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December 16, 1980
533-4207

Dr. Duane Nowlin
Ecodyne, The Lindsay Division
P.O. Box 43420
St. Paul, Minnesota 55164

Re: Magnetic Water Conditioners

Dear Dr. Nowlin:

Enclosed is a copy of our last year's laboratory evaluation for your files on Bon Aqua. Apparently, Bon Aqua has gone out of business; but their sales agents, Techniclean, continue to market another magnetic product. Our Attorney General has therefore released this report.

Also enclosed for your information and files is a recent EPA Region V document on these devices. I am not so sure they are impartial in their comments since they have measured nothing themselves.

With Best Wishes,

Larry Scanlan

Larry Scanlan
Chief, Technical Assistance
Bureau of Public Water Supplies

LPS:es

Enclosures

74-

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V

DATE: November 20, 1980

SUBJECT: Investigation of Magnetic Water Conditioners

FROM: **STEVE KIERAS**
Joseph F. Harrison, Chief
Water Supply Branch, Region V

TO: Regional Representatives (Regions I-IV & VI-X)
Gary Logsdon, MERL, Cincinnati, Ohio
Peter Lassovsky, ODW, Washington, D.C.

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The attached two papers provide an interim report of a special survey we have embarked upon and brief abstracts of papers on the subject which we have obtained.

Our survey covered six areas:

1. Review of literature.
2. Discussion with proponents.
3. Discussion with manufacturers.
4. Discussion with detractors.
5. Field visits to users.
6. Observation of an installed device.

Future work will continue in all of these areas, but will emphasize the field visits to users and the observation of an installed device. Should you desire more detail from us or copies of specific papers, please contact Don Maddox at (312) 886-6183.

Attachments

bcc: Mr. Jack Hoffbuhr

Investigation of Magnetic Water Conditioners

Following discussion with Dr. G. Logsdon of MERL, Cincinnati, and Mr. P. Lassovszky of ODW, Washington, I decided at their suggestion to pursue further data on this purported water treatment method.

It was decided to take several approaches:

1. Review of the literature independently.
2. Consultation with proponents of the method (George Elliott, Robert Corning).
3. Consultation with manufacturers (Kemtune, Hako).
4. Field visits to companies or individuals having the equipment already installed.
5. Obtaining one or more devices, installing them ourselves and observing them in operation.
6. Consultation with detractors of the method.

The Literature

Initially, our review of the literature turned up very little. There were several articles by Eliassen who worked at MIT and several articles from Belgium and Russia. The former demonstrated the devices did not work for Eliassen's test while the Belgium and Russian articles describe great effectiveness in scale prevention using electro-magnetic devices.

It should be mentioned here that we have become aware of four different non-chemical equipment types which purportedly work particularly well at preventing scale build-up. These types are permanent magnet, electro-magnet, dissimilar metal alloy, and high frequency current.

A brief review of the information we found on these devices begins with work done in Belgium as early as 1945 by Vermieren. In 1952, Eliassen published an article in JANWA comparing claims of non-chemical water conditioning devices with scientific fact. From this article, it can easily be seen that American advertisers do get carried away. Many of the claims appear to have been based on subjective observations of users. Also, many of the claims use scientific jargon incorrectly, making the claims easy to ridicule or disprove without any real empirical experience. In the mid 1950's, a dissimilar metal device (Evis) appeared on the market which rapidly gained in use and soon came to the attention of the FTC apparently on complaints from conventional chemical treatment suppliers. Then began a see-saw of what counts, user satisfaction or scientific testimony by non users. First, in 1956, the FTC examiner dismissed the complaint on the basis of the testimony of 92 users including licensed professional engineers, operating engineers and others who had been faced with critical water problems which had been substantially alleviated by use of the device. In addition, the examiner

magnetic types of equipment and who had urged us to look into its usefulness further. We contacted Mr. Elliott for further information on the location of devices in use and for information on manufacturers. A check of the yellow pages had revealed only one non-chemical equipment supplier (Ultrasonics - a high frequency current device). Mr. Elliott proved to be a source of much information including testimonial type letters, several studies and candid detail on what had apparently happened in the past.

