

# **Advanced magnetic treatment of fluids in service of the sugar industry, cost benefiting sugar-mills worldwide**

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## **Overview**

The paper discusses a novel in sugar making industry, breakthrough, proven and permanent magnetic method of curing and preventing scale build-up during sugar juice preparation in a modern sugar production facility, postulating it as the most cost effective solution to this particular bane in one of the world's oldest and essential industries. Historical background of the MHD (Magneto-Hydro-Dynamics) precedes Theory of Operation, followed by detailed examples from some of Europe's largest mills, discussing elimination of inhibitors and other chemical agents, elimination or in worst case scenario tripling the cleaning cycle, i.e. biggest problems a sugar-mill technologist faces today (and the accounting dept. has to deal with and find resources for, campaign-after-campaign). This paper published here for the first time, is based on real life examples from the Europe's third largest sugar industry, where the 1995 season was "wasted" in learning how to use the U.S. patented mono-polar magnetic technology and then the 1996, 1997 and 1998 seasons were to verify and solidify those findings, whereas the following four campaigns (1999, 2000, 2001 and 2002) were spent on applying "lessons learned", which allowed to win the original sceptics of the sugar-mill industry in Poland to this most effective and ecologically sound method known today in any sugar-mill operation (cane or beet-root) and save them hundreds of thousands of dollars. Reads in about 20 minutes.

## **History of The Magnetic Fluid Conditioning**

History of scientific research regarding the influence of magnetic field on passing fluids dates back to 1831 and concerns mostly experiments made by Michael Faraday and James C. Maxwell. Faraday discovered that water flowing past a conductive material will generate a weak electrical charge. The first known patent of a device ameliorating water characteristic through the use of the magnetic field of a solid magnet was filed for protection in Germany in 1890 on behalf of France and Cabell. At the turn of XX-th century a Dutch physicist, Dr. Johannes Diderik van der Waals discovered that hydrogen has cage-like structures, which, when combined with carbon, form pseudo compounds. These molecular forces of mutual attraction and repulsion which stay next to each other ("van der Waals forces"), when influenced by the magnetic field de-cluster and then interlock (bind) with additional oxygen, which may result in dramatic increases in combustion efficiency, and ascertained that due to them e.g. gases condense or water coagulates. In 1910 he received a Nobel prize for this discovery. However a difficulty in creating a sufficiently intense magnetic field has hindered its commercial application until recently. His theory of a possibility to break hydrocarbon molecules under the influence of a strong and focused magnetic field found its practical confirmation and expression only in the 1980-s in the workings of the Magnetizer energizer systems that Mundimex, with acquired know-how and installation techniques has successfully utilised since 1991 in various water and fuel applications worldwide from the sugar-mill production processes in Poland to nuclear power plant operation in France.

The first work in civilian usage of magnetic treatment of fluids was done in Europe in 1936 by a Belgian engineer Teofil I.C. Vermeiren, whereas today, Rodger Vermeiren, continues the pioneer work and business of his father.

Further development of research on magnetic energizers of fuel started during the World War II. As part of the armament strategy, specialists from the German industrial and airspace concern Messerschmitt-Flugzeugwerke worked on the problem of eliminating smoke waft of the exhaust gases left by the engines of a military aircraft (fighter planes and bombers). As a solution to this problem they designed a magnetic device ("jet fuel energizer") consisting of fire resistant ceramic element with a hole for the fuel line, around which rod magnets were placed. As a result of trial and error testing, a proper configuration of magnetic field was found, at which the smoke of the aircraft engine exhaust gases was limited to the bare minimum. Also the reduced fuel consumption was noted, which was regarded at the time though as nothing more, but a beneficial side effect.

An interesting counterpoint to the above was found by the authors in a recent web-search - with the following report on internet by Tom Shelley:

*“And during World War II, powerful magnets were placed adjacent to fuel lines for Merlin engines in Mustang [U.S. made] fighters. The result is said to have been an increase in useful range by 15%, saving the lives of many crew members in the bombers the fighters were assigned to escort. At the time the idea was classified as a military secret, and subsequently forgotten. It required the use of large and heavy magnets, in order to generate the field strengths, and is only now being revived with the advent of new, high strength magnetic materials”.*

For years the "old-timers", who piloted their fishing boats out of Murro Bay in California, would strap horseshoe magnets around their fuel lines. They swore the magnets saved fuel and made their engines run or start better and ... they were right.

