CHEMICAL ENGINEERING TRANSACTIONS
VOL. 32, 2013
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at: www.aidic.it/cet
Chief Editors: Sauro Pierucci, Jiří J. Klemeš

ISBN 978-88-95608-23-5; **ISSN** 1974-9791
DOI: 10.3303/CET1332222

Alcohol Production Process Modelling Based on Indicators using Transactional Software, Industrial Automation and Manufacturing Execution Systems-MES

Lourdes Andreo Gonçalves*[a], Rubens Maciel Filho[b]

[a]Information System Department, Adventist College of Hortolândia, Rua Hugo Gegembauer, Parque Ortolandia, 13184-010, Hortolândia-São Paulo, Brazil.
[b]School of Chemical Engineering, University of Campinas, Cidade Universitária Zeferino Vaz, P.O. Box, 6066, 13083-970, Campinas-São Paulo, Brazil.
lourdes.goncalves@unasp.edu.br

Ethanol production plants face several issues, among which increased productivity with overhead reduction. A possible way to achieve such requirements is through a reliable computer tool and bearing this in mind is proposed in this work an operating model based on operational indicators of the ethanol production process, using ERP software (Enterprise Resource Planning), transactional software, MES (Manufacturing Execution Systems) and industrial automation.
The article presents this new model which consists of: Integration of information obtained from strategic decisions taken by top management, the agricultural sector, automation, operational controls, using indicators and production planning (MES). Acting based on pre-defined knowledge and on real time, using state-of-the-art automation and information technologies, backed by a very well defined information flow system.
The main objective is to achieve process optimization. The main results obtained by the model are: automation of production processes, reliability and efficiency in the exchange of information, improvement of communication among the production areas and the other management areas, appropriate use of state-of-the-art technologies, real-time access to information anywhere (web) to make it possible for decisions to be made safely and secure.

1. Importance of Automation and Information Technologies in the Process of Production of Ethanol

Brazil pioneered the research and production of ethanol and, has for the past 25 years, put a major effort into it and believed in reaching higher objectives. It has developed unprecedented technologies, and as a result there are currently over 28 thousand fuel stations with hydrated ethanol pumps. Unica (2010) has reported, the nation is always in search of better technologies when it comes to ethanol production.

1.1 Automation

The most recent automation and information technologies play a pivotal role for businesses, boosting development as well as supporting operations.
Automation is currently useful in diverse areas of a process, such as: electrical, electronic, mechanical, pneumatics and hydraulics.
A large scale ethanol production plant is composed of several steps, as shown in Figure 1, which have to work in an integrated fashion and as much as possible near the optimal operating conditions.
Taking this into consideration automation and real time information on the process variables and management requirements are not only important but necessary.
However, It is important to point out that every automated process requires human control and supervision. Alasmar (2010), large investments in state-of-the-art technologies using digital technology in

Please cite this article as: Goncalves E., Maciel Filho R., 2013, Alcohol production process modeling based on indicators using transactional software, industrial automation and manufacturing and execution systems mes, Chemical Engineering Transactions, 32, 1327-1332 DOI: 10.3303/CET1332222

the construction of new units, preferably projects where there is integration among the various sectors involved in the production process, have been made.