~~Mr. Elliott's~~ background is that of a real estate manager, through which he became interested in these devices (protection of apartment boilers). After seeing several devices (CEPI, EVIS and Packard) apparently prove their effectiveness, he became a user of them and began gathering information on them. He states that the Evis (a dissimilar metal device), electrostatic, and magnetic units are definitely effective. Mr. Elliott noted that he had seen numerous frauds on the market also. He stated as an example devices he had seen with wood dowels and plain copper spikes as cores. He also questioned how the devices which clamp on could work noting that many such devices have very weak magnetic fields and would seem to be capable of subjecting the water to no magnetic effect where the pipe is iron or an iron alloy.

Mr. Elliott wrote the article "Revolutionary Water Conditioner" published in the July-August 1976 issue of the Journal of Property Management. Mr. Elliott worked briefly for Hako from 1972-1975, but presently is retired. His activity in retirement has been gathering information on magnetic treatment and trying to convince government and other interested officials of the economic potential of magnetic treatment in this age of high costs, inflation and environmental degradation.

In mid-October, Mr. Robert Corning of Serco Laboratories contacted our offices by letter regarding his independent tests of the Polar (Norway) unit. His experience began in the late 1950's when he was visited by a Packard salesman. At that time, he rejected the proposed installation on the basis of "knowing" the principle could not work. In 1977, Mr. Corning had the opportunity to visit Norway and during his visit became interested in the company manufacturing the Polar Water Conditioner. He returned to the United States with several units which he had installed at several problem locations in Cedar Falls, Iowa. Those installations showed graphic results which made a believer of Mr. Corning.

Consultation with Manufacturers

On leads provided by Mr. Elliott, we were able to contact and meet with Mr. Charles Sanderson of the Kemtune Company (Ft. Wayne) and Messrs. Kent and Merrill Kontmeier of Introdel Incorporated (Chicago). Both manufacturers were cooperative.

found the "scientific" testimony to be severely flawed. On appeal to the FTC commission, the case was remanded back to the examiner for the receipt of further scientific information. After considering the additional scientific data, the examiner again dismissed the complaint in June 1958. Then, on April 3, 1959, the FTC commission set aside the examiner's decision and ordered the manufacturer to stop claiming its device had any beneficial effect on water. Finally, on March 6, 1961, appeal to the U.S. Court of Appeals was confirmed and the FTC commission's decision was discontinued with the statement. "The Commission erred in disregarding the testimony of the user witnesses. We cannot sustain the findings of the Commissioner as they are unsupported by substantial evidence. The order of the Federal Trade Commission is set aside." By this time, however, the company has lost one of its two owners due to heart failure and with its business reputation in ruins due to the publicity of the FTC investigations, it soon went off the market. The reading of this record is very interesting particularly with regard to what constitutes scientifically sound testimony. Most of the scientists involved were revealed to have been previously biased against the device and, although this bias was not in itself damning, it led individuals of otherwise impeccable reputation to come to conclusions not warranted by the data available to them, to come to conclusions with incomplete data, to ignore instructions as to proper methods of installation prior to testing, to disregard significant differences between their experience and what was being evaluated, to make carte blanche statements which their own testimony later amended or qualified, to conduct tests obviously not directly relevant to the performance sought to be measured, to fail to conduct tests obviously relevant to the performance to be measured, and to incorrectly interpret obvious meanings of advertising statements for the Evis.]

In the same time period, Eliassen followed-up his 1952 article with laboratory tests reported in JAMWA in 1957 and 1958 of the Evis, the Packard and the Capi (the latter two were both flow through permanent magnetic devices). These tests did not show any positive effects of the devices on the treated water's quality. That water quality, it should be noted, was not typical of water on which these devices are usually used with purported success. The study reports also omitted several critical points such as flow rate and electrical grounding which the manufacturer's literature specifically note can cause failure of the devices. Despite these discrepancies, these two reports appear to form the basis for the practically universal skepticism which exists today regarding the efficacy of these devices.