In the United States the commercial use of magnets for fluid conditioning started in the U.S. in 1950's by the pioneering patent of Dean Moody, the world precursor, together with the Belgian Vermeiren, of that form of fluid conditioning. In 1954 a complaint was lodged with FTC (Federal Trade Commission) against a company manufacturing the magnetic units, and FTC issued an injunction (administrative order) prohibiting further production, based on a false allegation that these units did not work. In 1961 the federal court ruled against the FTC, as court records revealed that only 3% of the 100,000 units sold malfunctioned.

The men who wrote the next chapter in the world history of the magnetic treatment of fluids were in the 60-s a Japanese Saburo Miyata Moriya (focusing on the so called "wet" devices, i.e. inline energizers requiring cutting-off pipes for bi-polar devices to be retrofitted) and in the 70-s an American inventor Roland Carpenter (also with a bi-polar system).

In the 80-s a brilliant U.S. inventor by name of Peter Kulish, and a colleague of ours, designed the so called monopole system (subjugating liquid to one pole of a magnet only) and strapped onto lines without cutting them. He pushed the research forward, improved the device (originally it was a snap-on, already a great improvement, but still... a bi-polar one) and finally obtained the optimal shape and several American utility and design patents for it.

Peter Kulish has done in the U.S. what no one else has been able to do - design a simple yet powerful magnetic system that, not only effectively conditions water, but effects ground level ozone, reducing carbon monoxide (CO) emissions as much as 100% and hydrocarbon (HC) pollutants in excess of 85%. Since 1987 the patented Magnetizer Engine Energizer System passed every emissions test thrown at it.

Mundimex is proud to present upon request its latest tests (Feb. 2003), made by an independent party in Switzerland, of fuel consumption reduction in automobiles equipped with these devices - confirming 10% and up gasoline savings in the latest European car models such as Mercedes Smart. The astounding results of real life sugar-mill applications are presented later on.

A lot of heavy research into magnetic treatment of fluids and the science of magnetics (including bio-magnetic treatment) was done on a large scale in Israel (mostly in the agriculture, with the extensive research by the late prof. Lin from Haifa University) and in the former USSR. Moscow professor Villy Klassen is known for his monograph «Magnetization of water systems», whose first edition appeared in Russian in 1978 and was republished in 1982. His student, Vitali Prisyazhniuk, Doctor of Sciences, expert in physical chemistry, finished post-graduate course at the Moscow University in 1976 and since 1975 has been engaged in magnetic treatment of liquids dealing with scientific aspects of it, as how it is associated to the theory of solutions, phase transitions, etc., with his own theory revealing physical essence of the phenomenon. He gave a brief statement of his theory in a paper published recently in 5 (5) 2003 magazines «Power Plant Chemistry». Shortly, in the same magazine, his new paper will be published, in which he explains from the physical chemistry's point of view, why «magnetic treatment» or «magneto-hydro-dynamic resonance», as he names this phenomenon, prevents formation of new scale and moves off the old one. He thinks *“it would be useful for engineers in many industries to understand, that it actually works”*. *“Understanding [MHD resonance benefits] protects from mistakes”* as he has put it in his recent correspondence with Mundimex.

Finally, in order to fully understand MHD and to explain the theory of operation of its 'sister branch", Magnetic Treatment of Fuels, the work on the fundamental properties of electrons was necessary, which was done first in 1928 by the English mathematician and physicist Paul Dirac (Nobel Prize in 1933) who noticed in his experiments that whole atoms absorb and release energy as the electrons undergo spin flips. In the span of the last 40 years this research on the basic characteristics of electrons has been continued by Hans Dehmelt of the University of Washington in Seattle, who in 1989 was awarded the Nobel Prize in Physics for it as well.

## Theory of Operation

The explanation is different for hydrocarbon fuels and for water. With regard to the former, it deals with electron and its characteristics, i.e. spin and magnetism, apart from mass, and charge. Providing it with proper amount of magnetic energy (determined by gyro-magnetic ratio, or g-factor discovered by P. Dirac) the spinning electron will absorb that energy and flip into alignment. We know e.g. of Barnett effect resulting in iron rod becoming magnetised when placed into rotation.

Unlike most materials that possess paired electrons, some of them, like iron, have unpaired electrons. The spin of the unpaired electron produces its magnetic moments and what we call magnetism. Thus, depending on the spin orientation an element can be in isomeric para- or ortho- spin form, i.e. be paramagnetic or diamagnetic. By altering the spin properties of the hydrogen electron, we can enhance the reactivity of the fuel and related combustion process.

In general all materials on Earth can react to magnetic field. The only thing different is the degree of response. Thus all elements on the Mendeleev's chart can be divided into paramagnetic and diamagnetic. The former are concentrated at (drawn to) the lines of magnet's flux and thus are very susceptible to magnets (e.g. oxygen, iron, Sc, Mn, Pd, Tb, etc). The latter, diamagnetic, are non-magnetic (meaning non-ferromagnetic), and

are not attracted to magnetic force (e.g. glass, Cu, Zn, As, Kr, In, Te, etc.) and its induced magnetic fields is much weaker than the outside magnetizing field thus being driven into magnetic flux's weaker area.

