Magnetic Separation News, Vol. 2, pp. 179–187
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TREATMENT OF DRINKING AND IRRIGATION WATER IN ANIMAL AND PLANT HUSBANDRY BY ELECTROMAGNETIC TECHNOLOGY

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Abstract

A survey is given of recent preliminary results of a broad-based investigation in Israel of the potentially beneficial effects of the magnetic treatment of water on plant and animal husbandry.

INTRODUCTION

The professional literature quotes and mentions physical techniques for the prior treatment of water to be used for irrigation and drinking in agriculture (1) with a view to altering the basic physical properties of the water, which in turn is intended to increase yields of both plants and animals. These techniques are based on the application of an external magnetic field, mechanical energy, or controlled hydraulic energy.

These methods are not utilized in practice, since the efficiency of the pertinent devices is low and the scientific and engineering background as well as an understanding of the underlying mechanisms are lacking. For the same reasons professional publications have been received with great scepticism by academic circles and engineering experts.

In research carried on at Technion concerning the influence of low-power magnetic fields on the properties of water in a regime of laminar flow (1,3) it was found that these fields affect the functioning of inorganic membranes. Improvements in the efficiency of operations and the kinetics of the process were achieved. On the strength of these findings it was decided to test organic membranes as regards the mass transfer through them; and when positive primary indications became apparent, field tests were devised for treating the water to be consumed by animals and plants in order to examine the cumulative influence in agriculture (4) in the framework of the research, which lasted four years. The following points were stressed:

a) The type of instrumentation: Field strength, gradient, character of the magnetic circuit, directions of water flow, flow regime, flow rate, etc.

b) Water quality: Type, composition and quantity of solutes, electrical conductance, pH, temperature.

c) Operating conditions: Flow rate, operation in open or closed circuit, pressure drop, form of installation, maintenance procedures, etc.

d) Costs and technical adaptation to the needs of potential clients.

The field tests embraced a number of branches: ruminants (cattle, goats, sheep), poultry (chickens, geese, turkeys), as well as field crops (vegetables, fruits, etc.), in order to determine the efficiency of the prior treatment, its power, and the period of effectiveness achieved as a function of the various parameters. On the strength of the findings it was possible to optimize the technical aspects in prepraration for the design and construction of the system and for improving the equipment. At the time of writing over 150 units of this type are operating throughout this country.

The point of departure for the experimental work was an examination of the findings while disregarding the nature of the mechanism, the reasons for the phenomena, the location of the mechanisms, and the explanation of the effects. Rather, long-term field observations were made at the experimental sites, with and without magnetic treatment. Repeated experiments were made, and the interdependence between the nature of the prior treatment and the output of plants and animals was established. In other words: The first approach was to assume that both animals and plants are a kind of "black box" and to view, to investigate and to learn, in controlled conditions of observation, the connections between the input (the treatment) and the output (the yield). The input is a controlled magnetic treatment, the output-the yield as expressed by the number of eggs laid, the rate of fertility, the hatching and death rate; the veterinary condition; the quantity of milk and the fat and protein contents, the rate of weight increase; the size of the crop, the shape and weight of the fruit and its sugar content, the length of the yield season, etc.

GENERAL BACKGROUND

Electromagnetic treatment has begun to spread at an accelerating rate to biology (5) and medicine (6). In these fields the method is applied in conditions of prolonged exposure (as distinct from the present case, in which the magnetic treatment is administered upstream-to the water, not to the object, the consumer). Much research has been carried out, equipment is commercially available, and the practice is gaining momentum.

Magnetic treatment in chemistry is well known and is used in

the control of the direction and rate of reactions, the treatment for altering such properties as absorption, wetting, crystal growth, corrosion, melting, coating, electrolysis, casting, treatment of cementing materials and of ceramics, separation by membranes, flotation, filtering, precipitation, dissolution and many more.

In the present case the subject is the magnetic treatment of water before it reaches the consumer. The treatment may be one-time (open circuit) or repeated (closed circuit). From an overview of cases the following facts emerge.

a) Prior treatment does have an effect, which depends on the type of water and its contents, the temperature, the type of equipment and its location in the system; the different factors of the treatment such as flow rate, fluid velocity, manner of installation, maintenance, the intensity of bleeding and its timing, etc.

b) There are definite conditions in which the desired effect cannot be obtained, for instance: upper limit of the temperature of the liquid; upper and lower limit to the content and type of solutes, certain flow regimes, the presence of neighbouring electromagnetic fields, relationships between the vectors of the magnetic field's direction ahd velocity of the fluid, and others.