Discussion with Proponents

Coincident with our decision to pursue further information on these devices, we found in our files reference to a visit made to our offices by a Mr. George Elliott who has had long experience with the permanent

The Kemtune Company (Superior) formed in the early 1960's and was based on the purchase of the Packard patents. Kemtune was originally limited to commercial and industrial applications. Merrill Kontmeier in the late 1960s worked as a salesman for Kemtune and set up his own company based on a change in design of the magnetic device, an idea to sell to residential users and small commercial applications and a disagreement with Kemtune management.

Introdel makes a small unit series, 1-200 gpm, which caters primarily to small applications, coffee brewers, humidifiers, etc. Upon seeing the success of Introdel, Kemtune broadened its line to include small units so that it now has a series running from 3 gph to 15,000 gpm.

From our consultations with Mr. Elliott, Mr. Sanderson and Messrs. Kontmeier, we were able to obtain copies or portions of studies done by various persons and Universities other than Eliassen. These are:

1. Report on Performance Test of Packard Water Conditioner - Professor Paul Broten, Cornell University, 11/14/57. Test of old and new pipe installation at university dormitory over 7/4/56 to 5/6/57.
2. Letter describing test results - Professor Alan Rubin, Ohio State University, 4/30/73. Test shown to be effective in preventing formation of scale. Theory of dissimilar metals advanced as reason for effectiveness.
3. Magnetic Treatment of Water - Advance Research Projects Agency, Department of Defense, 1/30/73. Paper summarizing Russian work.
4. Study of Electric and Magnetic Treatment of Water to Prevent Sealing and Corrosion: Biological and Medical Implications" - Dr. Ergun Ar and Dr. George Nace, University of Michigan 3/30/73. Paper showing conclusions from preliminary tests indicating beneficial effects of magnetic water treatment.
5. Physical Testing of Treated Water (Superior Water Conditioner) Residues versus Non-treated Water Residues - United States Testing Company Inc., 12/5/68.
6. Capi Process in Industry - Theo Vermeiren, Epuro S.A., 5/15/73. Paper by the purported 1945 inventor describing device's principle and applications.
7. Evaluation of CEPI-COMAV Unit for Magnetic Treatment of Water - Ruakura Agricultural Research Center, Ministry of Agriculture and Fisheries, New Zealand, 8/26/76. Unit shown to be effective.

The manufactures were also quite cooperative in passing on adverse studies which had come to their attention. Such information included:

1. Test of a Magnetic Water Conditioning Device - L.S. Herbert, CSIRO Division of Chemical Engineering, 10/70. The test demonstrated no strong influence of magnetised water in an operating boiler.
2. Electrostatic Descaler Testing: An Evaluation - M. Meckler, Meckler Associates, 8/74. An installation which over 6 months was not observed to provide any benefit.
3. Descal-A-Matic Magnetic Water Conditioner Test - Advance Engineering, 6/26/75. Questionable results shown. Rebuttal by manufacturer attached.
4. Do Water-Conditioning Gadgets Work? Welder and Partridge Hall Laboratories, 10/53. A well written paper documenting various systems for preventing scale and corrosion as far back as 1865. Documents a large number of failures for various devices but does not name the devices (descriptions of the device and manufacturer claims are given).
5. NASA Tests of Descal-A-Matic Device, 5/75 - 11/77. This work describes a well designed corrosion test system which was apparently very poorly and carelessly applied in testing the Descal-A-Matic Device. Initial excellent results are followed by negative results in two subsequent tests conducted 5 months and 13 months later. Then the unit was installed on the make-up water for a 125 ton cooling tower system with negative results. The manufacturer advises the unit was improperly applied (recirculated water must be treated at least in part) and could not have succeeded.

Field Visits and Telephone Calls to Users

For this part of the project, we referred to limited information available in our files and requested names and addresses of users from Kemtune Incorporated. The manufacturer provided us with the address and phone numbers for 10 users in the Chicago area.