Of the materials that are paramagnetic we have a group called ferromagnetic - they respond strongly to magnetic force/attraction (neodymium, rare-earth, ferrites). Magnetic energizers that Mundimex offers and installs in sugar-mills use this type of components, with very strong ceramic, permanent in its action, magnets ranging from 4,500 to 11,200 Gauss-Oersted energy units.

**For the purposes of proper, correct and fool-proof magnetic installations in the sugar-mill environment a distinction between para- and diamagnetic has been found by Mundimex to be extremely important and the Company takes special precautions to make sure this distinction is correctly reflected and handled by its specialists at the time of data reception from sugar plant engineers in order to make the right selection of materiel. It has further bearing on the logistical aspects, on what is in fact shipped to and installed in the mills, in addition to the mono-polar magnetic energizers (that also require special pre- and post-production treatment beyond the standard stock). We can only state herewith, that here's where, in case of sugar-mill application, our know-how complements the technology and constitutes a true make-or-break for this particular approach to fighting scale and obtaining life-time savings in the technological process of sugar making.**

Since, for the purposes of this paper we are more interested in the non-fuel aspect, i.e. influence of magnets on sugar juice - for more information on the effects and benefits of magnetic treatment of fuels and diamagnetic or paramagnetic response to the magnetic flux depending on the relative orientation of hydrogen's nucleus spins - we refer interested readers to Mundimex internet site - [www.mundi.com](http://www.mundi.com) - which boasts one of the largest amount of information in cyber space regarding theoretical aspects of Magnetic Fluid Conditioning, enjoying over 140,000 visitors a month from around the world, with vast bibliography on the topic included therein.

## Magnetic Treatment of Water

In view of the intended end-use (sugar industry), the Reader, to whom this paper is addressed, is probably less interested in magnetism caused by unpaired electrons in the dipole moment of ferromagnets (of which he/she can find more in the above referenced source), thus we shall devote more attention to water aspect of MHD.

We can begin by saying that also a water molecule possesses dipole, the electrical one, due to electrical polarity, as confirmed by the concept of «**debye**»<sup>1</sup> (water has index of 2.3 Debye), which is only signalled here and is beyond the scope of this paper.

Ground water contains thousands of particles and microelements whose impurities give rise to the surrounding electron shells: cations (+) and anions (-). "Pure" water is a polar liquid, i.e. part of the water molecule has a positive and part of it has a negative, electrical charge, but overall the net electrical charge is negative. Thus, with the water molecule being a small magnet (dipole), one may effect its magnetic (or electric) field by causing the molecule to turn or rotate in one direction or the other, taking on a positive or

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<sup>1</sup> Debye's dipole moment in chemistry is a measure of whether the center of negative charge coincides with the center of positive charge. If these centers don't coincide then the molecule is said to be "polar". Such a molecule constitutes a dipole: two equal and opposite charges separated in space. [p. 22, Morrison and Boyd, Organic Chemistry, 3rd ed. 1973]

negative higher potential, depending, whether the S (South, positive) or N (North, negative) outside magnetic field had been applied.<sup>2</sup>

Water flowing in the soil is affected by the Earth's natural magnetic field and has a higher potential than the surrounding rock and thus creates an attractive force, dissolving limestone and other mineral salts (mainly calcium and magnesium), much the same as sugar or salt dissolves in a glass of water. The minerals dissolved in soil are subsequently carried into pipes, installations and water process equipment. These metals having in turn a higher potential than water, attract those minerals which, when drawn, seed and conglomerate (crystallize) back into rock like formation, i.e. "calcite" (popular "scale"). When the soluble calcium bicarbonate,  $\text{CaHCO}_3$ , changes to the less hydrated, insoluble calcium carbonate ( $\text{CaCO}_3$ ), the result is doubly harmful, since water loses its beneficial minerals and the accumulating sediment destroys pipe installations. Because of the overwhelming negativity of the  $\text{CO}_3$  component, the Calcium Carbonate molecule possesses a net negative charge, resulting in a few attractive forces between it and liquid (in untreated water there is always a low concentration of Carbonate that remains dissolved).

