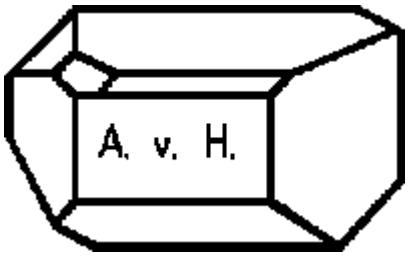

Association Andrew Van Hook

For the advancement of knowledge on sugars

XVII th Symposium

New Constraints and Challenges faced by the Sugar sector

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NEW PROGRESS IN THE SUGAR SECTOR TO RESPOND TO ENVIRONMENTAL AND REGULATION CONSTRAINTS

Sylvie FIEVET - Jean-Manuel MORANT
AGROBIOSUCRES *Engineering*

For more than 3 decades, agricultural and industrial activities have been ruled in France by a specific regulation called « **ICPE** » (Regulations of the **I**nstallations **C**lassified for the **P**rotection of **E**nvironment) which originates from the law of 19 July 1976 (nowadays integrated into the Environment Code).
Major industrial accidents which occurred in Europe (Seveso, 1976 ; Boiry-Sainte Rictrude, 1982 ; Lyon, 1987 ; Blaye, 1997 ; …) as well as international actions regarding the environmental questions (greenhouse effect emissions) have progressively lead to a strengthening of European and French regulations as concerns the prevention of accidental risks and protection of environment.
To face the evolution of regulations, the prevention and reduction of environmental, sanitary and technological risks became major concerns needing important engineering work to upgrade existing installations with regard to the new approaches and concepts of industrial projects.
The level of demand of regulations has gradually modified the management of new projects both in terms of the preliminary investigations required (technical studies and administration authorizations) and as concerns the investments in the fields of safety and previsional agenda for starting up the construction and the exploitation of installations.
In practical terms, the achievement of a project should follow a reasoned appraoach of risk control integrating in each step the environmental and regulation constraints.
The installation site is chosen after listing and analyzing the constraints related to the ground and its environment : aptitude to building construction with respect to local plan of urban development and natural risks (flood, sismic risks, …), presence of protection arealinked to classified or protected zones (potable water channelling, historical monuments, …), risks of accident due to neighbouring industry (domino effect).
The sudy of site integration should allow to verify the feasibility of the project and define the setting up of the workshops taking into account the regulation constraints in terms of distances basic allowances, constraints associated with the projected activity (by maintaining of zones of accidental effects in the limits of the property) and constraints linked to the risks of internal over accidents (called internal domino effects).
Finally, the processes and equipments should be conceived in order to control the environmental impact on the one hand (choice of the best technologies available guaranteeing the respect of regulation in terms of limit of emission in natural medium, use of recycling to limit water consumption, coupling of energies to allow rational utilisation of energy, …) and reduce the risks of accidents on the other (implementation of preventive and protective security barriers against fire, explosions, ... according to the sector regulation in effect).

SUSTAINABILITY AT THE HEART OF THE EUROPEAN BEET SUGAR INDUSTRY

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Comité Européen des Fabricants de Sucre

Sugar beet *processing* has some intrinsic features which are relevant from a sustainability point of view:

- Sugar beet is around 75% water. In the 2007/08 campaign around 100 Mio tons of sugar beet was transported in the EU, mostly by truck and to a lesser extent also by train and via waterways. This has several consequences for sugar processing :
  - Beet sugar factories are net water producers.
  - To avoid excessive transport distances (Energy, CO2, costs,…) sugar beet factories must be located near the beet fields and the local sourcing and processing of the raw material remains, from an ecological perspective, a characteristic and significant feature of the European beet sugar industry. Acc. to CEFS Statistics, in 2008 the average distance from the factory to the beet field was 44 km (weighted av. acc. to production level).
  - The location of factories in rural areas limits the access of sugar factories to adapted energy infrastructure.

At the current stage of varietal development, sugar beet can only be processed in the EU during a limited period of the year (most commonly between September and January). Thus, in a period of three to four months factories must accomplish most of the sugar production needed to supply the market for an entire year. This has also important consequences:

