

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 the sugar-making industry, a 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.

The historical background of the MHD (Magneto-Hydro-Dynamics) precedes the Theory of Operation, followed by detailed examples from some of Europe's largest mills, discussing the elimination of inhibitors and other chemical agents, elimination or, in the 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 Europe's third-largest sugar industry, where the 1995 season was "wasted" learning how to use the U.S. patented monopolar magnetic technology.

Then, the 1996, 1997, and 1998 seasons were to verify and solidify those findings. In contrast, in the following four campaigns (1999, 2000, 2001, and 2002), engineers applied "lessons learned," which allowed to win the original skeptics of the sugar-mill industry in Poland to this most effective and ecologically sound method known today in any sugar-mill operation (cane or beetroot) and save them hundreds of thousands of dollars.

Reads in about 20 minutes.

History of The Magnetic Fluid Conditioning

The history of scientific research regarding the influence of magnetic fields on passing fluids dates back to 1831. It is mainly concerned with 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 characteristics through 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 the 20th century, a Dutch physicist, **Dr. Johannes Diderik van der Waals**, discovered that hydrogen has cage-like structures, which form pseudo compounds when combined with carbon. These molecular forces of mutual attraction and repulsion 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, creating a sufficiently intense magnetic field has hindered its commercial application until recently. His theory of the possibility of breaking hydrocarbon molecules under the influence of a strong and focused magnetic field found its practical confirmation and expression only in the 1980s in the workings of the Magnetizer energizer systems that Mundimex, with acquired know-how and installation techniques, has successfully utilized 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 civilian use of magnetic treatment of fluids was done in Europe in 1936 by a Belgian

engineer, **Teofil I.C. Vermeiren**. In contrast, Rodger Vermeiren continues his father's pioneer work and business today.

Further development of research on magnetic energizers of fuel started during 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 military aircraft (fighter planes and bombers). To solve this problem, they designed a magnetic device ("jet fuel energizer") consisting of fire-resistant ceramic elements with a hole for the fuel line, around which they placed rod magnets. As a result of trial and error testing, they found a proper configuration of the magnetic field, which eliminated the smoke of the aircraft engine exhaust gases to the bare minimum. Also, they noted reduced fuel consumption but regarded it at the time as nothing more than a beneficial side effect.

An interesting counterpoint to the above the authors found in a recent web- search - with the following report on the 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 large and heavy magnets to generate the field strengths and is only now being revived with the advent of new, high-strength magnetic materials".

The "old-timers" piloted their fishing boats out of Morro Bay in California and would strap horseshoe magnets around their fuel lines for years. 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 the 1950s with the pioneering patent of **Dean Moody**, the world precursor, together with the Belgian Vermeiren, of that form of fluid conditioning. In 1954, the F.T.C. (Federal Trade Commission) received a complaint against a company manufacturing magnetic units, and the F.T.C. 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 F.T.C., and court records revealed that only 3% of the 100,000 units sold malfunctioned.

The man who wrote the next chapter in the world history of the magnetic treatment of fluids was a Japanese **Saburo Miyata Moriya** in the 1960s (focusing on the so-called "wet" devices, i.e., inline energizers requiring cutting-off pipes for bi-polar devices to be retrofitted) and an American inventor **Roland Carpenter** in the 1970s (also with a bi-polar system).

In the 1980s, a brilliant U.S. inventor named **Peter Kulish** and our colleague designed the so-called monopole system (subjugating liquid to one magnet pole only). They strapped it onto lines without cutting them. He pushed the research forward, improved the device (originally, it was a snap-on, already a significant improvement, but still a bipolar one), and finally obtained the optimal shape and several American utility and design patents.

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 also affects ground-level ozone, reducing carbon monoxide (C.O.) emissions by as much as 100% and hydrocarbon (H.C.) pollutants by more than 85%. Since 1987, the patented Magnetizer Engine Energizer System has passed every emissions test.

Mundimex can 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. These tests confirmed 10% and up gasoline savings in the latest European car models, such

as the Mercedes Smart—the astounding results of real-life sugar mill applications we present later.

Much heavy research into the magnetic treatment of fluids and the science of magnetics (including bio-magnetic treatment) was done on a large scale in Israel (primarily in agriculture, with 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, an expert in physical chemistry, finished the 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 theory revealing physical essence of the phenomenon. He briefly stated his theory in a paper published recently in the 5 (5) 2003 magazine «Power Plant Chemistry.» Shortly, the same magazine will publish his new paper, 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 the 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 works."* *"Understanding [MHD resonance benefits] protects from mistakes,"* he said in his recent correspondence with Mundimex.