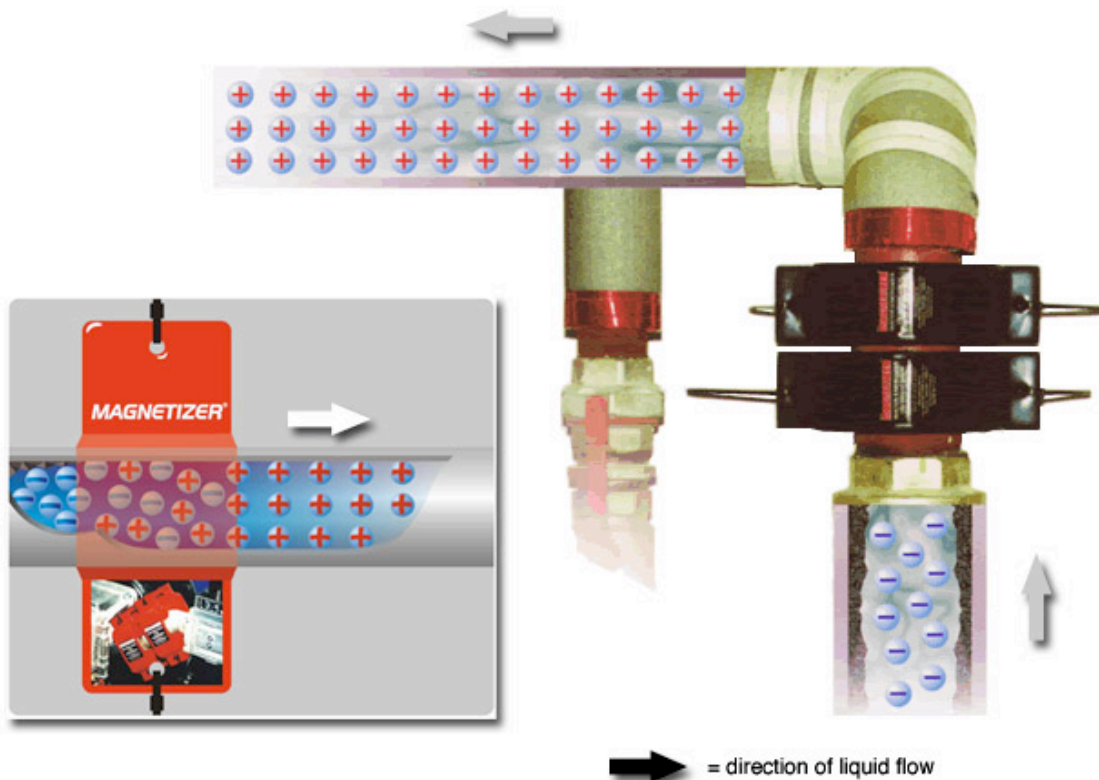
Normally, molecules in a fluid are in a completely random configuration, due to slight natural variance in their electrical net charges. As polar bodies they will react uniquely to the magnetic stimuli, depending upon the net charge of the outside force. For example, a positive charge (South pole) would physically configure the fluid so that the negative poles of the molecules were closest to the magnetic source (opposite charges attract, like charges repel). After passing through the influence of the direct external magnetic force there is a transformation of the randomly oriented population into an ordered matrix of molecules: the molecules with greatest opposite net charge will be closest to the stimulus and conversely, those with the greatest like net charge will be furthest away. The energized and amplified (magnetized) molecules, like little magnets, uniformly line up end-to-end as the net charges are all equalized by the external magnet influence. Thus the polarization consists of changing the chaotic molecules of liquid or gas fluid into such fluid which has equal charge and is uniformly linearized. Exposure to a magnetic South pole field affects an atom's electron spin in such a way as to compact the size of the electron orbit. For the  $\text{H}_2\text{O}$  molecule, the hydrogens, which are bonded to oxygen by "sharing" the oxygen's electrons, are drawn closer to the oxygen atom. This action changes the bond lengths and in turn, the bond angles, from a triangular formation to a closer linear configuration. In the magnetized "linear" condition, the more positively charged hydrogens (H) tend to shield the negatively charged oxygen. The result shielding is what changes the net negative charge of the non-magnetized water molecule to the net positive charge of the magnetized water. Therefore magnetizing will change the water's net charge so that the carbonate molecules are not allowed to aggregate and crystallize. This also works on dissolving existing crystalline structures (previous scaling) by cleaving bonds between the carbonate molecule via the same

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<sup>2</sup> The Positive, expanding, field influence of the South Pole makes liquids more soluble (lowering surface tension); thereby hydrating, dissolving and removing calcite and other mineral/various water by-product build-up in pipes and equipment. The Positive field hydrates all mineral build-up by de-clustering the liquid and solid pre- and post nucleated crystalline scale material. Such a S-pole induced change in the orientation affects the aggregation and crystallization of a water molecule causing increased hydration (water saturation), solubility and selective ionization, thus changing fluid physically, structurally and behaviourally. The mobility of ions in water solution is considerably increased. This creates a more solvent fluid flow (which e.g. impregnates the membranes or filters more efficiently), increased flocculation, i.e. greater particle size (causing higher filtration efficiency) or the electromotive force of the softener's solution raised to 99.9 percent efficiency. The negative contracting field influence of the North Pole has a diametrically opposite effect on fluids, clustering (and hardening) minerals and increasing surface tension. It is used in precipitation and separation, also in sugar-mill's case (e.g. its sewage treatment plant).

charge influence - an actual magnetic attraction of the carbonate molecule to the water molecule.