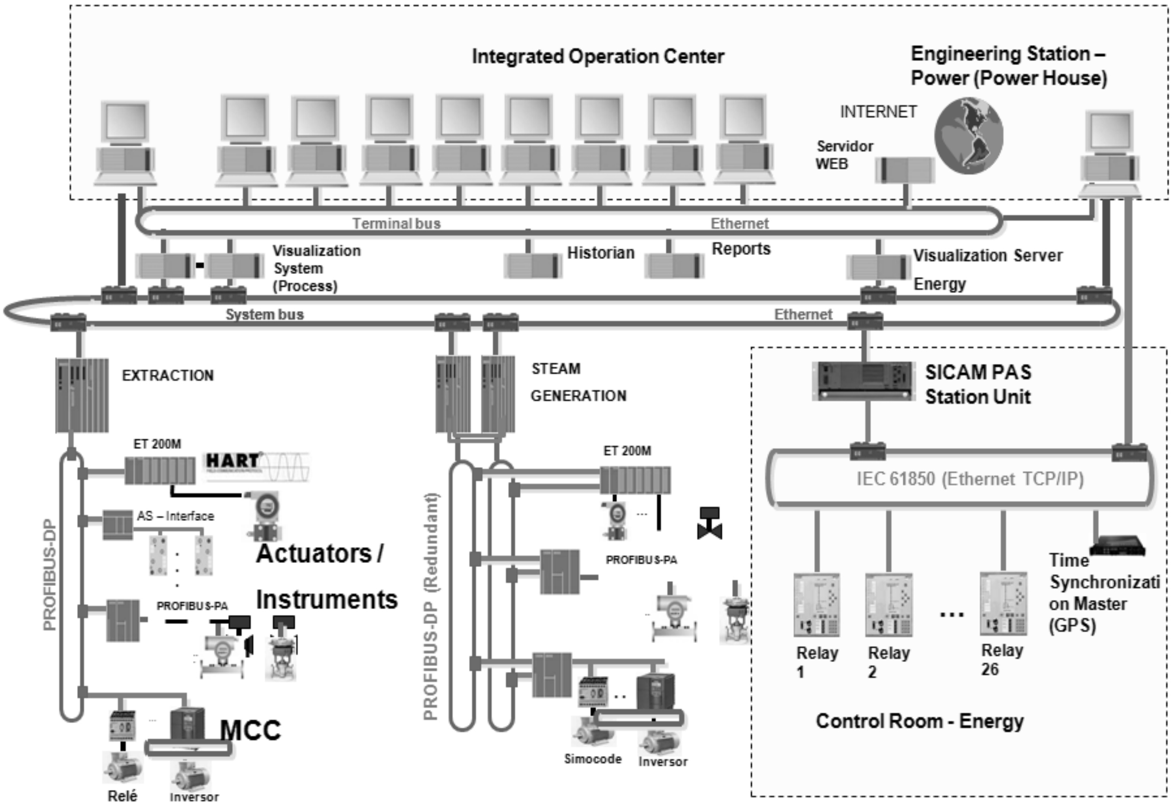


Figure 1- Integrated structure of an automated process.

Scada: SCADA (Stands for Supervisory Control and Data Acquisition), came on the scene due to industrial automation in the most diverse areas of the production process. These are systems used to supervise and control automated equipment by checking indicators and its values graphically. It is possible to exercise effective and real time control through constant monitoring of parameters set into SCADA.

It has the ability to pinpoint defects and to instantly detect equipment outage, thus prompting human intervention in order to fix the problem in the least amount of time. Figure 1 represents automation of an Alcohol Production Unit using state-of-the-art technology.

1.2 Information Technologies

ERP (Enterprise Resource Planning): As (Souza and Saccol , 2003), **ERP** consists of information systems connected to each other with the objective of assisting organizations throughout all its business and operational phases.

ERP is a generic term representing the information systems contained therein.

Transactional Systems: Transactional software have the sole objective of supporting operations in the sugarcane agroindustry, from the initial weighing of the sugarcane, through sucrose labs and finally to the shipping and warehousing of the final product – Ethanol.

Transactional software that attends the industrial sector is based on multi-harvest and multi-company concepts; in other words, it is able to attend several harvests at the same time as well as several production units within a group. It fully integrates with all other systems within the whole organization.

They possess reliable analysis mechanisms, with the most advanced formula resources, graphics and diagnostics.

Monitoring of processes and industrial maintenance in a transparent and qualitative way is made possible; along with effective automatic data acquisition from labs.

Software for managing industrial labs, to control the glass utensils, as well as equipment calibration, chemicals and reagents used. Enables automatic product classification, and issues quality certificates for final products (leaven, alcohol and sugar. Software that can calculate complex mathematical functions, different units of measure, calculation of averages of variables that represent quality in the process. Emits alarm messages to the analyst, whenever analysis results are off track from what is expected.

MES (Manufacturing Execution Systems): Barros (2007) defines MES as a mixed group of technologies, responsible for managing production throughout the whole chain. It puts business strategies into practice, churning out productive activities. The main expected activities whenever using MES are related to data integration among the most diverse platforms of Information Systems used within the limits of a production process. Figure 2 presents the architecture for a production process, where MES is inserted among other layers such as automation, transactional systems and ERPs.

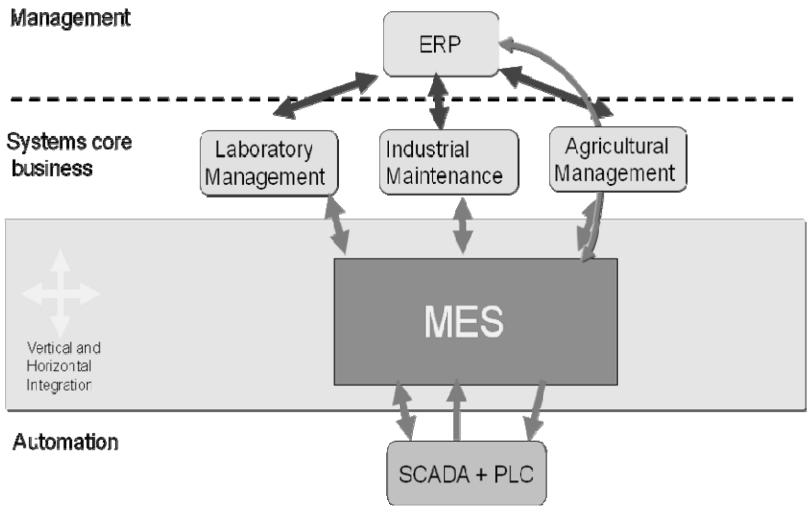


Figure 2 - Integrated Structure of the Production Process.

