THE APPLICATION OF ELECTRO MAGNETIC BOILER WATER TREATMENT

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INTRODUCTION.

Over the last fifty years, magnetic field radiation processes have been advertised as a kind of panacea for water treatment. It has been claimed that these devices require no technical training or control and will treat water nonchemically, to control bionics, prevent scale, and inhibit corrosion. Fluctuating effectiveness and little scientific understanding of the process mechanisms produced substantial skepticism. Recent findings, however, indicate the use of magnetic processes may be a viable aid for water treatment under specific environmental conditions.

History tells us something happens in the presence of magnetic fields. This knowledge has been used in one way or another for centuries. Magnetic force has been widely and effectively used in industry, household and sometimes even in medicine without having a specific scientific explanation.

Improvement of water treatment technology has become one of the major objectives of industry and the search for new water treatment methods, particularly those which do not require the use of reagents has been emphasized.

AIM OF TEST

Aradale Hospital was faced with an increasing cost of conventional chemical boiler water treatment and was in the process of planning a new boiler installation.

We were approached several times to change to magnetic water treatment but due to ignorance and a lack of local practical experience were reluctant to take the risk.

In 1987 when the new boiler house was approved, it was decided in conjunction with the Health Department of Victoria to trial a magnetic water treatment system on our old boiler plant. The equipment chosen carried the trade mark 'Turbomag'.

HOW DOES TURBOMAG WORK?

A strong static electromagnetic field is produced by a coil wrapped round the pipe through which the fluid flows. A rotating impeller inside the feed line transforms the static magnetic field into a rotating magnetic field which modifies the physical properties of the fluid solids.

More exactly, the TURBOMAG process changes the charge structure of colloidal carbonates by polarization. This change of the structure inhibits the binding or adhesive effect of water borne chemicals and minerals on surface walls.

By polarizing the chemicals and minerals form a long aggregate which precipitates rather than adhering to surface walls.

With Turbomag electromagnetic water conditioning, solids precipitate to the mud leg on the boiler which is then removed by blow-down.

The treatment dissolves scale on the boiler tubes thus increasing efficiency and lowering fuel costs.

The machine chosen for the trial was the Turbomag A100 available from Dynamag Pty. Ltd., 123 Camberwell Road, Hawthorn, Victoria, 3122.

TURBOMAG GUARANTEE

The guarantee given with the system was money back, if, after three months Turbomag did not achieve the specifications given by the supplier.

ELECTRO MAGNETIC BOILER WATER TREATMENT

TECHNICAL SPECIFICATION OF BOILER PLANT

The boiler plant originally operated on bunker fuel oil but was converted to distillate firing in 1974.

A summary of steam produced over three years showed a trend towards an increasing fuel usage and a rise in steam produced.

USAGE

Year	Fuel Used	Kg Steam
1984-85	1,089,169 Litres	15,125,888 kg
1985-86	1,063,028 Litres	14,757,812 kg
1986-87	1,158,250 Litres	15,928,586 kg

At the same time chemical costs for water treatment were also on the increase.

Year	Cost
1984-85	$2,268
1985-86	$3,046
1986-87	$5,109

Boilers (two of)	Cowley underfired fire tube boilers.
Fuel	Distillate.
Average fuel consumption per year	+ 1,000,000 litres
Date of Installation	1953
Horse Power	150 H.P.
Operation	Summer - two shifts, Winter - three shifts
Steam Usage	Heating, hot water, cooking
Manning	5 Boiler attendants

CHEMICAL TREATMENT PRIOR TO TEST

The boiler plant was treated by a conventional chemical programme monitored by a boiler chemical company.

Prior to 1981 treatment was slug dosed direct into the feed tank. Subsequent to 1981 the use of an adjustable dosing pump was commenced direct into the feed tank.

The raw water entered the feed tank through a water softening plant and testing was carried out by the day shift boiler attendant on a daily basis.

WHEN THE TURBOMAG WAS INSTALLED ALL TREATMENT WAS STOPPED INCLUDING WATER SOFTENING.

It is fair to say that the chemical companies had reservations and made several attempts to convince us we were making a mistake.

TURBOMAG INSTALLATION

At Aradale it was decided to install the Turbomag directly onto the feed tank and circulate the water by means of an electric pump.

The Turbomag specification called for a flow rate of 12-15 GPM (54-67 litres P.M.) and test points were installed, so that we could monitor the through put.

Flanges and fittings were insulated in order to isolate the unit from possible dissimilar metal electrolysis.

This included insulating the bolts on flanges.

TOTAL DISSOLVED SOLIDS (T.D.S.)

If concentrations of dissolved solids are not monitored and checked in boiler feed water foaming and priming can occur.

At Aradale the Hospital uses 'live Steam' for cooking and if priming occurs it causes problems in food preparation areas.