The random configuration of a water molecules is changed to a charged and organized form, with their shape and size also modified. In the process the associations clustering around the suspended particles are broken up as the molecules line up in polarization. The fluid's paramagnetic properties allow for more dissolved material to be contained in it due to increased efficiency of the fluid's available space. It appears that the magnetic treatment allows the carbon dioxide (CO<sub>2</sub>) to stay dissolved in water of a higher temperature. Calcium carbonate is converted back to calcium bicarbonate. With the increased solubility of CO<sub>2</sub>, pH is lowered, which also accelerates the de-scaling, the end product of which is aragonite - a soft hydrated form of calcite crystal obtained through its increased hydration. It is now maintained in a "colloidal" suspension (microscopic solution) ready to be mechanically flushed from the attached surface and not placing itself on the pipes, instead its health beneficial effect staying in liquid (e.g. drinking water), or can be removed by jute filters in the sugar making process. The polarized cations, such as calcium and magnesium associate (micro) electrically in a water solution with other complementary particles (anions) in the form of ionic conglomerates and continue their way with the water flow.



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Fig. 1 Schematic illustration of a magnetizing process in a sugar production feed pipe

That the magnetic field amplifies the potential in water (electromotive force) making it greater than that of the plumbing (thus the minerals are re-attracted into water) and it maintains the "magnetic memory effect", which can be empirically proven by a simple voltage test<sup>3</sup> of hard water by measuring the millivolts (mV) before and after the magnets installation on the cold water tap (or entrance to home and furthest tap therefrom). It will show change from approx. -0.5mV to an approx. +1.0 mV. On the average with the

<sup>3</sup> Use a more precise volt meter with the L.E.D. readout, and not the gauge type one

magnets there is an increase of 1.5 millivolt.<sup>4</sup> Please note that other bi- or multi-polar systems show no mV increase or very little. A report from "Science News" (Sept. 6, 1980) by Ellingsen, John Hopkins University, indicates the "memory effect" was still available for days after treatment.

Due to the movement of the ordered molecules magnetic moments of the shifting electrical charges add up partially, creating an electromagnetic field whose influence on the passing fluid can be considerable. Depending on its velocity periodic eddying currents inducing magnetic micro-fields ("Tolmien-Szlichting wave packet") are generated at the walls. Maintaining vortices during the laminar (non-turbulent) pass is known as the magnetic memory effect of a passing fluid. Experiments indicate that a container of magnetized water left standing for over a year still had a small portion of its magnetic effect remaining, however magnetized fluids that lie dormant for months at a time will eventually lose their induced orientation.

Applying Magnetizer's extremely strong and focused magnetic field, the natural process that occurs underground in soil is imitated due to magnetic polarization of all these particles, when the electron shells change their potential after passing through the single magnetic field of our device.

Air (oxygen: valence -2) circulating in the installation has a strong negative charge that favors the electro-chemical process of corrosion. The magnetic field charges air positively and destabilizes (micro) electrically this process creating a difference of potential between the piping and air which permits to isolate and protect the system in a reliable and permanent way. The electrolytic corrosion is stopped by binding magnetically the excess (free) hydrogen H<sup>+</sup> (in acidic fluids) or hydroxyl OH<sup>-</sup> (in alkaline fluids) ions, responsible for brittleness of piping, which are now bound up with other molecules. This buffers pH, reducing wide pH variations found in fluids, regardless of outside influences. This is achieved by changing electro-statically neutral fluid to a positive state, whereas the increased electron excitement (voltage) makes potentially viable an immediate bonding of free ions with fluid at the molecular level. In addition to this mechanism, once this potential of fluid hydrates any mineral build-up, the pipe material remains clean and cannot dissolve into fluid as there are no free-ions to nucleate with the pipe material.

A proper change in the electron orientation by this advanced mono-polar magnetic technology effects aggregation and crystallization of the water molecule causing increased hydration (water saturation), solubility and selective ionization, in this way changing fluid physically, structurally and behaviourally. The mobility of ions in the water solution increases dramatically. This causes that passing fluid is more soluble (which e.g. saturated more effectively membranes and filters), increases flocculation, i.e. the molecule size increases (causing the augmentation of filtering efficiency) or the electro-motor force of the softening solution increases up to 99.9%.