Finally, 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 last 40 years, Hans Dehmelt of the University of Washington in Seattle, in 1989, was awarded the Nobel Prize in Physics for continued research on the essential characteristics of electrons.

Theory of Operation

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

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

In general, all materials on Earth can react to magnetic fields. The only difference is the degree of response. Thus, one can divide all elements on Mendeleev's chart into paramagnetic and diamagnetic. The former are concentrated at (drawn to) the lines of the 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 their induced magnetic fields are much weaker than the outside magnetizing field, thus being driven into magnetic flux's weaker area.

Among the paramagnetic materials, we have a ferromagnetic group, which responds strongly to magnetic force/attraction (neodymium, rare Earth, ferrites). Magnetic energizers that Mundimex offers and installs in sugar mills use this type of component, with powerful ceramic magnets, permanent in action, ranging from 4,500 to 11,200 Gauss-Oersted energy units.

Mundimex found a crucial distinction between para- and diamagnetic pipe material for proper, correct, and fool-proof magnetic installations in the sugar mill environment. 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 to make the proper selection of equipment. It further bears on the logistical aspects, such as what is shipped to and installed in the mills and the monopolar magnetic energizers (which also require special pre- and post-production treatment beyond the standard stock). We can only state herewith that here's where, in the case of the 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 lifetime savings in the technological process of sugar making.

Since, for this paper, we are more interested in the non-fuel aspect, i.e., the 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—with a large amount of information 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

Given the intended end-use (sugar industry), the Reader we address in this paper is probably less interested in magnetism caused by unpaired electrons in the dipole moment of ferromagnets (of which they can find more in the above-referenced source). Thus, we shall devote more attention to the water aspect of MHD.

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

Ground water contains thousands of particles and micro-elements 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 has a negative electrical charge. Still, overall, the net electrical charge is negative. Thus, with the water molecule being a small magnet (dipole), one may affect its magnetic (or electric) field by causing the molecule to turn or rotate in one direction or the other, taking on a positive or negative higher potential, depending on whether the S (South, positive) or N (North, negative) outside magnetic field had been applied.²

¹ Debye's dipole moment in chemistry measures whether the negative charge's center coincides with the positive charge's center. 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]

² 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 an 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 behaviorally. It considerably increases the mobility of ions in water solution. It creates a more solvent fluid flow (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. We recommend using it in precipitation, separation, and sugar-mill cases (e.g., its sewage treatment plant).

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, CaHCO_3 , changes to the less hydrated, insoluble calcium carbonate (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 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).

Usually, 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 opposing poles of the molecules were closest to the magnetic source (opposite charges attract as 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 the greatest opposite net charge will be closest to the stimulus, and conversely, those with the greatest like net charge will be furthest away.

Like little magnets, the energized and amplified (magnetized) molecules uniformly line up end-to-end as the net charges are all equalized by the external magnet influence. Thus, polarization consists of changing the chaotic molecules of liquid or gas fluid into such fluid with equal charge and uniform linearization. Exposure to a magnetic South pole field affects an atom's electron spin, compacting the size of the electron orbit. For the H_2O molecule, the hydrogens, 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 changes the non-magnetized water molecule's net negative charge to the magnetized water molecule to the net positive charge of the magnetized water.

Therefore, magnetizing will change the water's net charge so the carbonate molecules cannot aggregate and crystallize. It also works on dissolving existing crystalline structures (previous scaling) by cleaving bonds between the carbonate molecule via the same charge influence - an actual magnetic attraction of the carbonate molecule to the water molecule.

We can change the random configuration of water molecules to a charged and organized form with their shape and size are also modified. The associations clustering around the suspended particles are broken up as the molecules line up in polarization.

The fluid's paramagnetic properties allow more dissolved material to be contained due to the increased efficiency of the fluid's available space.

The magnetic treatment allows carbon dioxide (CO_2) to stay dissolved in higher temperature water. Calcium carbonate is converted back to calcium bicarbonate. With the increased solubility of CO_2 , pH is lowered, which also accelerates the descaling, 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 placed on the pipes. Instead, it has a health-beneficial effect by 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.