Another problem that can be dangerous in the event of priming, is carry over of feed water into the steam lines and consequent danger of water hammer possible leading to a failure of the steam distribution system.

The dosing of chemical treatment in itself leads to a solution of dissolved solids in the boiler due to the breakdown of scale on tubes and the chemicals used.

The normal means of controlling T.D.S. is during the routine boiler water testing programme where the boiler attendent will test for T.D.S. and operate the blow down valve to maintain T.D.S. readings within the pre-determined limit.

Under standard chemical treatment systems for boilers the parts per million of the treated water is of great importance and can cause corrosion or scaling.

With Turbomag process physical changes in the structure of water-borne chemicals and minerals is claimed to take place (i.e., polarity), which will remove the aggressiveness of the chemicals and minerals.

Because of these changes, Turbomag treated fluids will precipitate rather than adhere to surface walls.

At the commencement of the trial Turbomag indicated that T.D.S. readings would probably rise due to the breakdown of existing scale then drop dramatically as the boiler became clean.

Figures obtained during the 12 month test period show T..D..S. readings of around 900-1000 P..P.M. and daily blowdown of 2" daily.

The very fact that we ceased all additions of conventional chemical treatment would have led to a lowering of the T.D.S. reading anyway.

In the future I would expect T.D.S. and blowdowns to further decrease as more and more scale is broken down.

Tests were carried out on the T.D.S. of the town water and compared to the treated boiler feed water to compare the two.

ELECTRO MAGNETIC BOILER WATER TREATMENT

DATE	TOWN WATER T.D.S. (P.P.M.)	BOILER FEED WATER T.D.S. (P.P.M.)
11/05/88	40	1100
12/05/88	90	1050
13/05/B8	90	1000
14/05/88	90	950
15/05/88	90	950
16/05/88	90	950
17/05/88	90	1000

Once again as we are not introducing chemicals to our system a proportion of the T.D.S. reading in the feedwater would be due to the action of scale being broken down.

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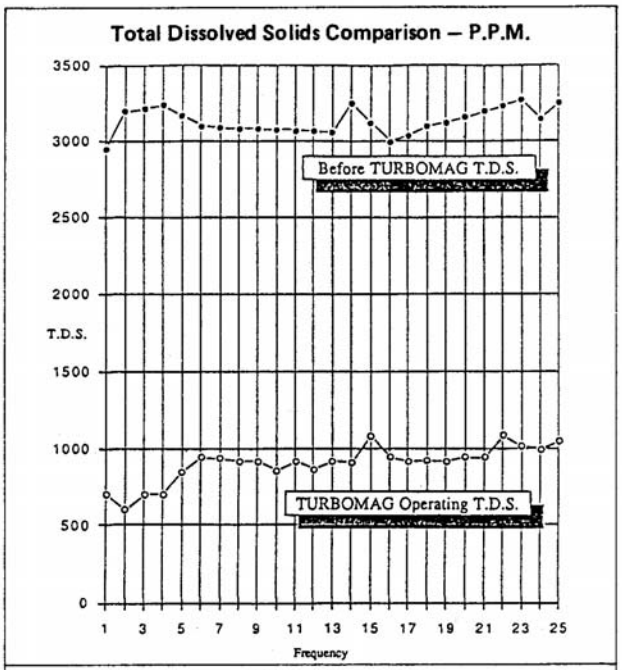
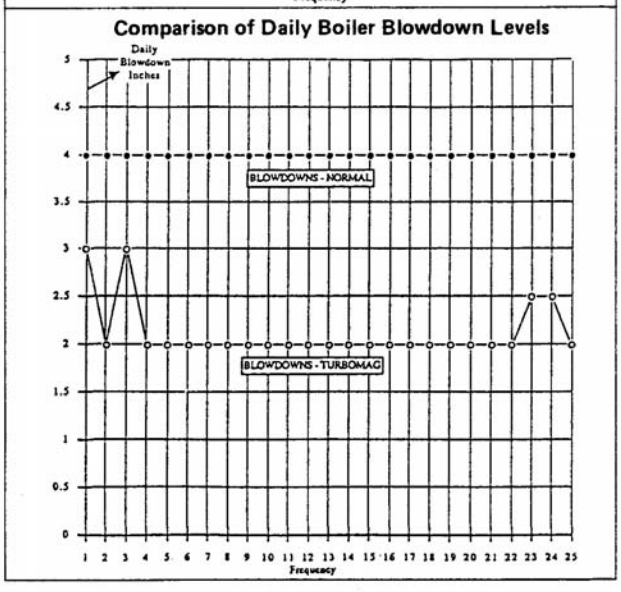




pH RESULTS OF BOILER FEED WATER

The strength of an acid or alkali is measured by the extent to which it is dissociated, or ionized in solution to give H+ or OH-IONS. Pure water is dissociated to give one part in 10 million, i.e., 10 P.P.M. H+ IONS, and one part in 10 million as OH-IONS, the H+ and OH-IONS will balance each other to give an exactly neutral solution and the pH of pure water is considered as 7.