- Beet sugar factories must have 3-4 times the size and capacity that would be required to process a raw material that would be available all-year-round. Beet sugar factories are among the biggest if not the biggest in the food and drink sector.
- Factories require important amounts of energy to process the raw material within a short time-period. The very process of sugar extraction requires significant amounts of energy, notably in the diffusion and evaporation steps of the process. Thus, in common with other primary food processors (notably, the starch and oils sectors) the sugar sector is classified as an “Energy-intensive sector”. Savings in energy and CO2 are therefore a constant concern of the sugar industry and its technologists. Some examples of energy reduction in the different EU countries will be provided.
- Self-generation of energy on-site is a necessity considering the peak energy needs of beet sugar factories and the insufficient grid capacity in rural areas to provide the required energy. More importantly, co-generation of both heat and electricity -which are both required for the process- is a must. Beet sugar factories are a precursor and to some extent pioneers of the co-generation technologies due both to their geographical isolation and important energy (heat and electricity) needs.
- The future is already here: from “beet sugar industry” to “beet processing industry”, the EU sugar industry today is deeply involved in the maximization of sugar beets’ biomass. From the same 1 hectare of sugar beet you can produce enough ethanol to drive over 60 000 km and obtain at the same time animal feed corresponding to 1.3 hectares of soy meal. When looking at the lifecycle GHG emission savings of beet ethanol, the latter can represent about 60% compared to equivalent fossil fuels. Biogas produced from the organic residues of the sugar process or, since more recently, from the methanisation of sugar beet pulp, is another contribution from the sector to the reduction of GHG emissions. Biogas produced on 1 hectare of sugar beet provides 1 household with electricity for three years.

NEW CONSTRAINTS INTRODUCED BY EUROPEAN REACh REGULATION

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The EC regulation n° 1907/2006 published on December, 30 2006, by the European Union Council establishes a new system of **R**egistration, **E**valuation and **A**utomation for **Ch**emical substances which became effective on June 1st, 2007 and will be completely achieved in 2018.
This regulation deals with our activity of supplier of the sugar industry for products like detergents, antiscale, antifoam formulations. The biocides are treated by a special European directive. They need a special demand of authorization of marketing.
The pre-registration of some 30 000 involved substances was finished at the end of 2009. The substances produced at a tonnage above 1000 tons/year, the most dangerous substances CMR 1 and 2, those harmful to environment (R50/53) should be registered before the end of 2010. Substances produced at a tonnage above 100 tons/year should be registered before the end of 2013 and those between 1 and 100 tons/year before the end of 2018.

What would be the role of the different partners?

Ecolab, provider of formulations is not a producer according to REACh regulation. As a manufacturer of formulations, user and importer of chemical substances, Ecolab should provide the information relative to all substances in order to comply to the legislation and communicate properly on the safety matters. An inventory of the chemical substances used in the formulations or manufactured in situ is needed for a clear communication with the suppliers and a pre-registration.
A regular link with suppliers is established to insure that the substances present in the formulations and their utilisation conditions are included in the registration files, the safety reports and in FSD (Files of Security Data). FSD is used as a basis for the communication with the final users and suppliers. This tool will be strengthened in the course of establishing the REACh regulation.
Producers and importers of chemical substances except if they are exempted, should register the substances at the European agency for chemicals (ECHA). For registration, a set of data should be supplied to evaluate the risks presented by the substances and their utilisation. Chemical substances which are dangerous or marketed with high volumes are subject to a report on the chemical security. Registration is validated with a registration number which will be implemented in the FSD. FSD is the tool for communication along the chain of supply. After establishing of REACh, these files should contain information on exposition and measures of reduction of risks to implement.
Sugar industry, as user of such products, has a role in establishing a communication with suppliers to be sure of the pre-registration and further registration which should take into account the specific utilisations by the sugar sector, if these are different from the use listed by the suppliers.
The manufacturing of co-products like ethanol make the sugar industrialist, a producer of chemicals who should register his products and participate to forums of information exchange with his clients concerning the downstream utilisation of ethanol.

Application of Pulsed Electric Field to beet cossettes and consequences on sugar processing and environment

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Pulsed electric fields (PEF) stand for non thermal, short time (generally hundreds of nanoseconds to milliseconds) treatments which differ from other treatments because it provokes a targeted damage of cell membranes which only slightly destroys the tissue matrix. Under PEF action, the biological membrane is electrically tapped which makes it loose temporarily or definitely its semi-permeability property and allows an easy crossing of low molecular size molecules (like sucrose). Electrical permeabilization of membranes (also called electroporation) might be reversible (in this case there is spontaneous reparation of pores electrically induced) or irreversible (if membrane pores don't disappear after removal of the electrical field).

Among potential and promising applications of PEF, we may cite the development of sucrose extraction technologies from sugar beet. Combining PEF and sugar beet extraction may provide numerous advantages:

- non thermal or mild temperature extraction
- increased selectivity in the cellular components extraction which reduces or simplifies the operations of juice purification and clarification.

The work lead at the Technology University of Compiègne aimed at the study of the effect of PEF treatment on electroporation of biological tissue and on the improvement of plant extraction and separation. It was demonstrated that PEF treatment improves the yield of pressing of different plants (because of the increase in hydraulic permeability of tissue). It accelerates mass transfer during aqueous extraction (increase in diffusivity of solutes) and intensifies the dewatering (increase of water diffusion).