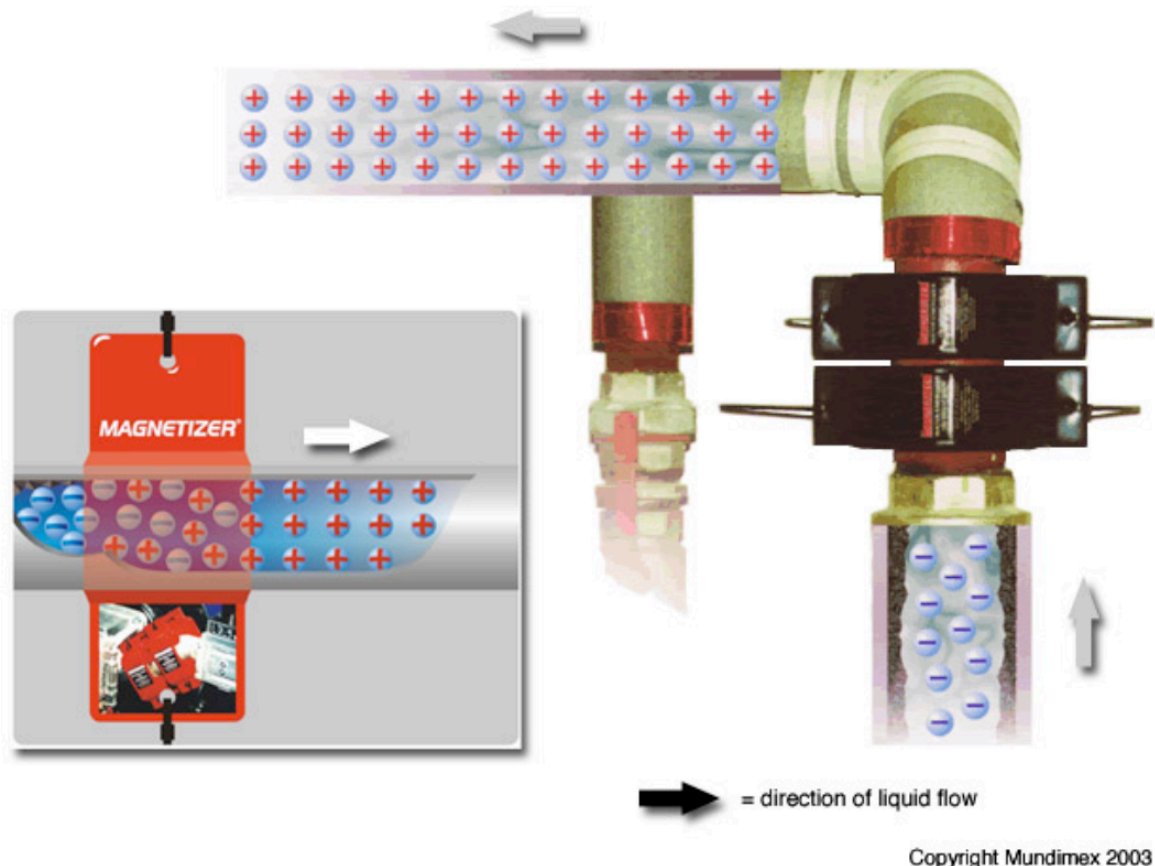


Fig. 1 Schematic illustration of a magnetizing process in a sugar production feed pipe.

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). It maintains the "magnetic memory effect," which can be empirically proven by a simple voltage³ test of hard water by measuring the millivolts (mV) before and after the installation of the magnet on the cold water tap (or entrance to the home and furthest tap from that place). It will show a change from approx. -0.5mV to an approx. +1.0 mV.

On average, with magnets, there is an increase of 1.5 millivolts.⁴

³ Use a more precise volt meter with the L.E.D. readout and not the gauge type.

⁴ Workings of our system in the example of flowing water can be proven thus mathematically: H₂O has a net negative charge, say: -300 mV, whereas iron pipe is electrically neutral, i.e., = 0, thus $0 > -300$. It attracts the minerals contained in flowing water, which starts building up the scale. In this example say Ca = -350 mV and Mg = -400 mV, thus $0 > -300 > -350 > -400$. Upon installation of our magnets, with its solid positive magnetic pole, say of +310 mV, the equation above is effected in the following manner: H₂O = -300 mV (before) + 310 mV (with the

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 induce magnetic micro-fields ("Tolmien-Szlichting wave packet") to be 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. However, magnetized fluids that lie dormant for months eventually lose their induced orientation.