The mathematical formulation is that one in 10 million can be written as 1 in 10^7 or $1/10^7$ which can also be written as10^{-7}.

The index figure with the negative sign omitted for reasons of convenience is taken as the pH value.

pH numbers from 1 to 7 indicated solutions of lessening acidity to the neutral point at 7. Above this value and up to 14 the solutions are in increasing alkalinity.

In practice the maintenance of pH is important in corrosion. The maintenance of alkalinity is important in preventing scale, and fortunately, if the correct amount and type of alkalinity is present to prevent scale formation, the pH value will automatically be correct.

Many technical journals and papers suggest that for the prevention of corrosion, alkaline conditions should be maintained at all times and pH held in the range 10.5 to 11.

pH READINGS ON TURBOMAG

DATE	pH	DATE	pH
01/04/88	7	14/04/88	7

The pH readings on Turbomag on April 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 25, 26, 27, 28, 29 and 30, 1988, was 7.

During the month of April, 1988, the pH reading remained static on 7. This caused concern (even though it is representing a neutral reading), due to industry parameters suggesting we should be in the vicinity of 10.5 to 11.

Subsequent testing was carried out on town water and the readings compared.

DATE	TOWN WATERpH	BOILER FEED WATER pH
11/05/88	6	7
12/05/88	6	7
13/05/88	6	7
14/05/88	6	7
15/05/88	6	7
16/05/88	6	7
17/05/88	6	7

This test showed that after Turbomag the pH went from a reading of 6 to a reading of 7.

The reasons for this is unclear as I can find no reference as to why the pH reading will alter with Turbomag.

Inspections of the Boiler Plant do not at this stage show any indications of problems developing due to a pH reading of 7.

ELECTRO MAGNETIC BOILER WATER TREATMENT

DISSOLVED OXYGEN

Oxygen is brought into the boiler in the air dissolved in feed water and is liberated by the application of heat.

This oxygen may combine with iron forming ferrous oxide or ferric oxide.

Small bubbles of expelled air from the boiler water attach themselves to the heating surface. The oxygen acting on the steel forms rust, which when washed away leaves a small hole or pit.

Normally the problem of oxygen is controlled by:(a) adding an oxygen scavenger (b) heating the feed water.

At Aradale the feed water is heated to 92C before entering the boiler. We initially were concerned with oxygen levels due to discontinuing the use of a sulphite chemical and had thought that this would be a problem area.

Inspections have shown no apparent corrosion in areas likely to be affected. The mains stay in the steam space which would be prone to attack due to the liberation of air from the entering feed water have shown no indication of a problem.

A paper published by the Tulane University School of Public Health and Tropical Medicine, New Orleans, Louisana, states; "inlow and intermediate pressure boilers, the applied-fields have reduced saturation levels of oxygen by approximately 10 to 15 percent, and therefore deaeration has been made more effective by the application of applied-fields which did not require further oxygen scavengers".

INSPECTIONS

During the trial the boiler was opened up on three occasions to physically inspect the steam space and tubes and on each inspection the boiler showed signs of scale removal.

Initially at the time of Turbomag installation the water side of the tubes was coated with a hard layer of scale approximately 1/16" thick. This scale thickness has reduced to 1/32" and shows obvious signs of removal to the naked eye. The interior of the steam drum shows a reddish tinge that at this stage is causing no problem but is thought to be the result of the high oxygen level in the boiler.

RESULTS

Total dissolved solid reading have reduced from a figure of averaging 3200 PPM to a reading of 1000 PPM on Turbomag.

This represents a reduction in blow downs of the boiler plant from 4" daily to 2" daily. It is anticipated that as more scale dissolves the total dissolved solids reading will drop even lower.

