

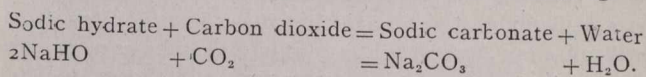
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CAUSES OF DETERIORATION OF BOILERS.*

By C. C. Nelson.

Boilers were once considered of only secondary importance to the majority of marine engineers, but lately it has become the practice to study the boilers more, and they now rank in the first place of importance, so that it is essential that they be kept in good order. To do this requires the knowledge of the causes of deterioration, of which causes the principal is corrosion. Water at ordinary temperature (60° F.) and under normal pressure (14.7 lb.) dissolves its own vol. of CO₂, but a change either in temperature of water or pressure of atmosphere will be accompanied by a change in the quantity of gas dissolved; so that if temperature of water is increased the water gives off gas, but should the pressure be increased the water will absorb more gas. This is the reason that heating the feed water tends to preserve the boilers. And it also shows the advantage of heating the feed water (up to about 200° F. under atmospheric pressure) before putting it under pressure. The carbon dioxide that gets into the boilers can be completely absorbed by the addition of sodic or potassic hydrate. The CO₂ unites with alkaline hydrate forming a carbonate and liberating water.



Corrosion may be caused by the oxidization of the steel by acidulated boiler water, and by electro-galvanic and thermo-galvanic action. The most fruitful of these is rusting, which is directly caused by the carbonic gas (CO₂). This is present both in the air and water and enters into combination with the iron or steel and forms carbonate of iron, which in turn absorbs oxygen, and the final product is oxide of iron (Fe₂O₃). This thin coating would preserve the iron, only unfortunately in this last change the original particles of the CO₂ are liberated and in turn attack the plate and so the cycle continues. Dry pure oxygen alone will not exert any action on iron or steel, neither will CO₂ while dry, but the two together in the presence of moisture set up rapid corrosion.

While rusting may take place anywhere inside a boiler it is often in evidence at the water level on the shell plates, as at this place the washing about of the water alternately wets and dries the plate, which is the exact state iron and steel need to be in to facilitate heavy rusting. The excessive difference of temperature at the line of fire bars tends to set up thermo-galvanic action, to which is assigned the pitting found here, but some authorities state that this pitting is caused by small air bubbles which cling to the sides of vertical heating surfaces; the period that these small bubbles rest on a plate is long enough for the oxygen they contain to act on the iron or steel and cause small irregularities, on which subsequent bubbles find a still better lodgment, and speedily effect the formation of pitting. The straining of the plates, as at the line of fire bars, loosens the rust and the pitting gradually gets deeper. Mr. Macfarlane Gray's idea of pitting was that it was caused by minute particles of copper, but this was questioned by another

authority, who stated that he had found pitting in land boilers, in which there could be no question of copper at all.

Acidulated Boiler Water.—It seems to be generally accepted that boiler water, when using a surface condenser, after a time becomes acidulated, even if the supplementary feed is obtained by means of an evaporator; there are many theories advanced to account for it, but none seem to be universally accepted, though I think the idea that hot water is in itself a solvent, carries some weight; but having the acid in the water, the best thing to do is to remedy it by using an alkali, preferably carbonate of soda, or caustic lime, in fact it is advisable to keep the boiler water slightly alkaline. The use of only hydrocarbon oils for internal lubrication of the engines prevents acids from oil forming in the boiler, as it takes a temperature of about 700° F. to decompose these oils, while animal and vegetable oils decompose at about 270° F., and form stearic and oleic acids respectively, besides their own particular acid due to the base they come from.

Sea water contains many salts injurious to iron and steel, but we must take into consideration the different behavior of salts at the conditions present in boilers with steam up. Sea water put into a boiler will, when heated, deposit Calcic sulphate, at a temperature of about 300° F., which forms an insoluble skin and prevents the injurious action of the other salts. But continual feeding with salt water would increase the thickness of this skin, and in time cause overheating of the plates, etc., owing to its non-conductive properties. Sea water fed into boilers previously containing fresh water will probably, other conditions being favorable, cause corrosion on the same principle that dilute nitric acid will eat right through a leaden vessel, while strong nitric acid will not affect it further than forming a coating of nitrate of lead which prevents the further action of the acid. Chloride of magnesia is always present in sea water, and is exceedingly injurious; it will attack iron or steel with or without the presence of air at about 212° F., while the following chlorides only attack in the presence of air. They are here arranged in the order of their corrosive power:—Ammonium, Sodium, Potassium, Barium and Calcium. Chloride of magnesia will, under certain conditions, decompose and form hydro-chloric acid, which is also highly injurious to iron and steel, but although some authorities quote this as being one of the causes of corrosion in boilers it is a fallacy, as to cause decomposition of magnesium chloride it has to be heated to dryness at not less than about 300° F., and this dryness cannot be obtained when in contact with saturated steam: the only way it could happen would be by the salt water being carried into the super-heater by priming.

Copper salts seem to be a constituent of nearly all feed water; its effects may be seen as green scale on or near the zinc plates. For some unaccountable reason, it does not deposit itself uniformly over the boiler, but only in spots—chiefly non-heating surfaces. The origin of copper salts in boiler water is supposed to be from particles carried in with the feed water, and also that the distilled water acts on copper as a solvent.

*Paper read before the Institute of Marine Engineers.