The bottom layer is the industrial automation, where it runs the software for automation of data from devices that control the production. The intermediate layer is where the MES is running, i.e. the production control. Where the rules already established, are performed. The two layers superiors represent managements and technical and administrative controls, where the rules and techniques of businesses are defined.

2. Operational Model Based on Indicators

It is the model which uses automation and Information technologies to obtain information of operations for each unit, of the productive process and MES (Manufacturing Execution Systems) as an information integrator, thus creating a proactive model, integrated and in real time, with synergy among all areas.

It uses indicators and knowledge of the production process to establish a basis to enable decision making in real time. The proposal that the model offers is to bring a solution to an important issue, to know: to manage all production units in real time, where several events can take place down the line, such as lack of raw material, change in raw material quality, break down of equipment in the field or in the industry and quality issues with materials being processed or already finished, and others.

Bearing all this in mind, the ability to cope and to provide response to all these events is invested of extreme importance. These rules are obtained, in practice the production process and in the literature, such as Giarola (2011) about administrative decisions, and Souza Leite (2011) and Drapela (2009) about news technologies.

Once indicators are established and integrated into one database, actions are defined which will become rules, or operational knowledge. Rules or knowledge are stored in data base and will be presented a graphical chart flow under ‘Business Logics’; to be executed and react on any given event which requires a response on a physical level. The differential this is that these rules share information stemming from the most diverse sources, as plant automation, agro management, ERP, labs, production and maintenance;

which makes them future strategic knowledge for decision making in real time. Figure 3 presents the flow diagram of the model

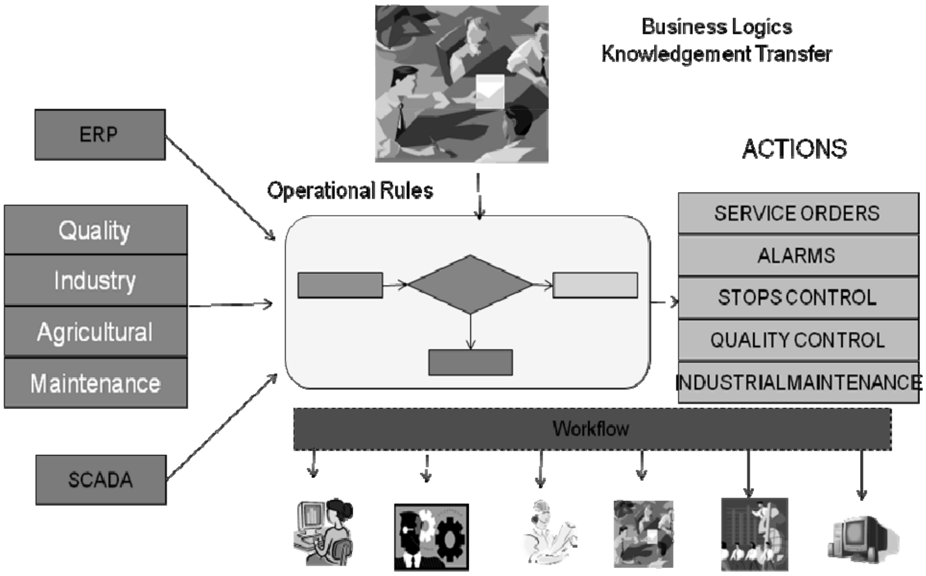


Figure 3 Diagram of the Model.

3. Case Study

Vista Alegre Plant, located in the town of Maracaju, state of Mato Grosso do Sul - Brazil, is the youngest alcohol production unit of the Tonon Group. The group opted for using, from the very first harvest, the Operational Model based on indicators that received the name of MESAgro. The model was implemented using management transactional software for the Industrial Production Process and Industrial Maintenance from Proxima: PIMS-PI and PIMS-MI, using Siemens products to tend to the automation process and SIMATIC IT to the MES technology. Figure 4 demonstrates the phases in the project.