Generally speaking, the exposure of water to an electromagnetic field is a complex and involved phenomenon. Its treatment in the professional literature is for the most part a collection of data and findings, without determination of the physico-chemical mechanism that would be apt to explain the phenomenon, without a classical-universal definition of the basic mechanism, and without establishing the basic background interconnecting the engineering parameters as a whole-without all of which it is impossible to design magnetic equipment suitable for an effective treatment of water.

In the present research a basic investigation was carried on in parallel with the experimental work. The interdependence of the magneto-chemical and magneto-hydrodynamic effects was established, and a contribution to a deeper, fundamental understanding of the subject was made. As a general rule, in an electrically conducting fluid, such as tap water, flowing at a given velocity in the space of a magnetic field, electric currents and voltage are induced (capable of being both calculated and measured), if the basic conditions known from electromagnetic theory and principles (magneto-hydrodynamics) ae fulfilled. The energy required for obtaining in-

duction is derived from the kinetic energy of the fluid and not from the magnetic circuit. Although, in the present case, prior magnetic treatment is administered for a verv short period and there is no prolonged exposure, a "memory effect" is observed in the treated water, which preserves it downstream for some time (about 6 hours), incorporating new properties.

FINDINGS CONCERNING ELECTROMAGNETIC TREATMENT OF WATER IN AGRICULTURE

Agriculture in Israel is highly developed, innovative, and intensive, which habitally breaks through the bounds set by tradition and introduces new practices that are of world-wide interest. Efforts are invested in the development of new strains, in increasing yields, in improving the resistance to hard environmental conditions-water, soil, and climate; in finding substances and methods for pest control, fertilization, and irrigation; in developing methods of cultivation, of techniques for vegetative reproduction, and of agromechanical and agrotechnical technologies, etc.

In animal husbandry stress is laid on the development of lines for improving breeds, on the development of feedstuffs and methods of fattening, on the discovery of medications, on planning controlled and computerized farms, etc. It is a fact that until now irrigation and drinking water have been accepted as a given quantity, and no attempt has been made to investigate its universal properties as regards the yields of animal and plant farming. The findings presented in the following summarize a number of selected examples (7,8).

a) Milch Cows at Kibbutz Gvat

Controlled magnetic treatment was given to the drinking water mains used by a selected group of milch cows, at the same time a control group was set aside to be given ordinary drinking water. Both groups were kept in identical environmental conditions, were fed indentical feedstuffs, and were milked separately. In the group watered with electromagnetically treated water a higher milk yield was recorded, the percentage of fat was identical, the duration of the milk yield was increased, milkless days were fewer, the veterinary condition was improved, and impregnation was enhanced.

b) Calves at Kibbutz Gvat

Week-old calves were selectively transferred to controlled-growth stables, to be fed both magnetically treated and untreated water. The calves were kept in these stables from age one week to

age three months. In the group given magnetically treated water a growth rate increased by 10%-12% was recorded.

At the same Kibbutz the growth of males for meat was observed. Three-month-old calves were transferred to controlled-growth sheds. The drinking water was magnetically treated, and an increase in performance was recorded, expressed in an intensified growth rate, a high final weight, and in meat with a lower fat content (30-40 kg less in 10-12 months-old calves).

c) Goose Breeding at Hayogev

One-day-old goslings were kept for two months in intensive growth. Prior magnetic treatment of their drinking water resulted in enhanced performance: The growth rate (daily weight increase) improved, so did general health, and the financial return to the farm rose. The drinking water mains and tanks suffered less from scale, the cleanliness of valves and of the drinking cup surface improved. There was no more clogging, which in the past has caused flooding of the coop.

d) Sheep farming at Giv'at Zeid

This is a farm enterprise raising sheep for milking, meat, and wool. Yield intensified in all three fields. Milk production increased considerably after shearing, as compared with the situation customary in this branch of animal husbandry.

e) Turkey run, Nahalal

This is a run for the heavy production of breeding birds. The percentage of egg-laying increased, so did the laying years and the period of maximum laying capacity. Fertility and hatching percentages improved.

f) Cantaloupe growing in the Southern Arava

Achievements were-increase of overall yield and of fruit size, lengthening of the yield period, raising of the sugar content of the fruit.

A further series of tests is currently under way in different branches: Goats, hogs, maize (corn), tomatoes for industry, cotton, orchards and others.

It may be stated clearly that at most test sites and in a variety of branches of agriculture, improvements were achieved as expressed in increased yields (harvests and fruit bearing), in

other words the farmer's net income increased by between 5% and 25%.

There is no doubt that cooperation between research and the men in the field, between development and the farmer, will extend the range of applications, to the benefit of the farmer in particular and agriculture in general.