The results of these telephone visits and phone calls are as follows and were recorded on a pre-established form:

1. Has installed Superior C-100 on a computer room humidifier. Humidifiers historically need cleaning about every 30 days. To be visited when winter season and use of humidifiers is initiated. Hardness is 458 ppm.
2. Grocery installed Superior R-1000 on cooling water for store refrigeration. Also has units installed in home for humidifier and hot water heater. Previously build up of scale would cause overheating of compressor-condenser which require acid cleaning of

- system. Since installation in 1978 has not had an overheating problem or required acid cleaning. Hardness is 125 ppm.
3. Has just installed on ice machines and coffee makers in new kitchen. No previous experience. No opinion as of 9/80. Hardness is 125 ppm.
 4. Installed Superior R-2500 and R-2000 on water cooling tower. Previously used water softener and required algae and foam control with chemicals. Have eliminated chemicals, manpower needed to check water quality and need for automated control devices. As of mid-September had been in operation for 3 months with apparent success. Hardness is 157 ppm.
 5. & 6. Both Indianapolis, not visited.
 7. Michigan user not visited.
 8. Installed Superior R-750 in home with over 400 mg/l CaCO_3 hardness. Installed 2 years ago after hot water heater failed in four years due to CaCO_3 build-up. Previously faucet strainers had to be cleaned every week, now only every 3-4 months. Notice deposits on dishwasher walls appear to be clearing up. Hardness is 576 ppm.
 9. & 10. Not visited as yet.
 11. Installed four years ago at university for domestic hot water heaters, ice making and dish washing machines. Previously had to clean hot water tubes 2 times per year. Has not required cleaning since installation 4 years ago.

Observation of an Installed Device

Through our contact with the Kemtune Corporation, we obtained a R-100 Superior Unit and installed it at Mr. Prince's home. (Region V. Toxicologist). Mr. Prince lives in LaGrange where the water quality has historically ranged from 300-500 mg/l total hardness. We note the water quality for LaGrange had drastically changed in March 1980 when a renovated softening system had gone on line (the hardness is now about 100 ppm).

After six weeks installation, observation of the device's influence on water flow and deposition in system piping was inconclusive primarily due to errors in our installation. Observation, however, of lime deposits on a kitchen drain board showed that the previously hard scale deposits had been removed. The evaporator element of a furnace humidifier had been heavily scaled and now appeared to be much cleaner. Previously hard deposits of scale in the water reservoir were easily

removed. A basement water tap which previously had to be opened with a wrench, now could be opened by hand. Flow at this tap was improved by still greatly restricted. These improvements might be a result of the water quality improvement and our attention to the system. The clean up of the drain board, however, was too coincident to the devices installation to attribute to a March 1980 improvement in water quality.

For the future, we plan to run some brief experiments using treated and untreated water and install the device on a real problem water. Our present installation is unsatisfactory due to the high degree of treatment now provided by LaGrange.

Discussion with Detractors

In mid-September, we met with Mr. John Scanlon of Culligan regarding small system problems in meeting the NIPDWRs and the industry's capability to provide treatment equipment to meet these problems. This meeting was initiated by and conducted by EPA consultants from Temple, Barker and Sloan.

It was mentioned casually that we were interested in magnetic water conditioning and Mr. Scanlon was asked if he had any information and what his opinion was. He stated that "you either work with nature or you fail. Since the magnetic water treatment devices work against the laws of nature, they must fail." He provided a brochure which included a Culligan paper on why water treatment gadgets cannot work, the Meckler paper on an electrostatic device (1974 test), the Welder and Partridge papers (1954) and the Eliassen papers, (1957 and 1958).

In mid-October, Dr. Duane Nowlin of Lindsay Division was contacted by telephone for information on magnetic water conditioners. He informed us that the South Dakota report (Water Quality Association contract) could be expected to be completed in one to three months. He also described a wealth of information he had available on this type of equipment and offered to provide copies of about 15 studies and summaries he had collected. We subsequently received from Mr. Nowlin: The Meckler paper; various court findings, Better Business Bureau issuances, and State Attorney General investigations on Bon Aqua and other devices (Arizona, Minnesota, South Dakota, Illinois, and Utah); summary statements on tests of three units (Hydrotron, Cepi-Comav, and Aqua Scale Control) by the U.S. Naval Engineering Experiment Station, Annapolis, Maryland; Efficacy Test of the Bon Aqua by Truesdail Laboratories; Magnetic Water Conditioners: Are They for Real? Water Well Journal, 1979; "Evaluation of Electr-A-Sonic Water Treater," Canadian Ministry of Environment 8/77; and Report of Testing of the Bon-Aqua Broom Water Conditioner, Engineering Experiment Station, South Dakota School of Mines and Technology" 4/3/79.