The main established functions for the case study were:

- Define indicators in the different areas
- Multi source data integration. Data from the agro sector in order to know the quality of the raw material and manage milling. Automation data to know the life span of the equipment of critical utilization. Data from quality control for use in decision making. Information of anomalies within the process which may or may not impede its continuity.
- Opening of service orders for industrial maintenance.
- Configuring of automation set points if needed in the change of pace in the milling process, based on real time information from the agro sector or any other issues that might be a nuisance to normal functioning of this area.
- Know and register motives for stoppage in the main pieces of equipment of the process, such as: the Mill, Centrifugal, etc.
- Define business rules for decision making.

3.1 Presentation of Software

Below, presents software for information management of the production unit. Figure 5 and Figure 6 are copy of the software. Figure 6 presents Indicators derived from the Agro System, quality of raw material. Graph contains forecasted information (planning area), and real information from sugarcane production.

The Figure 6 presents Indicators from several different information sources: from the mill, with data from automation as well as from variation, rotation, pause and stop controls.

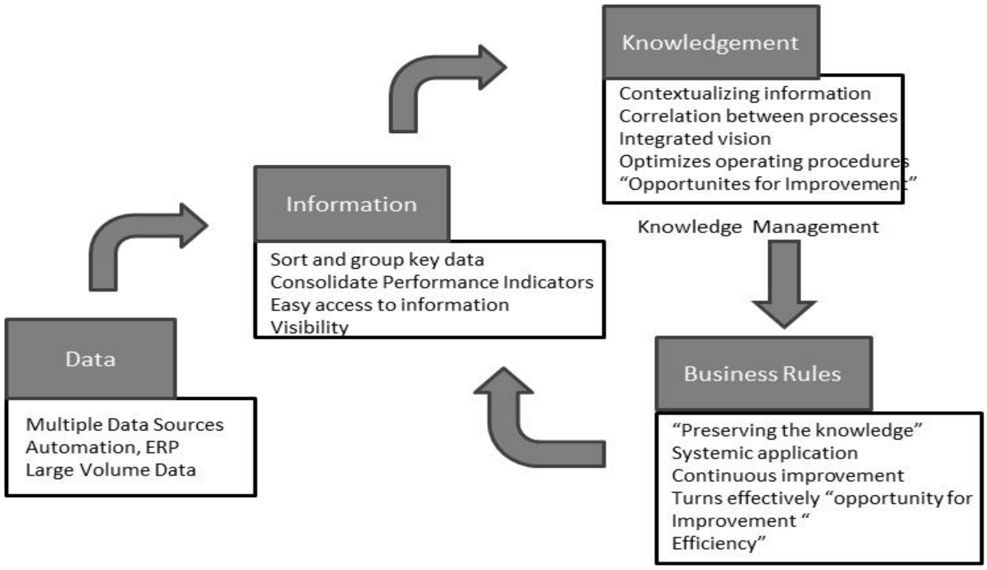
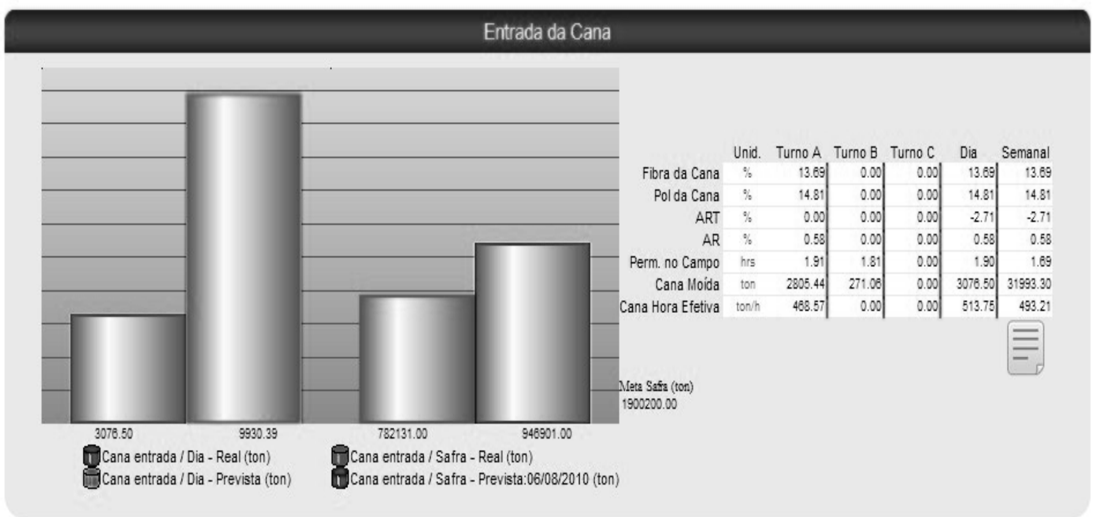