In this work, the effects of PEF on the properties of beet tissue and sugar diffusivity inside the tissue are demonstrated. The degree of beet cell membrane spoilage was studied for different parameters of pulsed electrical fields and compared to thermal spoilage. Application of PEF accelerates the spoilage of cell membranes and allows a more rapid denaturing of beet tissue than thermal treatment. Mechanical properties of PEF treated tissue are less modified and closer to the fresh state than that treated at temperatures around 70-75°C. Diffusivity of beet sugar was determined for PEF treated and non treated beets at different temperatures. PEF treatment increases the diffusion coefficient and accelerates mass transfer of sucrose at 20 to 60°C.

Some examples of small pilot press extraction and PEF accelerated diffusion are presented. Advantages of PEF treatment and some of its consequences on the sugar extraction process are discussed.

Power Generation and Renewable Energy in British Sugar Beet and Cane Sugar Factories

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Power and Steam generation have always been an essential requirement in the Sugar Industry, with factory operations, fuel availability, technology, local network infrastructures and now increasing environmental legislation shaping the infrastructure required to meet the needs of the industry.
This paper will give an overview of how Power Generation has changed over recent years with British Sugar's UK operations and how lessons are being learnt with the groups expanding global operations, particularly with Renewable Fuels.

Which Fuel, Risk Management or Opportunity?
Fuel availability and cost have been a major contributing factor to shaping the infrastructure used within the UK Factories; the current fuel mix includes Coal, Fuel Oil and Gas. Investments in the 1970s and 80s resulted in the traditional Boiler/ Steam Turbine combination, but with opportunities in the Electricity Trading Markets the investments in the late 1990s, Gas Turbine/ Heat Recovery Boiler/ Steam Turbine Combinations have been utilised giving a higher Power to Heat ratio than the tradition combination.
With the planned tightening of emissions limits under the new Industrial Emissions Directive, the business is at key point in planning for the future with the Boiler Plant installed in the 1970s. Investments could be based on reducing emissions with the existing plant, invest in current fossil fuel based technology or invest in renewable fuels.

Lessons From the Cane Sugar Industry
Fuel for the Cane Sugar Industry has been based on renewable fuels for many years, with the raw material itself being the source of Boiler fuel. After the cane has been crushed and the sugar extracted the residual material bagasse becomes the Boiler fuel. Due to the need to use all of the bagasse by the end of the crop session overall plant efficiency has not been the key driver, but with factory expansions, coal has been used to supplement the bagasse, this has now been challenged, with the objective of returning to renewable fuels as the sole fuel source.
Based on the approach of the Cane factories, this is now being investigated for the Beet Factories, can a Beet Sugar Factory be solely operated on Renewable Fuel, the next decade could see this vision start to develop.

CONTROLLING THE ENVIRONMENTAL SECURITY RISKS

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The durability of activities goes through the control of all risks to which industrials are exposed, especially as concerns the environment security. Within this framework, the control of regulations relative to industrial and professional risks constitutes a predominant factor whose economic consequences and responsibility involvement might be important.

In order to draw up an inventory of the situation with regard to the regulation in effect , there is a need of knowing the list of regulation texts applicable, of examining the environmental performances of the process and of evaluation of the level of compliance to the laws. This will be based on Labour Code, Environment Standards Code, typical decrees and authorization of exploitation decisions.

Evaluation of the level of compliance to regulations is also a way to insure the conformation of procedures with regard to regulation commitments and to have the elements needed to establish a plan of action in order to correct the observed gap.

What to do n case of accident ? What consequences for the company and its manager ? How to structure all the regulations which might appear to be endless? The answer to these questions resides in the overall control of all environment security risks. This will allow to protect collaborators, own responsibility and planet integrity at each step of a project from its conception to its exploitation.

Risks of explosion regarding sugar storage, biofuel storage and biogas production workshop

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Sugar factories exploit installations for sugar storage and in some cases distilleries producing bio-ethanol and equipments for fermenting by products into biogas.
Implementation of these products yields the risk of formation of explosive dusty atmospheres, ethanol and biogas vapours (ATEX). For this reason, these installations are subjected to the French transposition of the text of the European regulation ATEX 1999/92/EC, relative to protection of workers exposed to ATEX risks of explosion.
Sugar factories are also subjected to ICPE regulations relative to classified facilities and some of them are under Seveso classification. In this case, installations should obey the technical criteria imposed by this regulation and the security should be organised in consequence.
The legal requirements for declaration, authorization of biogas workshops and the decree n° 2009-1341 of 29/10/09 (creation of a category ICPE n° 2981 relative to biogas transformation of non dangerous by products or raw plant material excluding the water purification stations) have been published in 2009. The threshold fixed for declaration and authorization is 30 T/day of matter treated. It should be noted that a new regime of registration of installations setting a tonnage between 30 and 50 T/day should be published some time in 2010 in order to simplify the administrative approach.
To be notices are the following decrees:

- decree of November 10, 2009 relative to general prescriptions applicable to classified biogas installations submitted to a declaration under the category n° 2781-1.
- Decree of November 1O, 2009, setting the technical rules to which should satisfy the installations of biogas submitted to an authorization in application of the title 1 of book V of the Environment Code.