Further Observations

Interesting on-going activity concerns the South Dakota School of Mines and Technology which is conducting a research investigation of magnetic units under a contract with the Water Quality Association. This research was reported on by Dr. Nowlin of Lindsay Division in March 1980 at the WQA annual conference. Hopefully, the research will not be biased by Dr. Nowlin's obvious opinion even though it is primarily funded by the chemical and softener industry through WQA. The fact that the researchers did not contact the manufacturers for the equipment to be tested, and did not seek to consult with the manufacturers or their representatives regarding installation and operation, does not pretend an unbiased research product.

Rather than provide copies of the many papers and studies we have received on this subject, attached is addendum listing them with a brief statement on their content. In some cases, I have included critical comments which, I hope, are fair and objective. At this point, I personally believe there are beneficial effects which result from exposure of problem waters to magnetic fields. Right now our efforts are being directed to determining conclusively whether or not hard scale prevention and removal of existing hard scale can be achieved by such exposure.

Observations on Various Studies and Reports Regarding
Non-Chemical Water Conditioners

1. "So-called Electrical and Catalytic Treatment of Water for Boilers" by Eliassen and Uhlig, 1952.

This paper excerpts various claims and statements made by non-chemical water conditioner manufacturers and sales media. The claims are then picked apart in terms of the scientific jargon used. No empirical data is developed.

2. "Experimental Evaluation of Water Conditioner Performance" by Eliassen and Skrinde, 1957.

This study evaluates Evis conditioned water (a dissimilar metal device) against untreated water. Unfortunately a relatively soft water (62 ppm total hardness, 24 ppm alkalinity) was used for the tests, so that it is hard to see how short term tests could have proven anything. To be truly valid one would expect that tests should have been conducted with a problem water, ie one having high hardness. In addition, a number of the tests can be criticised as to whether they truly measure what the manufacturer claimed or not.

3. "Experimental Performance of Miracle Water Conditioners" by Eliassen, Skrinde and Davis, 1958.

This study evaluates the Evis, the Packard (a permanent magnet device), and the Capi (a permanent magnet device). Again high quality Cambridge tap water was used for the experiments with hardness added for some of the experiments. Most of the tests were short term and did not duplicate the situation of water in pipes under pressure. Even so, several of the experiments appear to have been aimed at benefits claimed for the devices and should have shown some effect if the devices are effect. The authors do not present adequate detail defining what was done for anyone to reproduce the experiments (flow rate, etc). The curves are remarkable for their continuity in every case. Normally one would expect some anomalies for so much data. In several cases the curves go to 0,0 as an origin where the authors do not appear to have had data (Figures 3, 4, 5, 6 and 8) or where 0,0 could not have been the origin due to the hardness of the raw water (Figure 7). This might be nitpicking, however, and some attempt should be made to reproduce Eliassen's work with cooperation from the manufacturers to assure no confounding influences cause question with regard to the results.

4. "Magnetic Treatment of Liquids for Scale and Corrosion Prevention" by Vermeiren, 1958.

In this paper, the author describes effects of magnetic treatment and causes of treatment failures. In general, failures are attributed primarily to too high a flow rate, iron oxide fouling of the magnet, stray electrical currents due to use of water pipe as a ground, and aeration of the water to be treated. The author also describes various applications.

5. "Magnetic Treatment of Water" by Belova, 1972.

A paper describing Soviet Russian experience and the controversy over how magnetic treatment works. The author refers to research from 1950-1970 which demonstrated changes in scale formation, improved ion exchanger take-up capacity, reduced corrosion, improved flotation, improved capacity to remove dusts and improve cement stability.

6. "On the Magnetic Treatment of Feed Water for Steam Boilers" by Todorigev and Yovchev, 1962.

This paper describes the problem of control of chemical treatment of water for small boilers (unskilled operators) and suggests magnetic treatment as a solution in Russia. A very good discussion of the treatment method is presented including advantages and disadvantages. The authors also describe tests run on a 5 tube boiler in 1960. Those tests concluded that the treatment was successful.

7. "Revolutionary Water Conditioner" by Elliott, 1976.