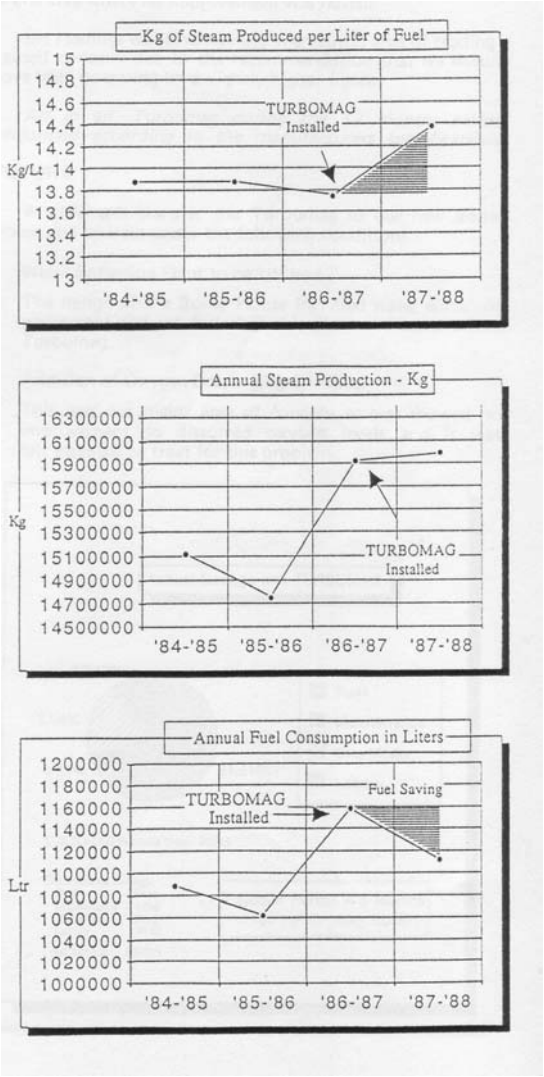
FUEL QUANTITY ANALYSIS

1 In the period Turbomag was installed we observed an increase of steam produced per litre of fuel used over previous years. This increase is due to the scale removal taking place on the tubes and the increase of heat transfer rate.

2 During this period of Turbomag testing we used 1,111,850 litres of fuel to produce 15,994,528 kilograms of steam. This can be compared with the previous year of 1,158,250 litres of fuel to produce 15,928,586 kilograms of steam.

The Turbomag period shows a reduction in fuel used of 46,391 litres of fuel for slightly more steam produced.

This demonstrates one of the claims of Turbomag that they can obtain a fuel reduction on boiler plant. The reduction of fuel used is one again directly attributed to the increase of heat transfer rate on the tubes due to scale removal occuring.



ELECTRO MAGNETIC BOILER WATER TREATMENT

EFFECT ON BOILER ATTENDANTS

Prior to Turbomag, boiler water testing was carried out daily and the firemen would spend on average $1^1/_2$ hours per day sampling, testing, setting chemical pumps, refilling dosing tanks and blow downs, etc..

With the installation of Turbomag the time dropped to $^1/_2$ hour per day which represents a saving in man hours of 365 hours over a year. This enables the firemen to be allocated other duties and is a saving to the hospital.

MAINTENANCE

During the annual inspection carried out on the boiler plant it was evident that the condition of the boiler mountings had improved and generally required less maintenance.

The Weir Feed pumps suffered only one failure in the test period on Turbomag and prior to the installation of Turbomag, failed 5 times on average per year. Failures occurred on the water side and were caused by the rings jamming in the cylinder and water inlet/discharge valves leaking.

The time and costs involved in the repair of a Weir Feed Pump are as follows:

2 Men x 5 hours = 10 hours total
Mechanical spare parts = $280.00

CHEMICAL COST

In the period that Turbomag was tested all chemical treatment was stopped for the 12 months trial period.

This represents a saving to the hospital of $5,415,00 per annum.

ANALYSIS OF COSTS

	1 st Year	2nd Year
Purchase Price	$ 7,145	$ Nil
Fuel Savings	$19,484	$19,484
Maintenance Saving	1,480	1,480
Chemicals	5,415	5,415
Labour	3,640	3,640
	$22,019	**$30,019**
Nett Saving per annum	**$22,874**	**$30,019**

The above figures in the first year of operation represent a pay back period of 3 months.

Improvement in fuel figures will increase as more and more scale dissolves from the tubes.

CONCLUSIONS

The test demonstrated that Turbomag will perform to the manufacturers specifications, those specifications included:

1 Elimination of scale;
2 Increase in efficiency;
3 Removal of existing scale;
4 Turbomag can not adversely effect any surface it contacts.

These points were proven during the test with substantial initial cost savings available in the first year.

The test carried out over 12 months on old boiler plant demonstrated scale removal but the protection offered on new boiler plant was not verified as part of this exercise. Hospital and/or Boiler House engineers view “dissolved oxygen” as extremely harmful to steam raising plant and this is one area where no improvement was noted.

pH readings whilst remaining in a neutral area of reading caused concern due to the recommendation that we should have been operating on a slightly higher figure.

All in all, Turbomag during the 12 months period performed according to the manufacturers specifications.

FUTURE

Aradale will transfer the Turbomag to our new Boiler House and operate under the following conditions:

1 Water Softening Plant to be Utilised.

The design of the Boiler House included water softening equipment and we feel that this plant will complement Turbomag.

2 Addition of Oxygen Scavenging Chemical

This was our major area of concern as test showed no improvement in dissolved oxygen levels and it was felt essential to treat for this problem.