

# ELECTRO COLLOIDAL BOILER WATER TREATMENT

By MURDOCH HILL.

Considerable interest has been aroused recently by the introduction on the market of electro colloidal systems of boiler water treatment to eliminate the depositing of scale on boiler heating surfaces.

Today's conditions in industry, and especially the sugar industry, demand that the operating engineer must always be on the alert to seize any opportunity which may appear to assist him in reducing running costs and at the same time maintain, and in some instances improve, his plant efficiency. One can, therefore, readily appreciate the receptive market there is for a unit which can be installed in any boiler plant in a few hours, and whose maintenance and running costs are practically nil and which, once in operation, will render all scale-forming salts in the boiler water into a non-scale forming condition. This in brief is more or less what is claimed for these units today.

To the writer's knowledge, there are two electro colloidal systems on the market today, both being based upon an accepted electro chemical phenomenon, viz., that if any mineralized water is subjected to a definite electrical charge, some physical change occurs to the salts in solution, which causes them to precipitate in the form of sludge instead of scale when the water is evaporated.

The two systems, which have come to the writer's notice, differ greatly in construction and appearance, the one being arranged so that the electrical charge is applied to the water outside the boiler, whereas the other unit is installed inside the boiler below water level where, due to the nature of its construction, it induces its own electrical current, which is in turn applied to the water in the boiler.

Last year we installed at Renishaw a unit of the first mentioned type, viz., where the electrical charge is imparted to the water prior to entering the boiler. This unit itself consists of an outer casing of cast-iron within which, and completely insulated from it, a hollow cylindrical electrode is situated. This electrode is made from a non-corrosive alloy with selected electro chemical characteristics. Longitudinal slots one sixteenth of an inch wide are milled in this electrode tangentially to its bore, while the bottom end of electrode is closed, the top end being open. Terminals are attached to both electrode and casing for the application of a current of predetermined potential and quantity. Water enters the unit at the bottom of the outer casing through the milled slots of the electrode, where it receives its treatment, then out of the top end of electrode to service, the whole unit being a closed circuit and installed in a pipe line. It will be seen that at the

moment the water is subjected to a uni-directional electrical force, it is broken up into very fine streams, a condition which the inventor of this system found to be very essential.

The electrical charge is supplied from a  $1\frac{1}{2}$  volt dry cell with positive terminal coupled to the electrode, and the negative to the outer casing. The magnitude of the charge is determined from the resistance or conductivity of the water being treated, the required electrical charge being obtained from a special ohm/microamp graph supplied, and we believe compiled by, the inventor.

Once the charge has been ascertained the terminals are connected to the control panel and correct charge set by means of variable resistances, all of which are incorporated in a control panel together with a micro or milli-ammeter. Once this has been set no further attention is required other than occasional conductivity checks, especially if there is likely to be any change in the source of water supply.

The unit at Renishaw is installed in make-up water supply pipe leading to boiler feed tank, so that only the make-up water is being treated. The charge required for the Renishaw make-up water was 400 micro-amps.

This unit was installed at Renishaw in September last year, i.e. after the boilers had been steaming for 3 months, so that there would probably be a fair amount of scale in the boilers at that time.

The boiler plant consists of 3.B & W boilers, each of 5,400 square feet heating surface, the average make-up water containing solids averaging 22 grains per gallon. Our usual week-end routine is that one boiler is completely emptied each week-end, the mud box opened and all loose scale removed from there, this being 3 weeks accumulation. Every alternate 3 weeks, in addition to opening the mud boxes, the two bottom rows of tubes were opened and brushed out, this means that mud boxes were cleaned every 3 weeks and two bottom rows of tubes every 6 weeks. This procedure gave us a fair opportunity to observe any change in conditions after installing the electro colloidal treatment unit. Prior to this, a well known boiler compound was used and this, of course, was discontinued at this time.

For the first few weeks there appeared very little change, both in quantity and quality of the scale being removed at the routine weekend clean, in fact there seemed to be a slight increase in quantity. After about 4 weeks however, each succeeding brush out seemed to produce less scale and the ratio of scale and sludge altered, showing an increased

amount of sludge. By the end of the season there was definitely less scale being formed, but when boilers were subsequently opened up early in off-crop, there was still a considerable amount of scale in evidence, but less than in previous years, and what scale there was appeared more loose and on the point of breaking away from surfaces, both in tubes and drums.