GENERAL DISCUSSION

In the technological development referred to emphasis was laid on the integration of the laws of magneto-chemistry and magneto-hydrodynamics with a view to producing optimal equipment. The design of such equipment and its suitability for the various fields of application depend on the following factors:

- Maintenance of an appropriate flow regime;
- Aptness for the ranges of electrical conductance of the water and the type of solutes;
- A well-defined orientation between the directions of the hydrodynamic and magnetic fields;
- Determination of the range of intensities and the gradients of the magnetic field;
- Design of the preferred magnetic circuit;
- Ranges of operation with respect to the temperatures of the environment and of the fluid;
- The types of material permitted for the construction of the system;
- Methods of assembly, maintenance, etc.

The equipment assemblies are based on rules and accord well with requirements, integratability, and correct weighting. Instructions are laid down for their operation and the sectors in which they are to be employed. A simple, efficient, and convenient technical solution is offered, as well as a flexible setup-all this by adapting the available models to the sectors that require them. In the specific developments emphasis is laid on adaptation to the different types of water and to changes in the agricultural system, which is dynamic in character (changes in growths, kind, and location; apportioning of crop types, water systems, etc). The equipment is adapted to manual or semi-automatic operation, in open or closed flow circuits.

For field crops the method was studied in conditions of drip irrigation, in calm flow regimes, and in intensive cultures. Later, the following will be studied:

- field crops irrigated via the foliage:

- field crops in hydroponic conditions, in an irrigation and fertilizing regime with unidirectional or circulating drain;
- application of the method to new branches of fruits and vegetables, flowers, edible and medicinal herbs, sprouts, algae, and others.

The clear indications obtained in our series of tests-the great similarity between the results achieved with plants and animals, the metabolic regimes and mechanisms of mass transfer through membranes, the compositions of the fluid within the body of plant or animal, and others-permit the assumption that in most of the sectors beneficial effects will be achieved with this method.

It is pointed out that, internationally, 480 companies and 125 research institutes are active in the biotechnological field. The farmer has great expectations as regards both increased crops and improved quality. Magnetic treatment pursues these same aims and, in addition, an extension of the fruit-bearing season. Those tendencies promise well for the well-known forecast concerning food supplies for the world's population, which by the year 2000 will be 40% greater than they are to-day.

Magnetic treatment of water has a most important economic potential. Its application is easy and requires no expertise in either operation of maintenance.

Excellent results were achieved in both crop and livestock farming and were confirmed by a great number of repeated tests in a wide variety of applications. The operational factors were defined, and various kinds of drinking and irrigation water were tried. Nevertheless, this treatment is still in its initial stages.

Phenomena common both to the animal world and to plants were observed, testifying to the existence of similar mechanisms and identical influential factors. Here are a number of examples.

Animals	Plants
Calves and chickens for meat-increase in unit weight.	Bigger fruits.
Increased ouput, as regards both rate and total product (milk, eggs, fertility level and hatching).	Enhanced cumulative crop per unit areas.

Animals	Plants
Extension of the productive season; stabilized ouput curve.	Extended crop season (growth, ripening, fruit) beyond that customary.
High quality of final product (meat/fat ratio, shiny fur, general appearance).	High-quality fruit size, shape, net cover sugar content, leaf greeness.
Feeding may be reduced.	Fertilizer portion may be reduced.
Water in troughs improved, algae grwoth restricted, scaling reduced, clogging in pipes diminished.	Less scaling in piping.
A "memory effect" exists in the water.	dto.

The data presented in this paper are but the "tip of the iceberg". Many more field tests are needed in different areas of application.

CONCLUSIONS

a) Electromagnetic treatment of water has produced results constituting a high specific contribution in the different branches of agriculture. The economic viability of this treatment has been proven, as expressed in the cost/benefit ratio. An appreciable contribution by it is expected in further branches of agriculture (fish breeding, algae, additional kinds of fruit and vegetable, the breeding of further varieties of animals, etc).

b) All the tests were carried out in field conditions and on a large scale. The important parameters were determined for the full functional operation of the magnetic systems.

c) Units for the electromagnetic treatment of water are commercially available.

d) Considerable efforts are being invested, in this country and abroad-in time, manpower, and financial resources-towards improving the quality of food, fertilizers, and others, in the animal and plant domains of agriculture. It would seem that

introducing the treatment in question to drinking and irrigation water will prove to be a breakthrough in achieving the maximum contribution in agricultural yields. The commercial potential of the method is inexhaustible.

e) It is recommended to begin with the selective, cautious, and controlled introduction of the treatment in the economy of Israel, with close tracking or the findings according to geographic distribution, type of water, kinds of consumer, etc.

ACKNOWLEDGMENT

Our thanks are due to ELIR-Advanced Technologies, Ltd., Kiriath Motzkin, who are engaged in the commerical application of the magnetic technology in agriculture, for their help in preparing this paper. Many thanks are due also to all the farmers in Moshavim and Kibbutzim, who contributed their time and their efforts and placed their respective branches of agriculture at the disposal of the research.

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