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<sup>4</sup> Workings of our system in the example of flowing water can be proven thus mathematically: H<sub>2</sub>O has a net negative charge, say: -300 mV, whereas iron pipe is electrically neutral, i.e. = 0, thus 0 > -300 and it attracts the minerals contained in flowing water, which starts building up scale. In this example say Ca = -350 mV and Mg = -400 mV, thus 0 > -300 > -350 > -400. Upon installation of our magnets, with its very strong positive magnetic pole, say of +310 mV, the equation above is effected in a following manner: H<sub>2</sub>O = -300 mV (before) + 310 mV (with the magnets on) = +10 mV, whereas Ca = -350 mV + 310 mV (with the magnets on) = -40 mV, and whereas Mg = -400 mV + 310 mV (with the magnets on) = -90 mV. Finally we get: +10 > 0 > -40 > -90 and this magnetic process can be thus proven mathematically, whereas water having a stronger electric charge attracts minerals that do not precipitate anymore on the pipe's walls.

A build-up of sediment called **scale** (a.k.a. “boiler stone”, etc.) is one of the basic problems that exist in all technological processes where liquids are used (heating, heat exchanging, evaporation, saturation, condensation, cooling, chilling, etc.). The higher the temperature – there is more intensive build-up of this rock-like formation. It is especially negative (harmful) in the sugar-mill production process due to expensive downtime caused by required cleaning cycles in short spanned sugar harvest/production campaigns; due to costly use of inhibitors or other chemicals as well as due to hazard involved in removing it by thermal (fire), chemical or mechanical means. Another negative side effect is the increased use of energy caused by heat transfer loss, with insulation clogging often-time up to 50% of juice pipes’ inner profile. This is a chronic problem, since sugar juice is to be kept in the proper temperature, ranging from 88°C (190°F) to as high as 124°C (255°F).

This phenomenon is unwelcome, since it harms equipment and installations by the crystalline precipitates that are caused by the loss of CO<sub>2</sub> gas from sugar juice when its temperature rises.

These crystals, above all composed of calcium and magnesium salts, form a very good thermal isolator and do not allow for free flow (transfer) of heat. They are very hard and difficult to remove, as calcite appears in a less hydrated form with hard surface bonds. The scale problems mean only one thing: constant necessity to clean sugar juice feed pipes and evaporation/saturation equipment, as well as overheated walls of the heating elements; imminent corrosion deterioration due to scale-metal electrolysis and needless consumption of energy for juice heating (one millimetre of scale thickness translates into 8-10% energy loss).

Furthermore, in the technological process of sugar production the sediment (scale) on the inner walls of the equipment is increased manifold, due to the fact that milk of lime - calcium hydroxide – Ca(OH)<sub>2</sub> - is added to sugar juice and a high temperature is maintained.

We have to point out here, based on our experience in the sugar making industry, that the hardness and quantity of sediment on the inner walls of equipment will depend on the chemical make up of the lime stone. Content of silicon compounds can influence in a very negative way the quality of lime milk. The best lime milk is such which is devoid of silicon compounds or has small quantity of it. **At the selection phase for the right magnetic systems recommended to sugar-mills, Mundimex engineers need to know this percentage as this will influence the strength and quantity of magnetic components in the final offer and installation.**

Money spent on cleaning clogged piping with chemicals, or brushing/flaming it, and necessary down-time has, up to this point, been a constant, re-occurring cost notwithstanding the “ecological price” for the polluted environment (water table at the sugar-mill’s vicinity).

This is why it is highly recommended to use the mono-polar magnetic devices together with the know-how that Mundimex has been applying, with unprecedented success in sugar-mills (and other water/fuel applications as well).

By subjecting fluids to active influence of a properly focused magnetic field we can now have the right effect on changes of their structure and can also obtain distinct changes of their properties.

It has been scientifically proven that a strong magnetic field, with properly chosen parameters has effect on change of such fluid characteristic as: electrical conductivity,

surface tension, density, viscosity, light extinction, moistening of solid bodies, etc. Mundimex has available on hand results of scientific tests from various Universities, Technical Colleges and industry carried around the world on its magnetic energizers in the span of the last 10 years that can confirm it.

