11TH OCTOBER, 1906.

DISCUSSION ON CORROSION OF METALS.

This discussion was opened by Mr. James Shirra, who said that practical experience with ferro-concrete had shown that Portland cement was a perfect protection for iron and steel when in close contact with the surface. Should the adhesion between the iron and the cement fail, the cement still protected the iron, so long as no moisture had access to the cavity which might be formed; if water did get in corrosion would occur. Hence a good coat of cement was a great preservative for iron, especially if rigidly secured at the margins to prevent water getting in there, as it was on a ship's bottom between the floor angles and keelsons. This application of ferro-concrete to preserve and strengthen an iron vessel's bottom, was half a century old; and in spite of occasional local and limited defects noticed where it has never been in contact with the plate or had got worn away by mechanical action, it had proved most reliable.

Even a thin wash of cement applied with a brush was good, although very liable to get knocked off mechanically; in double bottoms and ballast tanks of ships, it stood better than paint. In a steamer he was in in the Indian trade they mixed the cement wash for the engine-room floors, etc., with "Kunji" or the water rice had been boiled in, to make it more adhesive, and so got a thicker coat on; but it is doubtful if the cement was improved by the mixture of such starchy or mucilaginous matter, as, if it decomposed or fermented, the C.O. given off might prove corrosive beneath the cement.

Bituminous coatings were lighter than cement, and did well also in most situations. When exposed to heat, from boilers or from the sun's rays, as in decks, bituminous or asphaltic compositions soon perished and became useless, but when not subject to continuous heating, coal tar made a good and cheap preservative. Tar often contained acids, pyroligneous, acetic, carbolic, and others which injured the iron, and should be neutralised by the addition of slaked lime; this made it work stiff from the brush, and it should be laid on hot. Dusting the wet surface with dry cement dried it, prevented it from running , but it was on vertical surfaces it was apt to run, and he found it was difficult to get the dry cement to adhere there. In last weeks' "Engineering" (Aug 31) it was stated that 8 parts coal-tar, 1 part cement, and 1 kerosene, made a satisfactory paint for ironwork which the chemists of the Washington Navy Yard pronounced non-injurious.

Kerosene had been recommended for washing ironwork with before putting on oil-paint, to make the latter adhere, but he had not found it a success in bunkers, where the attriton of the coal stripped off almost any paint. If the iron was dry when painted and the paint thoroughly waterproof, it would adhere and last; to make the paint waterproof the Pennsylvania Rail-road with their iron bridges and roofs, put a coat of paraffine paper over a first coat of sticky paint, and a finishing coat over that. He had papered ironwork, but for decoration, not preservation, on a steamer. They had no artist aboard who could renovate the graining of the engine-room casing, so a few rolls of oak-grained wall-paper were taken to sea with them and pasted on and varnished. The rivet heads impaired the effect very much, so it was soon stripped off, and a less philistinic style of decorative art subtituted. The P.R.R. punched out holes for the rivet head, and covered each with an individual cap piece. A reference to this and some valuable information. as to paint appeared in "Engineering" for January 19 last

Water usually contained free oxygen and carbonic acid gas in solution, which enabled it to act on metals, and the air set free from water by boiling, or "suction" in a partial vacuum, consisted much more of these gases than the normal atmosphere. Hence the bad effect of the air in boiler feed water, and a similar effect to the pitting of boiler plates was observed on the back of cast-iron or steel propeller blades. The face of the blade did not corrode much, but the water could not flow in fast enough to the back, there was a pertial vacuum there, and the moist oxygen and CO_2 liberated under the reduction of pressure, adhered to the back of the blade, and as a result pitting rapidly followed. Condenser tubes and copper pipes conveying sea water often suffered from a similar cause, of two steamers on our coast identical in every particular, of the same age and in the same trade, the condenser tubes of one had to be renewed some years before those of the other. The only difference in working was that in the first to fail, the amount of circulating water was regulated by the old-fashioned plan of "throttling the injection. so that the dissolved gases in the water were set free in the inlet pipe and pump, and an extra amount of air sucked in through the atmospheric or pet valves, to circulate in the tubes and corrode them; while in the other the injection was regulated by a bye-pass valve between the suction and delivery side of the pump so that it was always pumping "solid" water; a fitting the use of which was ignored at first in the former. The copper pipes conveying clean sea water, as the sanitary water service would pit rapidly internally in the higher parts of the range especially in warm situations, owing to the action of the moist air liberated from the water. If the pipe was hot enough, the chlorides in sea-water attacked the copper directly, and auxiliary steam pipes on deck might also suffer from this. In one steamer the deck steam pipe leading to the steering engine wasted rapidly externally, as it was always getting wet with sea water; a black scale of copper chloride formed on it, which was thrown off with a creptitating sound every time steam was turned into the pipe. The exhaust pipe alongside did not suffer, as it was much cooler. Hagging the pipe did not prevent this. A fatal steam pipe explosion in a large mail steamer in Australian waters two years ago, was ascribed to this cause, the external corrosion due to the lagging being saturated with salt, though the proximate cause was the existence of a fine crack on the internal surface of the solid-drawn pipe.