This paper deals primarily with the results of the FTC hearings on the Evis and the Eliassen reports and the impact of these two occurrences in 1952-1958 on the acceptance of magnetic and other water conditioner used in the United States.

8. "Report on Performance Test of Packard Water Conditioner" by Broten, Cornell University, 1957.

Empirical observation of the unit installed in two systems practically scaled solid showed a restoration of flow. An empirical test was then set up with old scaled and new pipe to secure evidence of scale removal. No control loop was provided in the test. At the end of nine months, water flow through the old pipes had visibly improved and the pipes had lost weight indicating a loss of scale. In addition, a significant amount of loose granular material was removable by rapping from the old pipes. For this study we do not have the assurance of calibrated scales and different scales were used for initial and final weights.

9. Letter from Dr. Alan Rubin, Ohio State University, 1973.

Dr. Rubin's letter states that he found the Superior device effective for preventing formation of scale. He theorizes, that the unit acts as a galvanic cell which produces metal ions which change calcium precipitate character. He further describes experiments using metal salts (zinc, lead, tin) that produced a similar effect to that produced by the Superior unit. ✓

10. "Magnetic Water," Review and translation of magnetic treatment papers by several Russian authors including Belova and Klassen, done by Stevovich, 1973. Department of Defense.

This paper reiterates the material described above in item 5. The paper states there are several thousand installations in Russia (1969) and expands the list of purported benefits. Four research projects including field applications are described briefly.

11. "Proposed Study of Electrical and Magnetic Treatment of Water to Prevent Scaling and Corrosion, Biological and Medical Implications." Dr. Ar, University of Michigan, 1973.

Initial work for this study was done under a grant from the Institute of Environmental Quality. The paper provides a good discussion of scale formation and discusses the CEPI-COMAV device. Experiments describing definite effects attributable to exposure of water to a magnetic field are reported. The electrical pulse treatment method is also reported on as having shown definite effects on scale formation and plant growth. The paper is a well prepared document intended to obtain further grant funds for expanded research on this subject. Funding was not approved, however. An attached report by Dr. Kaufman, Department of Botany, describes literature and experiments documenting the effect of magnetically treated water on biological systems (plants, algae). Another attached report by Dr. Nace, Department of Zoology, describes work done with tadpoles and proposes further work.

12. "Physical Testing of a Water Conditioner" United States Testing Company, 1968.

This paper describes several simple tests which show physical differences between treated and untreated water. Most interesting is a test showing graphically different effects of treated and untreated water passed through glass tubes stuffed with steel wool.

13. "The Capi Process in Industry" by Vermeiren.

This paper describes what the Capi is, what it does, and how it is applied.

14. "Test of a Magnetic Water Conditioning Device" by Herbert, 1970, Australia.

This paper describes a field test of two boilers with previous severe scaling and corrosion problems despite costly chemical treatment. The experiment was well described and controlled but a radical change in water quality (10 fold reduction in hardness) occurred during the four month test period. Both the treated unit and the untreated unit were found to have cleaned up with a slight advantage to the magnetically treated unit.

15. "Electrostatic Descaler Testing: An Evaluation" by Meckler, 1974.

This paper describes a six month test using a non-problem water (82 ppm total hardness). The author describes a badly corroded and scaled system prior to installation but observation of the photographs provided indicates that pipes were only lightly scaled with large corrosion tubercles. Observation of the "before treatment" and "after treatment" pipes entering and leaving the water heater indicate improvement which the author ignores.

16. "Test of Descal-A-Matic Magnetic Water Conditioner" Borg-Warner Corporation, 1975.

This test appears to have been carefully designed not to differentiate between hard scale and the sludge said to be produced by the magnetic treatment. The paper states there was no indication that a soft purgeable mud was formed and yet pains were taken to not flush non-adhering deposits from the tubing used to collect precipitate.

17. "Do Water-Conditioning Gadgets Work?" Welder and Partridge, 1953.