Applying Magnetizer's powerful and focused magnetic field, the natural process that occurs underground in the soil is imitated due to the 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 creates a difference in potential between the piping and air, which permits isolation and protects the system reliably and permanently. The electrolytic corrosion is stopped by binding magnetically the excess (free) hydrogen H^+ (in acidic fluids) or hydroxyl $O.H^-$ (in alkaline fluids) ions, responsible for the brittleness of piping, which is now bound up with other molecules. This buffers pH, reducing wide pH variations found in fluids, regardless of outside influences. We achieve it by changing electro-statically neutral fluid to a positive state. In contrast, the increased electron excitement (voltage) makes 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 the fluid as there are no free ions to nucleate with the pipe material.

A proper change in the electron orientation by this advanced monopolar magnetic technology affects the water molecule's aggregation and crystallization, causing increased hydration (water saturation), solubility, and selective ionization, changing fluid physically, structurally, and behaviorally. The mobility of ions in the water solution increases dramatically. It causes the passing fluid to be 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%.

A build-up of sediment called **scale** (a.k.a. limescale or "boiler stone," etc.) is one of the fundamental problems that exist in all technological processes where liquids are used (heating, heat exchanging, evaporation, saturation, condensation, cooling, chilling, etc.). The higher the temperature, the more intensive the build-up of this rock-like formation. It is especially damaging (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 the costly use of inhibitors or other chemicals as well as due to hazards involved in removing it by thermal (fire), chemical or mechanical means. Another negative side effect is the increased energy use caused by heat transfer loss, with insulation clogging up to 50% of juice pipes' inner profile often-times. It is a chronic problem, since sugar juice is to be kept at the proper temperature, ranging from 88°C (190°F) to as high as 124°C (255°F).

magnets on) = +10 mV, whereas $Ca = -350 \text{ mV} + 310 \text{ mV}$ (with the magnets on) = -10 mV, and whereas $Mg = -400 \text{ mV} + 310 \text{ mV}$ (with the magnets on) = -60 mV. Finally, we get $+10 > 0 > -10 > -60$, 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.

This phenomenon is unwelcome since the crystalline precipitates caused by the loss of CO₂ gas from sugar juice when its temperature rises harm equipment and installations.

These crystals, composed of calcium and magnesium salts, form a perfect thermal isolator and do not allow for free flow (transfer) of heat. They are complex and challenging to remove, as calcite appears less hydrated with hard surface bonds. The scale problems mean only one thing: the 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 millimeter of scale thickness translates into 8-10% energy loss).

Furthermore, in the technological process of sugar production, the sediment (scale) on the equipment's inner walls is increased because the milk of lime - calcium hydroxide – Ca(OH)₂ - is added to sugar juice, and a high temperature is maintained.

Based on our experience in the sugar-making industry, we have to point out that the hardness and quantity of sediment on the inner walls of equipment will depend on the chemical makeup of the limestone. The content of silicon compounds can influence the quality of lime milk in a very negative way. The best lime milk is one that is devoid of silicon compounds or has a small quantity of it. **At the selection phase for the suitable 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.**

Up to this point, money spent on cleaning clogged piping with chemicals, brushing/flaming it, and necessary downtime has been a constant, recurring cost notwithstanding the "ecological price" for the polluted environment (water table at the sugar mill sugar mill's vicinity).

This is why we highly recommend using the monopolar magnetic devices and the know-how that Mundimex has been applying with unprecedented success in sugar mills (and other water/fuel applications).

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

Scientists have proven that a strong magnetic field, with adequately chosen parameters, affects changes in such fluid characteristics 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 industries worldwide on its magnetic energizers over the last ten years that can confirm it.

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

- in salt solutions, their crystallization occurs inside of the juice and not on the walls of the pipes
- the 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 critical 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). In contrast, plants often decide to install it curatively during the ongoing campaign in order to allow production to continue and to start immediately benefiting from the cost reduction by reducing chemicals/inhibitors/workforce. Later, its preventive nature will come into play for the lifetime 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 placed its technology in some of Europe's largest sugar mills, with very positive and satisfying results for all of its clients. Over the last four years, its engineers have perfected installation techniques, and the Company can now offer and recommend this advance in magnetic treatment to sugar mills worldwide.