In sea air there was always sea salt present, which condenses in the "sweat" or due that formed in metallic surfaces, and the deliquescent nature of the salt kept the surfaces always moist, a condition favourable to corrosion. This sweat too, especially in the internal surfaces of iron ships with raw sugar, timber or other cargoes containing decaying or fermenting organic matter, contained always CO_2 and hence was very corrosive; coating the surface with granulated cork or such non-conducting material, largely prevented its deposition. Good ventilation, which removed the corrosive gases and prevented sweating was hence a very effective means of preservation; it should be carefully provided in engine and boiler spaces as well as in cabins and forecastles.

Mr. H. Adamson said that in all ages the corrosion of Iron and Steel must have formed an interesting subject, besides a knotty problem to the more advanced of the ancient armourers of a bygone age, and he could not but think they must have had their own secret methods in manfacturing steel, in order to preserve it from corrosion. Similar to the methods they had of tempering it for special purposes.

A visit to any of the large Museums of Europe made one come to this conclusion; these give us abundant examples of armour and weapons of warfare hundreds of years old still in a good state of preservation. The Tower of London, the Museums of Naples and Malta, also the British Museums were full of examples. In the British Museum, the writer had seen specimens of early Grecian Armour said to be as old as the days of Troy, from this one could only conclude that the metal must have been treated by a special process of hardening and burnishing, (if not mixed with an alloy), thus effectually closing the atoms of the steels so as to make it almost impervious to the action of corrosion. If such was the case he was inclined to think that this special process was lost like many others.

In the present age, one of more rapid changes and when infinitely larger quantities were dealt with, it was not possible to bestow the same care in treating the material passing through the manufacturers' hands, which he thought was not to the interest of that same manufacturer.

And when we think of the enormous quantities of Mild Steel required, in proportion to the production malleable iron and cast steel of only 50 years ago, is it to be wondered at.

Shortly after Mild Steel was introduced the subject of its rapid corrosion soon became a vexed question, and is, he was sorry to say, so still. Several processes had been invented for the purpose of preserving it, but as these have either interfered with the quality or have been an expensive addition to the price after the manufacture, they have been given up as impracticable. True, we have Nickle Steel which is said to, in a measure resist corrosion, but as its price for general purposes is prohibitive, it can only be used for special work.

Nowhere are the ravages of corrosion more evident or more forcibly brought home to us than in the stucture of a ship, more especially a steamer; from the time the frames are erected and the first plate in the yard, the enemy begins the work of destruction, while man, on the other hand, applies in a feeble way all sorts of methods to arrest its progress, these are only partially successful, and my opinion is, that until the chemist can give us a non-corrodible material direct from the furnace having the same ductility and strength without increasing the cost, our troubles will go on as at present.

Compared with iron, steel is much superior in ductility tensile strength and homogenity but as a non-corrodible factor, iron has the advantage and it seems to me that the cruder and more inferior the brand the less liable it is to corrode, or in other words, the finer and milder the steel is the more rapidly it wastes away.

The ordinary theory is that the rusting of iron or mild steel in air or water, is due to a great extent to the action of carbonic acid free in the air and dissolved in water. The iron is attacked by the moist carbonic acid forming carbonate of iron, and this is converted by oxygen into rust, and the carbonic acid is again liberated in contact with iron taking up more metal. Again the corrosion or rust ensues, and so on the carbonic acid proceeds on its career.

Take for instance the outside skin of a ship, the process of corrosion is going on due to the presence of moisture carbonic acid gas, and free oxygen, which forms a coating of rust on the metal, which if not cleaned off and coated with a protection will in a short time do immense damage. There is also the more local corrosion due to galvanic action which is pitting. The corrosion of the inside of a ship is a subject of even more importance than the outside, from the position of many of the parts, they escape the detection and attention which the outside receives and are therefore a still greater source of danger.

Corrosion is much accelerated by variation of temperature, as a matter of fact he was inclined to believe that in plain words, it is this variation of temperature combined with fatigue and moisture which gives corrosion the greatest acceleration.

In the double bottom of a ship, especially under the boilers where it is a succession of hot and cold, wet and dry, we see disastrous results in an incredible short time,

The coal bunkers also by mere contact of moist coal with the iron (and more especially the steel plates) sets up rapid corrosion while if the coal contains any pyrites which is nearly always the case, the double sulphides of iron and copper are gradually oxydised, and at once cause corrosion.

There seems to be no doubt that iron plates of ordinary brand resist corrosion better than steel, such being the case it is no doubt better when building a steel ship to have the bunker walls and shoots; also floors and cradles under the boiler made of iron, thi partially gets over the difficulty where the greatest variation of heat and moisture exist, but the whole inside vessel requires very careful attention, and in order to preserve it for the period of its allotted span, say 25 years, it requires to be frequently cleaned and coated, But with what? That is the problem which he must confess is beyond me, corrosion may by certain coatings be arrested for a short time but not effectually.

He could enumerate many so-called anti-corrosive compounds but compressed he did not know of any one thoroughly effective.