This paper reports on the effectiveness of 5 devices; two electric current devices, two dissimilar metal devices, and an inert metal electrode device. A summary of various devices reported on since 1865 is provided in a table including year, author, and principle of device. An extensive bibliography of 106 references consisting primarily of US and British patents is provided. As a discrediting paper it is very well written providing numerous briefly stated case histories of failures. The authors go on to briefly describe three other devices including the permanent magnet device which were appearing on the market but for which the authors had no case history information. The oddest discrepancy I note with this paper is that the Evis Water Conditioner is obviously described and, although the authors had been aware of it for only one year, seven case histories of failure are reported. The odd thing is that shortly after the appearance of this article, FTC began an investigation into the Evis which lasted from 1954 to 1961. In that time

and in all the testimony involved, 92 case histories of success and no case histories of failure were reported to FTC. Over 100,000 of the devices were sold. What happened to the multitude of failures indicated by Welder and Partridge for this device?

18. "National Aeronautics and Space Administration, Lewis Research Center Test of Descal-A-Matic" 1975-1978.

This series of correspondence describes an initially successful experiment, followed by two failures. Instead of following up the initial success with a more carefully controlled experiment to verify the first test, NASA chose to delay tests from 5/75 to 10/75 to 6/76. Although their letter reporting initial successful results indicated excitement in a potential breakthrough, their action in follow-up was less than prompt. The experiments described are flawed by lack of controls and poor attention to system detail. (No cleaning of test system from prior chemical agent tests, no consideration of residual effects of treatment, unbalanced parallel systems, no raw water control experiment, lack of equilibration).

19. "Interesting Practical Test Installations in Cedar Falls, Iowa" by Corning, Corning Laboratories, 1978.

This brief paper with photographs describes a successful installation on hot water heater feed water and its effects on scale formation in the hot water heaters and on the heater elements. The unit installed was a Polar permanent magnet device.

20. "FTC on the Evis Water Conditioner" FTC and Ninth Circuit Court Records, 1956-1961.

This series of papers consists of the hearing examiners initial decision; the FTC Commission's opinion, findings and order; an AWWA article on the FTC Commission's decision; and the decision of the 9th Circuit Court of Appeals. In short, the hearing examiner dismissed the complaint as unsubstantiated by the evidence available (April 1956), the Commission remanded the case back to the examiner for consideration of further evidence (I do not have a copy of the remanding document), the examiner again dismissed the complaint (June 1958), (again I do not have this document), the Commission overrode the examiner's decision and issued a cease and desist order (March 1959) and the Circuit Court set aside the Commissions cease and desist order as being unsupported by substantial evidence (March 1961).

21. "Test of CEPI-COMAV Unit for Magnetic Treatment of Water" by Ruakura Agricultural Research Center, New Zealand, 1976.

This paper describes an experiment to test the subject unit for the treatment's effect on scale formation in stills. The unit was

found to successfully prevent scaling in clean stills and was found to cause the loosening of scale in a previously scaled-up still.

22. "Test of CEPI-COMAV Unit for Prevention of Scale in Vapor Compression Sea Water Stills" by U.S. Naval Engineering Experiment Station, 1954.

This is one of a series of at least three tests of different units run at the International Nickel Company test site. Five-hundred hour runs with untreated runs before and after each treated run showed no difference between the scale formed in treated or untreated runs.

23. "Bon Aqua Efficacy Testing" by Truesdail Laboratories, 1979.

This paper records before and after water quality tests, a taste test of orange juice prepared with before and after water, and a suds volume test. None of the tests showed any variation for before and after treatment water.

24. "Magnetic Water Conditioners: Are They for Real?" by Gass, 1979.

In an article appearing in the Water Well Journal, the author describes empirical observations and tests run by a distributor which failed to demonstrate effectiveness for the Bon Aqua device.

25. "Test of Bon-Aqua Broom Water Conditioner" by Engineering Experiment Station, S.D. School of Mines and Technology, 1979.

Four tests; boiling time, dissolution of limestone, Ivory bar soap sudsing and Joy liquid soap sudsing showed no effect resulted from the treatment.

26. "Report on Investigation of Magnetic Water Treatment Devices" by Nowlin 1979.

The author reviews the status of a Water Quality Association study of the Polar, Superior and Bon-Aqua magnetic devices. The study is expected to produce results by November 1979.

27. "Non-Chemical Water Treating Devices" by Westcott, 1979.

