

# THAT YELLOW STAIN

BY

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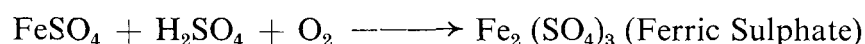
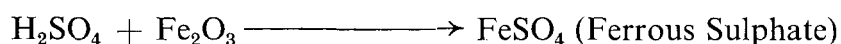
'When you made the Duke of Edinburgh an Honorary Member of the Institute of Fuel, I hear that His Royal Highness referred to the clean-air legislation and welcomed it in order to get rid of the "muck" which, he said "now passes as fresh air in most of our cities". We say that we would welcome clean-air legislation in the Navy, because the oil fuel we now burn is absolutely filthy. Of recent years there has been such a great increase in the extraction of middle distillates and the higher fractions, following the advances which have been made in the cracking of crude oil, that what is left for us to burn under boilers is absolutely filthy. The quarter decks look horrible, our awnings burn away, our paint is ruined and I, for one, am hoping very much that there will soon be a change to another fuel that won't make the ships quite so dirty.' (*From a speech by the First Sea Lord to the Institute of Fuel.*)

From time to time in the last ten years or so, dismayed Commanders of battleships and cruisers have tearfully surveyed an unexpected selection of autumn tints on their awnings, paintwork and quarter decks. When it occurs for the first time in a commission, loud cries arise that such a phenomenon is new and quite unheard of. However, reports have filtered through to Haslar at sporadic intervals for some years and, in 1948, an investigation into the cause of the staining of paintwork by products of combustion was made. Due to the lack of continuity, inevitable with the small sea-time ration, it is probable that the comments then made have been forgotten, so this article is written in the hope that some mitigating action may result.

The staining generally takes one of two forms : firstly, when solid matter from the funnel is allowed to rest on paintwork, decks and awnings it leaves a yellow-brown patch which, on canvas, is corrosive. Secondly, during a full power trial or when steaming into the wind, particularly in damp weather at night, the whole after superstructure, quarter deck, and awning if spread, are covered with spots which, if the surfaces are damp, merge into a form of colour wash. The general effect, on an otherwise clean ship, is hideous.

This phenomenon appears to be confined to battleships and cruisers, reports having been received from H.M. Ships *Duke of York*, *Anson*, *Birmingham*, *Glasgow* (on two widely separated occasions), *Liverpool*, *Ceylon* and others between 1947 and 1955. No complaints have been received from destroyers or carriers, the latter, of course, being less susceptible to such disfigurements. It seems reasonable to deduce that only ships fitted with air preheaters and economizers are liable to be affected, but any news of exceptions would be welcome.

The yellow-brown colour is caused by the ferric sulphate formed as a result of the following reaction ; starting with sulphur in the fuel, we get a mixture of  $\text{SO}_2$  and  $\text{SO}_3$ , the proportions depending on combustion conditions. The  $\text{SO}_3$  then combines with the water of combustion to give  $\text{H}_2\text{SO}_4$ , which reacts with the iron of the uptakes to give :—



There is a theory that the presence of vanadium in the fuel affects these reactions but, so far as is known, no research results have yet been conclusive on this point. The rotting of awnings, which normally follows staining, is due to the presence of free sulphuric acid.

In 1947, the permissible maximum sulphur content was raised from 2 per cent to 3.5 per cent, but this does not in itself account for the staining, as the quantity of  $\text{SO}_3$  formed does not necessarily vary with the amount of sulphur in the fuel.

The presence of sea water in the fuel at once causes an increase in the solid contents of the funnel gases ; the mechanism of the formation of bonded deposits in tube nests was fully explained by Mr. W. Killner, R.N.S.S., in Vol. 2, Nos. 3 and 4 of the *Journal of Naval Engineering*. The effect of these extra solids is to provide more carriers for the sulphuric acid and the ferric sulphates, and the sticky nature of the soot, as it lands and is smeared, is similar to that of the deposit found on the fire-row tubes when burning wet oil. Insufficient reports have been received to be able to say definitely whether or not sea water contamination of the fuel is present when the staining troubles occur, but it seems probable that this is, in fact, the case.

There is however, another fact worth mentioning, that the presence of loose carbon, in the form of soot, retards the formation of  $\text{SO}_3$  from  $\text{SO}_2$  and will therefore, reduce the existing  $\text{SO}_3$  to  $\text{SO}_2$  ratio ; this then prevents the formation of sulphates and sulphuric acid. If one steams with a light brown haze at the funnel, that is with a surplus of carbon, the trouble should be reduced.

The regular use of soot-blowers will help to keep the particles of soot small enough to be carried clear of the ship. It is not considered that once a watch is too often, and this is in fact the practise in the United States Navy. 'At intervals not exceeding 24 hours' as laid down in *Engineering Manual*, Article 213, is, in the opinion of the writer, an undesirably long interval. If delayed too long, soot-blowing will cease to be effective until after the next external clean.

The following then are the measures which could be taken now in existing ships :—

- (a) Steam with a light brown haze whenever possible.
- (b) Blow soot at least three times daily at sea and once in harbour.
- (c) Steam with preheater by-pass doors open to increase funnel gas temperature when fouling conditions are present, e.g. damp weather, little relative wind, suspicion of sea water in the fuel.

The use of sea water contaminated fuel will of course be determined by operational requirements, sullage disposal arrangements and the ship's equipment, and in many cases there is no option but to burn it.

A complete diagnosis of the yellow stain nuisance depends on further reports being received from sea, and from anyone with ideas on the subject. Please write direct to the Officer-in-Charge, A.F.E.S., Haslar, including in reports of actual experiences as much as possible of the following data :—

- (a) Source of fuel and any details known.
  - (b) Power at the time.
  - (c) Relative wind direction and speed.
  - (d) Humidity.
  - (e) Sea water content of fuel, if any.
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