We, however, considered the visible signs sufficiently encouraging to carry on for one more season with this unit, more especially, as our running conditions were not 100 per cent. correct, due to plant layout, etc. These conditions are being altered this year, so that for next season we shall have full control of all make-up water.

It is unfortunate that this system was not available at the beginning of our crop, so that we might have been in a better position today to give more definite conclusions on the efficacy of this unit. I would here like to mention that this paper is only submitted in reply to the many requests addressed to us at Renishaw for information regarding our experience with this water treatment system. The factory manager, Mr. Wheeler, and myself have taken considerable interest in the unit and it is only when one begins to sum up conclusions, etc. at the end of a crop, that one realises how lack of full boiler water control precludes one from arriving at definite conclusions with any degree of authority. As already mentioned, these conditions are now being altered in preparation for next season.

With regard to the second system of water treatment which might be classed in the electro colloidal group, this unit which is placed inside the boiler below water level consists of a copper casing which encloses and is in metallic contact with a specially processed metal cartridge.

At first sight this would appear to be an adaption of the old method of attaching a zinc plate in a boiler in order to counteract any corrosion which might occur due to any galvanic action which might be set up through dissimilar metals in the boiler construction. But whereas this zinc plate was placed in metallic contact with the boiler, this new anti-scale unit is completely insulated from the boiler and might be described as a self-contained galvanic couple once it is immersed, producing a sufficient electrical charge to satisfy the previously mentioned accepted electro-chemical phenomenon. There is a gradual disintegration of the special metal cartridge, which must be periodically replaced, but as this disintegration is more or less in direct ratio to the work it is asked to do, i.e., the harder the water the quicker the disintegration, it should easily be arranged to be of sufficient volume to last one crop. At Renishaw we are installing a unit of this type in a locomotive boiler and the writer understands

that one or two factories are installing this type of unit in their boilers for this coming crop, and would like to suggest that there be some collaboration between these places throughout next season, so that by the time of our next conference, we, as technologists, should be able to give a definite opinion on the merits or otherwise of this system of boiler water treatment.

It will be readily agreed that if this type of water treatment plant fulfils all the claims made for it, it will provide a cheap and apparently reliable means of boiler water treatment. Admittedly, the resultant sludge has still to be removed from the boiler, but sludge is much easier to blow out of a boiler than partially formed scale which, due to its capacity for accumulating in localised zones, is very often the cause of boiler failures due to overheating.

The costs of this type of treatment against an external chemical treatment plant are of course very much in favour of the electro colloidal system. The initial cost being about 3 per cent. of boiler plant value against 10 to 15 per cent. for the external treatment plant. Further, the running and maintenance costs are practically nil when compared with the costs of running and maintaining an external treatment plant.

Taking everything into consideration, the electro-colloidal system of boiler water treatment would appear to be well worth a trial.

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The PRESIDENT stated that electro-colloidal boiler water treatment had aroused considerable interest and reminded the meeting that the Association provides through the Chemical Control Committee much information on chemical control of feed water. This Committee has considered such control from time to time, but little has as yet been done in factories. He was, however, of the opinion that more control would be carried out in factory laboratories in the future.

Mr. MACBETH thanked Mr. Hill for his contribution to the most interesting and often discussed subject of boiler feed water. He wondered if Mr. Hill had found any ill effects from emptying boilers at the week-end and exposing the empty tubes to the still hot furnace. He would hesitate to do this.

This year electro-colloidal apparatus has been installed in all the Estate locomotives and he would be pleased to report at the end of the season on the results.

As far as factory boilers are concerned generally, however, he did not think some of these arrangements would be of very much assistance because the

biggest trouble in the past had been removal of mud or suspensions of sand. Consequently filters had been installed and these had given very good results. For instance the labour force required to clean boilers had been cut from sixty to thirty boys, and the scale which used to be from three sixteenths to one quarter of an inch thick, was only about one thirty second of an inch.

The main object in feed-water treatment is to rid the water of sediment which was the primary cause of scale forming and he did not think it necessary to use any expensive treatment to obtain that result, apart from efficient filters and the small amount of chemicals needed.