Before writing this paper, the practical findings and technological parameters obtained from sugar plants worldwide confirmed that Mundimex has a valuable and permanent natural solution based on the magnetic treatment of fluids to remove and prevent scale in sugar mills worldwide.

Our first contact with the sugar industry dates back to 1995 when we spent time figuring out how our state-of-the-art magnetic systems could fit into the sugar mill operations.

We knew from the start we had a winner, with a breakthrough technology used to successfully descale water pipes and equipment in a variety of industries (a nuclear plant in Golfesh, France, owned by E.D.F., included); however, due to lack of proper know-how in the sugar industry itself, we decided to initiate pilot installations in a few selected sugar-mills in Poland, first on the sugar heaters to investigate the issue thoroughly.

The objective was to examine the efficiency of Magnetizer work in harsh sugar mill conditions, where the scale was a much bigger and more pervasive problem than in other industries.

Experts described the results achieved by Mundimex as "sensational."

After the campaign, the scale thickness of heater tubes before saturation II in one of the pilot plants was about 0.5 mm. In previous years, the same thickness reached 10 mm, which meant stopping production on the "stuffed" heater and re-directing it to the second one.

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

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

"...We ascertain that the results have surpassed our boldest expectations." - Henryk Walachowski, Vice Chairman of the Board For Technical Affairs, sugar-mill "Nowy Staw" S.A.

Whereas the 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, it was 66.0. Bx of rare juice was in the first decade 13.8 and the last 14.3. The average for the whole campaign was 14.3. The Heating surface of the evaporator in that particular sugar mill was 3,901 m², which at the average output of 2751 t/24h gives a meager output (processing) coefficient of 1.42 m²/100 t. After applying the Magnetizers, they used 2 tons less of the German-made chemical agent KEBO DS compared with previous years.

The average calcium salt 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 descaling 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 (the scale used to cover 50% of the pipe's inner profile), and its effects were described as "incredible" by specialists who have for years seen various modifications, technologies, and techniques used.

"After processing 143,000 of beetroots, we did not clean pumps at all, and Saturation II boilers had a minimal sediment growth." - Tomasz Szczesniak, M.E.S., Production Chief, sugar-mill "Ostrowite, SugarPol S.A. holding.

"After termination of the campaign, we ascertained that there is less scale in the mere heaters and the Saturation II boiler 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 the mainline and the second on dia. 159 before the evaporators' Section III. After finishing the sugar campaign, we ascertained considerably less sedimented stone content on the tubes of the heaters and evaporators. During the production process, there was no need for 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.

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

We installed Magnetizers in one of the mills during the campaign (lasting two 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 skeptical as to its efficiency, or did not have funds to do so) did 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. There is no stone whatsoever and no need to stop production for maintenance (cleaning). It is essential to them since they have to maintain a steady temperature for sugar juice throughout the process, and if not (it goes down due to heat transfer loss caused by scaling), then the whole production has to be stopped for cleaning.

In general, we guarantee this technology and know-how 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 entirely 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 one can easily remove with water. There is 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 a lifetime,
- c) savings on energy due to elimination of heat transfer loss;
- d) descaling on the 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 the amount of oxygen in the system through the use of regular as well as reversed polarity (negative), specially designed "air energizers." These patented monopolar and strong Magnetizers cause a 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 get extra oxygen for their work. In addition, we magnetize with the negative charge air pipes that go to the sludge to increase oxygen and 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) oxide norms using an optional, proprietary magnetic separator – it works without fail on all metal particles/impurities. Also, it removes all metal oxides (ferrite oxides, etc.) from molasses/sugar due to its proprietary design and neodymium magnetic components. It is done half automatically (no need for additional cleaning), and one can upgrade it to a fully automated one.

The introduction of the latest-generation magnetic monopolar energizers fabricated specifically for sugar mill needs for the magnetic treatment of sugar juice has created optimal processing conditions for all equipment engaged in the technology of sugar making and comfortable working conditions for the personnel involved.

The properly installed Magnetizers allow for damage-free and non-stop, permanent work during the whole campaign and a lifetime of operation after that, as they have scientifically proven zero loss of power (energy). At the same time, engineers noticed a considerable reduction in the need for heat energy throughout the technological process. 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 the 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 "magnetized," are, for example: "Gliniojeck" – 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 the [beetroot-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 excessive costs campaign-after-campaign.

Please do not hesitate to contact us regarding this paper at info@mundi.com or call us at +1 (718) 915-2934.