Between 1960 and 1990, the sugar industry in France and in the world has experienced about ten major accidents due to dust explosion. The guide for the state of the art elaborated by SNFS (Syndicat National des Fabricants de Sucre) provides a complete description of accidents. From this description, it appears that sparks from mechanical origin, work with hot spots, and heating of mechanical origin are the sources of inflammation the most incriminated. Explosions mainly concern elevators, storage cells and air filters.
Fine sugar dust particles are likely to explode. Their activity as regards inflammation risk by electrostatic spark is medium (minimal inflammation energy around 100 mJ.).
The risk of explosion associated to biofuel storage is inherent to ethanol vapour in the headspace of storage vats. This risk is nowadays well controlled.
INERIS was approached in 2008 INERIS was approached in 2008 by MEEDDM in order to study the risks associated with the process of biogas production. The major objective of the study was to define the security rules to apply in order to assure a sufficient control of risks when exploiting such installations

Change in the sugar industry: ATEX Standards, New Food regulations and their applications

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ROTEX EUROPE Ltd., Wavre, Belgique

ROTEX is a 160 years old company with more than 90 years of expertise in finding solutions to the sifting and scalping of sugar. Amon gour activities, there is also classification and fine removal. Some examples will be detailed in particular the scalping 2.5 and 200 µm fine removal. Likewise, we recall the basics of sugar sifting.

Scalping has progressed from traditional method to a precision scalping . Therefore the unique movement of ROTEX machines allows a better yield. The screen XD MEGATEX allows higher performance with a reduced surface on the floor as may be seen in a video.

To notice there is also the ergonomy, easy access and possibility of control of the cloth for each bulk feeding. This permits a minimum of time for control and maintenance for the APEX sifter.

In this symposium, we will present the evolution of needs as regards the contact of machines with food products. Usually FDA regulations were applied but now they are definitely replaced by EC 1935/2004 regulations. What are the consequences of application of these regulations ?
We will also present the combined constraints of ATEX regulations and EC food regulations.

This communication is ended by the presentation and manipulation of the APEX apparatus.

Energy and water cost for the production of sugar in semi-arid regions: comparative study of cane and beet sugar production in Morocco

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The present work treats the subject of utilization of energy and water in the agro-industrial system of sugar production as well as the impact of this production on the environment. The choice of the sugar sector was dictated by the fact that this sector is a socio-economically strategic one, given that sugar is a staple product in Morocco where average consumption is 30kg per capita per year. Moreover, among the most significant inputs in sugar production, energy and water generally are predominant. Yet Morocco imports 98% of its needs in fossil energy and its agriculture uses more than 85% of water resources. With energy invoice which highly impacts the payment balance and droughts which are rife in the country with a higher and higher frequency, together with environmental considerations, it becomes more than a priority, even an immediate need to optimize the use of energy and water.

Sugar is produced in Morocco from beet and sugarcane. Annual production of sugar beet is around 2.8 millions tonnes and that of cane is about 1 million tonnes transformed in ten sugar factories.

Consumption of energy and water for the production of sugar in Morocco is determined according to the method of energetic analysis which accounts for balances and rates of energy flux (direct and indirect) as well as mass balances in the working system. Energy balances also allow evaluation of heat exchange between the system and the environment, which are basic elements for ecology impact analysis.

Therefore, analysis reveals that sugar beet consumes 33.8 GJ/ha whereas the consumption of sugarcane is 59.3 and 35.7 GJ/ha respectively for virgin cane and newly grown cane. For both crops, the main energy sources are gas oil, electricity for irrigation and fertilizers. In beet production, fertilizers cost 50% of energy input and for cane, it is only 37%. The energy yield (output/input ratio) is 3.2 for beet and 3.7 for cane.

As for the industrial part, energy consumption needed for white sugar production from beet is 26 GJ/tonne against 3 GJ/tonne from cane. In this energy, direct (fossil and electricity) energy is 22 GJ/ T of white sugar for beet and 1.3 for sugarcane.

The energetic yield for sugar production (agriculture + transformation) is 1.5 for beet sugar and 4.2 for cane sugar. Overall analysis shows that the production of beet sugar is more power-hungry and that of cane sugar uses 3 times more water (1155 m^3/T white cane sugar against 382 m^3/T white beet sugar).

In this paper, we present the methodology and the results of investigation and discuss the consumption of natural resources in a context of scarcity. The impact of these productions on the environment is also discussed and the approach of sustainability of the sector are explored.