Mr. WALSH thought that Mr. Hill might have shown an analysis of his feed-water and felt that this would occasion some surprise. He well remembered that when the pre-heater was installed some impurities actually came through with the super heated steam. He agreed with Mr. Macbeth that the best method was to instal proper water-treatment plant to remove suspended solids and some of the hardness. Any electrical apparatus could only be a secondary adjunct.

Mr. PEARCE said that he had used one of these units for removing scale in his car and had found it very successful. Although it was not easy to measure results he had installed it in the car after it had done four thousand miles and now, after running fourteen thousand miles with the unit, no scale was visible and the water was perfectly clean.

Mr. MURRAY in congratulating Mr. Hill on his paper said he was very glad to see something new coming forward in engineering papers read to the Congress.

Mr. WHEELER reported that when the unit was installed in the boiler feed line one was also installed on the clarified juice line to the evaporator. It was difficult to give an opinion on whether it did or did not lessen evaporator scale, as running had been so irregular. One would expect if there were any precipitation of inorganic salts the brix would be lowered and the purity of the liquor would rise. The syrup purity did rise  $0.1^{\circ}$  more than that of the clarified juice after the installation was made, but he was unable to say if that was merely coincidence or not.

Mr. LINDEMAN supported Mr. Macbeth's contention that the best way to treat boiler feed water was to get rid of the solids before it entered the feed tank, but said that this was not always practicable.

There were various new types of boilers coming on to the market such as the electro-boiler, which was unaffected by scale, and had many other advantages.

Electro-boilers generated pressures as high as 2,000 lbs. per square inch.

In the country districts all kinds of boiler compounds are used. Some of these were proprietary brands but the prickly pear was much favoured and gave marvellous results. He had had experience of the use of zinc plates in boilers and had found that at one particular power station they led to excessive corrosion and had to be discarded. Zinc plates were used with success in marine boilers and their beneficial action in that case might be ascribable to the movement which took place at sea.

The action of the second type of unit mentioned in the paper would seem similar to that of the zinc plate, except that use was made of the circulation of the water over the apparatus to break up the electric charge. He considered that good results could be looked for from that type of unit. He was reminded of Faraday's experiments on steam in which he collected an electric charge from the various fluids he put in the boiler. Faraday had found that the addition of turpentine gave a negative charge. The speaker had found that turpentine used in a blanket factory had prevented electric charges from building up and had so eliminated the fires they used to cause. He had also counteracted corrosion in a boiler by wiping the shell with turpentine.

He had worked for a number of years on water tube boilers and had applied a principle whereby an electric charge was neutralised by crossing the tubular system. The movement of the two elements, water and heat radiation, in a direction at right angles to one another caused the electric field normally produced inside a boiler, and his object was to neutralise this field with beneficial effect.

Mr. HILL replying first of all to Mr. Macbeth said that week-end emptying of boilers was not done by choice but was a procedure which had to be adopted. About the first year of this drought he had two sources of supply, one perhaps not very good but the second was very bad. Previous to these dry years, with the better water supply it was not necessary to empty boilers, they merely got a good blow down each week-end. When this supply dried up and the poorer water was used for a few weeks, a tube was found to be burst right at a blister caused by a small accumulation of scale at one spot. After that, it was thought necessary to thoroughly examine the inside of the boilers each week-end.

He did not think that enough attention had been paid to facilities for blowing down of boilers in sugar factories and it was difficult to blow out partially formed scale with the sludge as it circulated in the boiler. Some alteration of boiler arrangements was necessary to enable sludge to be removed more successfully.

While he thought that Mr. Macbeth and Mr. Walsh were most likely right and that outside treatment of water is preferable, the cost was very much higher than the electro-colloidal system, provided that the instrument could give the results the inventors claimed.

He was very interested in Mr. Lindeman's remarks and also in Mr. Pearce's installation of a unit in a motor car cooling system. With regard to the second type of unit mentioned in the paper, he would like to collaborate with Mr. Macbeth and to compare experiences.

The PRESIDENT suggested that it might be possible to form a Committee to investigate and report on any installations of this nature.

He found it interesting to learn of the various substances used for treating waters in boilers. All these seemed to be used before finding out just what chemical or physical processes took place. It would seem that the source of all troubles in boilers is electrical. This was not surprising since all chemical processes are electrical, and there remained much scope for investigation. Such investigation might be, even now, being carried out and we might hear something of this in the future.