Furthermore the following changes to sugar juice after magnetic treatment have been demonstrated by Mundimex specialists in 1995-2003:

- in salt solutions their crystallization occurs inside of the juice and not on the walls of the pipes
- process of dissolving and coagulation of suspended matter is intensified
- concentration of dissolved gasses increases
- absorption on the surface of phase distribution increases

We can pose here two important questions regarding the use of this technology: Prevent or Cure? There are many situations, where we can use it only preventively (when the equipment is clean and ready for the next campaign), whereas often-times plants decide to install it curatively during the on-going campaign, in order to allow production to continue and to start immediately benefiting in the cost reduction by reducing chemicals/inhibitors/manpower. Later its preventive nature will come to play for the life-time of a plant.

## **Practical Results of Magnetic Treatment in Sugar-Mills**

Mundimex leveraging risks undertaken with the initial investment in pilot studies and the acquired know-how, has now its technology placed in some of Europe's largest sugar-mills, with very positive and satisfying results to all of its clients. In the course of last 4 years its engineers have perfected installation techniques and the company is now able to offer and recommend this advance in magnetic treatment to sugar-mills worldwide.

The practical findings and technological parameters obtained from sugar plants around the world prior to writing this paper have confirmed that Mundimex has a natural solution, based on the magnetic treatment of fluids, to remove and prevent scale in sugar-mills worldwide, that is effective and permanent.

Our first contact with the sugar industry dates back to 1995 when that year was spent on figuring out how our state-of-the-art magnetic systems can fit into the sugar-mill operations. We knew from the start we had a winner, with a breakthrough technology used to successfully de-scale water pipes and equipment in a variety of industries (a nuclear plant in Golfesh, France, owned by EDF, included), however due to lack of proper know-how in the sugar industry itself a decision was made to initiate pilot installations in a few selected sugar-mills in Poland, first on the sugar heaters to thoroughly investigate the issue. The objective was to examine the efficiency of Magnetizer work in harsh sugar mill conditions, where scale was a much bigger and pervasive problem than in other industries. The results achieved by Mundimex were described by experts as "sensational". After the campaign scale thickness on heater tubes before saturation II in one of the pilot plants was about 0.5 mm. In previous years the same thickness was reaching 10 mm, which in practice meant stopping production on "stuffed" heater and re-directing it to the second one.

The pilot process of introducing the magnetic treatment in technological process of sugar production continued for the next two campaigns (1996, 1997). In many sugar-mills the magnetic energizers were installed before saturation I boilers, feed and press pipe saturation, near juice pumps after saturation II, etc. With the beet-root processed quantity of 200,000 tons, the inside of pumps and pipes was same as before the campaign, i.e. clean.

The positive results allowed subsequent further use of our technology and expertise. Many of the Polish sugar-mills installed Magnetizers before troublesome evaporator sections. The effects again were “sensational” in the words of plant’s technical personnel, and archived on testimonials and video. For example:

*“...We ascertain that the achieved results have surpassed our boldest expectations”.*

- Henryk Walachowski, Vice Chairman of the Board For Technical Affairs, sugar-mill “Nowy Staw” S.A.

Whereas Bx of dense juice in the first decade was 65.2, in the last it was 66.3, and on the average for the campaign 66.0. Bx of rare juice was in the first decade 13.8, in the last 14.3 and the average for the whole campaign was 14.3 Heating surface of the evaporator in that particular sugar-mill was 3,901 m<sup>2</sup>, which at the average output of 2751 t/24h gives a very low output (processing) coefficient of 1.42 m<sup>2</sup>/100 t. After the application of the Magnetizers they used 2 tons less of the German made chemical agent KEBO DS, compared with previous years. The average calcium salts content in the dense juice during the campaign period was the same as in the rare juice. The sugar-plant used 10% less coal for heating, compared to previous years with the comparably same harvest, due to de-scaling and lack of insulation in pipes, and thus no heat transfer loss.

This magnetic technology has helped to descale (remove) 20 cm of stone in the Saturation Process (scale used to cover 50% of pipes inner profile) and its effects were described as "incredible" by specialists who for years have seen various modifications, technologies and techniques used.

*“After processing 143,000 of beetroots we did not clean pumps at all, and boilers of Saturation II had a minimal growth of sediment”.*

- Tomasz Szczesniak, M.E.S., Production Chief, sugar-mill “Ostrowite, SugarPol S.A. holding

*“After termination of the campaign it was ascertained that in the mere heaters as well as in the Saturation II boiler there is less scale than in the previous years and the sediment is more “loose” and easy to clean up. After the first year of usage we ascertain positive working of the Magnetizers”.*

- Sugar-mill “Pelplin” S.A.