The author provides a general criticism of water conditioner devices. An unrelated case in which the author was burned in trying to cash in on a miracle material is described and the author places all non-chemical water conditioners in the same class. The Evis case is discussed with the author misrepresenting or erring on several key facts of the case. The author criticizes the U.S.

Ninth Circuit Court as being legalistic and technically inept. In fact, an unbiased reading of the record of the Evis case shows that the hearing examiner and the Circuit Court were quite fair and technically competent in their judgement. The paper then goes on to criticize the use of testimonials and the explanations of how such devices work.

28. "A Viable Approach to Water and Waste Treatment" by Reimers, et al, Tulane University, 1980.

This paper appears in parts aprts in Water Technology and describes investigation of field applications of an untrasonic/electrostatic device. The device was shown to be effective for descaling and bacteria inhibition.

29. "Evaluation of Electr-A-Sonic Water Treater" by Bondhead Water Works, 1977.

This paper describes an application of an ultrasonic/electrostatic device in an attempt to control iron precipitation (5 mg/l) and reduce the need for chlorination. The device was shown to have marginal capability to reduce total plate counts but was not nearly as effective as chlorine (20% reduction vs 99%) and did not reduce total coliform counts. Turbidity deteriorated following treatment by the device, indicating iron precipitation and bacterial growth in the treated water. No attempt was made to check the treatment's effect on the chlorination process.

30. "Does Magnetic Water Treatment Influence Precipitation of Calcium Carbonate from Super-saturated Solutions" by Ellingsen, 1979.

For this study, two well waters were passed through a 1000 gauss magnetic field, then super-saturated by the addition of calcium hydroxide and the rate of precipitation observed. It was found that the rate of precipitation as measured by pH change with time was significantly affected by the treatment. A similar effect was not observed for distilled water super-saturated with calcium hydroxide.

31. "Magnetic Water Treatment: Black Magic or a Scientific Reality?" by Ellingsen, 1980.

This paper related to two experiments. The first ran two identical boilers with the same water feed rate and showed large reductions in scale formed for the treated water. The second measured changes in the rate of precipitation and showed that increased rates of precipitation were caused by increasing magnetic field strength.

32. "Study of the Effect of Magnetic Treatment" by Kristiansen, Norwegian Institute for Water Research, 1977.

Tests on boiler water for treated and untreated units operated in parallel showed a reduction in pH for the treated water. Examination of treated and untreated precipitates showed a difference in structure with the untreated precipitate being more amorphous and more strongly adhering to glass surfaces. Xray examination of the precipitated calcium carbonate produced by rapid evaporation of treated and untreated water showed a significant difference in form (calcite proportion vs aragonite proportion).

- / 33. "Investigation of Magnetic Water Treatment Devices" by Duffy, Clemson University, 1977.

This dissertation found that magnetic fields only had an effect on the pH value of colloidal $\text{Fe}(\text{OH})_3$ and increased the corrosion rate of iron. The paper suggests that the iron ions produced by increased corrosion retard the growth of CaCO_3 .

34. "Critical Review of Literature on Formation and Prevention of Scale" by W.L. Badger and Association for Office of Saline Water, 1959.

This paper discusses the mechanisms of scale formation and prevention. Water conditioning devices are briefly discussed as coming in two categories - gadgets which are ineffective and those affecting pH or seeding sufficient to cause a beneficial effect.

35. "Bon Aqua Performance Tests" by Utah Department of Health Laboratory, 1979.

For this study, Bon Aqua units were installed on a high hardness water line with before and after taps. A series of soap and scale tests were run. The soap test was conducted by adding Joy Liquid to treated and untreated samples and shaking evenly. No differences in the height of soap suds developed was found. The scale test was a standard marble test and indicated both waters were scale forming. According to my understanding, this scale test, if Bon Aqua works similarly to the Polar unit tested in Norway, should have detected a difference between treated and untreated water since the process purportedly changes the rate of precipitation. In view of the encrusted fixtures noted by the author, it would have been helpful, if the devices had been placed on a line to a representative fixture to check for effects on that scale already present. This, however, was not done. *It was but not reported and it was*

inconsistent, I didn't clean it up!
J.S.