by Kitano et al. (1990) in their study with tuna hooks tied with nylon monofilament. The attachment of SS snood wire to carbon steel hook formed in a bimetallic couple, which resulted in an enhanced corrosion attcak. The passive SS snood wire when comes in contact with the hook which is more active in nature leading to progressive corrosion. The combined effect of formation of crevices and the bimetallic couple enabled in enhanced corrosion rate in snood wire attached hooks.

Methods such as using non corrosive rings for attaching snood wire to the hook may avoid/ minimize formation of crevices at the point of attachment and also prevent bimetallic corrosion. Non-metallic materials can be another option to avoid bimetllic couple. Ultra high molecular weight polyethylene (UHMWPE) fibre known as 'Dyneema®, a fibre, 15 times stronger than steel and three times stronger than nylon (DSM Dyneema, 2004) used for cod and seal bite resistant aquaculture cages (Varjopuro & Salmi, 2006; Moe et al., 2009) can be an alternative to SS snood wire. Further studies need to be undertaken along these lines.

Corrosion of hook and its premature break down is a problem associated with hook and line fishing especially in marine waters. The present study revealed significantly high corrosion attack in steel snood wire-rigged high carbon steel hooks exposed to salt fog for 300 h. Weight loss due to corrosion was very high (20.93%) in hooks rigged with snood wire compared to the control hooks (11.53%). Relatively higher corrosion rates were recorded at the initial stages of exposure both in control hooks and snood wire-rigged hooks. At 300 h of exposure, control hooks had a corrosion rate of 60.214 mpy whereas snood wire-rigged hooks had a rate of 109.316 mpy. The enhanced corrosion attack in snood wire-rigged hooks could be either due to bimetallic corrosion or by the retention of corrosive medium at the point of attachment or a combination of these two factors. Further studies would help in developing suitable measures in preventing and/ reducing the higher corrosion attack in hooks where metallic snood wire is used. Rigging snood wire to the hook using non corrosive rings and/replacing SS wire with UHMWPE yarn are suggested options in this line.

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