*“One of them [magnetic energizer] was installed on a pipe with dia. 159 before the battery of raw juice heaters for main line and the second on dia. 159 before the evaporators’ Section III. After finishing the sugar campaign we ascertained considerably less content of sedimented stone on the tubes of the heaters as well as evaporators. During the production process there was no need of periodic cleaning of heaters (as in previous years), and reduced usage of anti-scaling inhibitor for the evaporator”.*

- Tomasz Walczak, M.E.S., Chief of Production Dept., sugar-mill “Pustkow” S.A.

In the same time more and more of sugar-mills started to use our magnetic technology on milk lime pipes. The flow-meters that in previous campaigns showed decrease of its diameter by 50-60%, after campaigns, with the Magnetizers installed, were clean, with no changes to their inner diameter.

In one of the mills Magnetizers were installed already during the campaign (lasting 2 months) and after one month all the pipes were reported clean. Other sugar-mills that did not install them on time for that campaign (did not decide at that time to invest in this

technology, were sceptical as to its efficiency or simply did not have funds to do so) did in fact install Magnetizers next year, before the following campaign, on already cleaned up/prepared systems and throughout the whole period of their campaign the process equipment (saturators, evaporators, pipes, heaters, etc.) was super clean. No stone whatsoever and no need to stop production for maintenance (cleaning). This is extremely important to them, since steady temperature has to be maintained for sugar juice throughout the process and if not (goes down due to heat transfer loss caused by scaling) than the whole production has to be stopped for cleaning.

In general this technology and know-how are guaranteed to bring to sugar-mills:

a) savings on chemical inhibitors and/or agents (translated into tens of thousands of dollars per campaign) by eliminating them completely or significantly reducing their usage;

b) cost savings and improved turnover time due to elimination or considerable reduction of scale and therefore elimination or reduction (e.g. tripling) of maintenance and cleaning cycle where at worst there are only traces of lime and loose sediment that can be easily removed with water. No need for mechanical, chemical or fire methods. In brand new mills or existent mills with cleaned up equipment/pipes Magnetizer can be installed preventively, on the closing ones it can be removed and transferred to a new location, as it is guaranteed to work for life-time;

c) savings on energy due to elimination of heat transfer loss;

d) de-scaling on water side of boilers and improving heat transfer and water standard (stabilized pH, lowered surface tension, full oxygenation, removing gasses, etc.) as per Magnetizer's standard operation and application;

e) optimization in biological sludge plant operation - we can effectively increase amount of oxygen in the system through the use of regular as well as reversed polarity (negative), specially design "air energizers". These patented mono-polar and extremely strong Magnetizers cause magnetic field to be formed on the inner sides of pipes and the oxygen produced in this way is carried from those inner linings into the fluid. This way live bacteria used in the process gets extra oxygen for their work. In addition we magnetize negatively air pipes that go to the sludge to increase amount of oxygen and increase the sedimentation time.

f) guaranteed fuel savings on tractors, trucks (min. 5%), as well as passenger cars (min. 10%) via its fuel engine energizers;

g) improvement in the final quality of processed sugar - increasing sugar quality by meeting 0 (zero) oxides norms by means of an optional, proprietary magnetic separator – it works without fail on all metal particles/impurities and also removes all metal oxides (ferrite oxides, etc.) from molasses/sugar, due to its proprietary design and neo-dymium magnetic components. This is done half automatically (no need for additional cleaning) and can be upgraded to hydraulic fully automated one.

Introduction of the latest-generation magnetic mono-polar energizes fabricated specifically for sugar-mill needs for the purpose of magnetic treatment of sugar juice has created optimal processing conditions for all equipment engaged in the technology of sugar making and comfort working conditions for the personnel involved.

The properly installed Magnetizers allow for damage-free and non-stop, permanent work during the whole campaign and for life-time of operation thereafter, as they have

scientifically proven zero loss of power (energy). In the same time a considerable reduction in need for heat energy in the whole technological process has been noticed. All this gives very high and measurable economic (financial) benefits.

Out of 50 operating sugar-mills in Poland 26 are using our equipment and know-how either in part (with successive purchases planned for nearing campaign) or as a complex magnetic treatment solution in the whole technological process, with the outstanding results confirmed by their testimonials which are available from Mundimex upon request. The largest of them, equipped with the most modern technological production lines, fully "magnetised", are for example: "Glinojek" – one of the biggest in Europe (now part of British Sugar), and "Ostrowite" – part of "Sugar-Pol" holding group – whose whole sugar production is sold to "Coca-Cola".

Due to better than expected results and the enthusiastic response from [beet-root based] sugar industry in Poland and having studied and compared technological parameters from engineers working in cane based sugar-mills, Mundimex is now capable of providing the most cost effective and environmentally sound worldwide solution of scale removal in this particular industry, where scale is such a bane and causes unnecessary and exorbitant costs campaign-after-campaign.

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