Portland cement, we all know is one of the most effective, but when applied to a ship's bottom inside it is easily broken, or started off the surface when that surface is bruised, and unless renewed at once corrosion will also begin at once.

One thing which struck him many times was, when repairs are being effected, the old plate numbers are seen on the flat of the plates, say on the bulkhead of a ship's bottom which had been painted on with white lead and boiled oil before the ship was built, and under these numbers the iron or steel is in a perfect state of preservation, the only reason he could assign for this is that the numbers were painted on in the mill when the plate was hot and dry.

In order to follow up this idea one would say that the plates should be all heated before the preservation is applied. He was of this opinion. but to put it into practice there were too many difficulties in the way to consider it seriously.

Then there is the question of corrosion of steel boilers and the various methods past and present adopted to arrest it.

He didn't wish to enter into this because he considered it a subject by itself, only to remark that so far as internal corrosion is concerned, he did not think it any worse in the steel boiler than it was in the iron one, this is mainly due to the fact that the modern or steel boiler receives greater care in its construction, there is less external leakage, and while in actual use it is better looked after.

He concluded by remarking that he had only dealt superficially with the subject of corrosion as it had been brought forcibly before him in daily observation; the whole question is a very wide and a most appropriate one, one which affects the most of us are well worth the consideration of the members of this Association.

Mr. James Kidd stated that having had some trouble with the wasting away of economiser pipes, which were of cast iron, some experiments were made to find the cause, also a remedy of possible. He exhibited some specimens showing the pipes when new, also a section showing the soft plumbago like inner part, and another section with it cleaned off which showed the actual amount of metal lost after six years constant use.

They found that the cause of the corrosion was partly due to the air and steam, but principally due to the large amount of carbonic acid in the water, a very large quantity of this acid being found in the water during the time of the drought, most likely brought about by decomposed vegetable matter, this was intensified by the hot gases, ranging from 800 to 1000 degrees Fah., coming in contact with the tubes, whilst the speed of the cold water passing up the tubes was about 20 feet per minute, with a temperature of about 80 deg. Fah. After making many experiments to try and prevent this corrosion, they altered the plant by arranging for the water to enter the three back nests of the economisers, that was those nearest the chimney, where the temperature difference was not so great, the gases being 450 deg. Fah., which increases the temperature of the water about 150 deg. Fah., before entering the front nest, where the gases were 800 to 1000 deg. Fah.

The inlet and outlet pipes were increased to four times their original area in order to impede mechanical circulation by the feed pump, and the speed of the water through the pipes was thus reduced to about 3 ft. per minute. This alternative proved effective, as on examination being made after $3\frac{1}{2}$ years work the corrosion had entirely disappeared.

It had been shown by Professor Moody that no corrosion would take place in the absence of carbonic acid gas. He took samples of piano wire and placed them in water containing air and oxygen for several months, but no action at all was observed until small quantities of carbonic acid were admitted, when the rusting took place within a few days.

He (the speaker) would mention that for surfaces readily accessible they used a paint composed of white zinc and turpentine, which had proved very effective.

Mr. R. R. Ferrier said that in factories with which he had been associated with great trouble had been experienced through corrosion of steel and ironwork, in many cases this was due to the presence of acids, ammonical gas and the action of free air. Many compounds had been tried to militate the trouble with varying success, experiments carried out with black varnish, biturine and bitumastic solution would seem to indicate that such heavy solutions had not the penetration nor adhesive power desired.

It would appear that to effect reasonable preservation from oxidation of iron and other metal, the material or compounds used must be sufficiently liquid to penetrate the pores and hermetically seal the surface, rendering it impervious to the deteriorating effects of air, heat, and moisture and to an extent the wasting effects caused by the presence of free acids and ammonia, it must also be sufficiently elastic after it has been applied and dried to stand the contraction and expansion without cracking or blistering.

Recently he had been using a compound named "Ferol," which is being specially introduced for the preservation of iron and metals. At the works of the Colonial Fertilizer Co., at Glebe Island where the blood mixed with salt water is treated, in many places excessive corrosion was experienced, bolts and other wrought-iron work lasted for a few weeks only. Since "Ferol" was applied ironwork had now been used months as against weeks previously without any appreciable deterioration.

The Water and Sewerage Board had been experimenting with "Ferol," during the last eighteen months and after most exhaustive tests they are adopting it generally for coating pipes and fittings.

The sample pieces of iron pipe which were coated with "Ferol," the pipe had been in the waters of the Harbor between wind and water for six months, and it could be seen that the portions covered had not rusted in the slightest, the inside which was not coated was very much rusted. "Ferol" was apparently very light in body, but is was marvellous the covering power it has. He would like to mention that the best results seemed to be got when the metals to be treated were heated, the "Ferol" then penerates into the pores and a further coat would give a decided glassy surface. "Ferol" seemed to give best results from a corrosion point of view as when applied in a raw state it will readily adhere to polished surfaces and when finished tints are required pigments such as oxides and hermatite, etc., mix freely with the "Ferol" and give excellent results.

E. T. Radcliffe, Printer, 729 George-street, Sydney.