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DETERMINATION OF THE CAUSE OF LEAKS IN COPPER SANITARY LINES ON A SHIP

by

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EXTRACTION METALLURGY DIVISION

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SUMMARY OF RESULTS

An investigation was undertaken to determine the cause of leaks which were occurring in copper sanitary lines on board the newly commissioned Canadian Government Fisheries Patrol Vessel "A. T. Cameron". The results revealed that the pipes had developed leaks at areas where irregularities on the inside had produced localized turbulence in the salt water flowing through them. The increased agitation prevented the copper corrosion products from forming a protective coating in these areas which were thus subjected to impingement attack.

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INTRODUCTION

A letter, File No. 9400-35, 9400-43, dated September 9, 1959, was received from Mr. A. Cumyn, Director, Marine Regulations, Board of Steamship Inspection, Department of Transport, Ottawa. This letter confirmed a verbal request made by Mr. Smith, of the same organization, that an investigation be made of leaks which had occurred in salt water sanitary lines on Canadian Government Fisheries Patrol Vessel "A. T. Cameron". Correspondence from the Fisheries Research Board of Canada dealing with this problem, and detailed drawings of the pipe lines in question, were also submitted.

The sanitary lines, in which twenty-two leaks had occurred, were used to convey sea water to sanitary equipment throughout the ship. The system consisted of drawn copper pipe and brass fittings which had been soldered together. The leaks had developed during the first twelve months that the ship had been in service.

Two samples of pipe, a straight piece with no holes and a piece with two slight bends and one hole, were submitted for examination. Blue-green corrosion products were present on the interior surface of each pipe.

DETAILS OF INVESTIGATION

Analysis of the corrosion products

The removal of the corrosion products from the interior surfaces of the pipes revealed that the material from each pipe consisted of an extremely thin layer of blue-green material over a much thicker reddish-brown coating. The various products were analysed by X-ray diffraction, spectrographic and chemical methods. The corrosion products contained no unusual compounds and there was little difference between the products in the two pipes.

The metal in each pipe was analysed spectrographically and chemically. The analyses revealed no significant differences in composition, both being of commercially pure copper.

Visual examination

Although dark areas on the exterior surfaces of both submitted samples indicated that the pipes had been subjected to some form of local heating, the main corrosion attack had taken place on the inside surfaces. Each sample was cut lengthwise into two halves thus exposing the interior surfaces for examination.

The greater part of the interior surface of each pipe was observed to be covered with a uniform layer of the blue-green and reddish-brown corrosion products. These products were firmly attached in some locations and rather flaky in others. Two thicker, rough deposits were present in the bent pipe. In each case the deposit was located just to one side of a pitted area in which the greater part of the corrosion

products had been removed. One pitted area was oval in shape, 1 3/4 inches by 1 inch, and appeared to have consisted of a series of small deep pits which had extended into one another, thus forming a large deep depression. The pipe was perforated at the deepest end of this depression. The second pitted area consisted of a rather large, smooth, shallow depression with a group of deep pits beside it. Although these two pitted areas had occurred in different locations, each had occurred at a location where a slight bend in the pipe would have been expected to cause an increase in turbulence. The design of some of the pits (smooth sloping surfaces on one side, and undercut edges on the opposite side) was typical of that occurring in copper that has been subjected to an impingement (corrosion-erosion) attack. This type of attack frequently takes place in turbulent areas. No pits were visible in the straight piece of pipe, in which no excessive amount of turbulence could have occurred.

An examination of the submitted drawings revealed that many of the leaks had occurred beyond locations where pipe fittings such as valves, couplings, elbows and tees could have increased the turbulence in the salt water as it passed through the lines. Numerous slight bends similar to those which had caused turbulence in the submitted sample, undoubtedly were present in the system but had not been marked on the drawings. Each one would create a local disturbance in the flowing liquid.

The results of this investigation have shown that the compositions of the basis metal and the corrosion products in the case of the bent sample were reasonably similar to those in the case of the straight one. The adherent coatings of corrosion products had been

affording considerable protection in most areas; however, in locations where irregularities inside the pipe had caused an increase in the turbulence, the coating had been continually removed so that it could not provide protection for the copper. The combination of corrosion by salt water and erosion due to turbulence thus produced an impingement attack on the surface. Copper in the presence of salt water is extremely susceptible to this type of attack and numerous copper pipe failures have been attributed to it. Where there is danger of this type of attack occurring, the copper--10% nickel--1.5% iron alloy pipe is frequently being specified in preference to ordinary copper pipe.

CONCLUSIONS

It may be concluded from the results of the investigation that the leaks were caused by impingement attack on the interior surfaces of the copper pipes. This attack had taken place at locations where the turbulence had been increased due to irregularities in the line such as elbows, couplings, tees and bends.

RECOMMENDATION

It is recommended that the present copper pipes which form the salt water sanitary lines, be replaced with pipes made from the copper--10% nickel--1.5% iron alloy.

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