Figure 4 – Project Phases

4. Conclusion

The model is in operation, providing users with integrated data anywhere. Directors, managers, supervisors, may consult the real situation of production and operations, or any other events; from anywhere they may be, using a cellular phone or the internet. They receive alert messages through the flow of pre-established information, providing awareness of occurrences or notification by alarms which may require immediate attention. The main benefits reaped from the model are:

- Agility and security in decision making.
- Preservation of knowledge.
- Availability of information in real time.
- Control over production operations in each step of the production process.
- Outreach and maintenance of better performance levels.
- Transparency and reliability in generated information.
- Loss and risk minimization.
- Maximization of utilization of the productive capability.



	Unid.	Turno A	Turno B	Turno C	Dia	Semanal
Fibra da Cana	%	13.69	0.00	0.00	13.69	13.69
Pol da Cana	%	14.81	0.00	0.00	14.81	14.81
ART	%	0.00	0.00	0.00	-2.71	-2.71
AR	%	0.58	0.00	0.00	0.58	0.58
Perm. no Campo	hrs	1.91	1.81	0.00	1.90	1.69
Cana Moída	ton	2805.44	271.06	0.00	3076.50	31993.30
Cana Hora Efetiva	ton/h	468.57	0.00	0.00	513.75	493.21

Figure 5 – Information Sugarcane

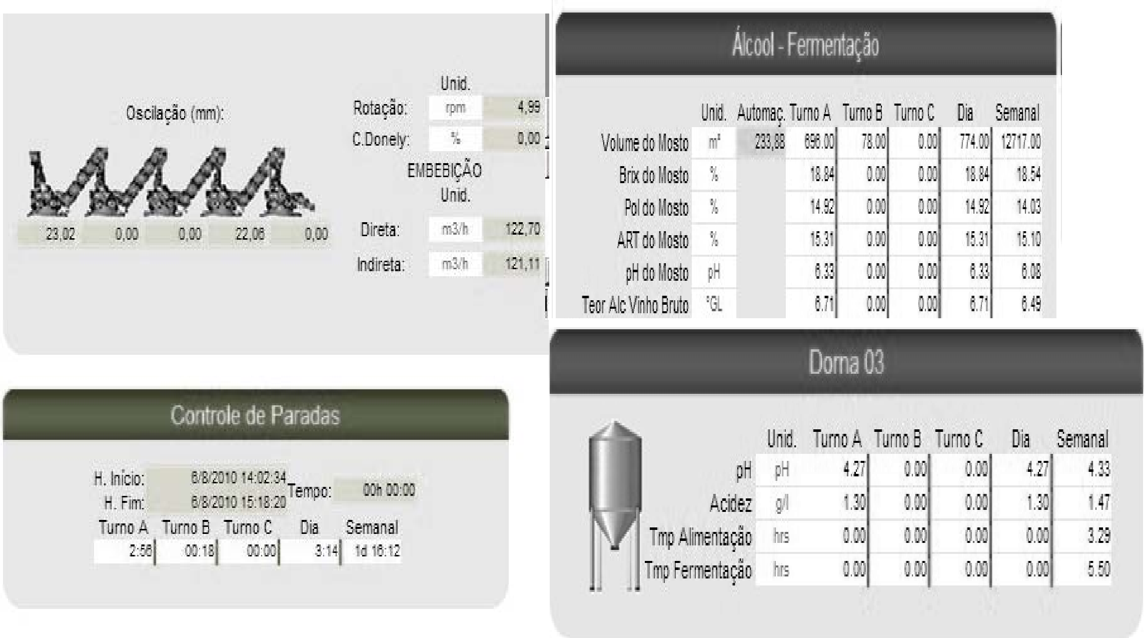


Figure 6 – Information and Indicators of the production

References

Alasmar, Marco.2010. Automation in the sector Sugarcane. Inteck. Mexico. 2010.(Português-Brazil).

Barros, Ronaldo. 2007. MES – Manufactoring Execution System. Today logistics & Supply Chain, vol. 15.

Drapela T., Pavlas M., Popela P., Boran J., Stehlik P..2009. Energy Conception of an Integrated System – I. Analysis of Available Data and its Processing. Chemical Engeneering Transactions. CET Vol 18.

Giarola S., Zamboni A., Bezzo F. .2011. Supply Chain Design and Capacity Planning: from first to second Generation Biofuel Systems. Chemical Engeneering Transactions. 24, 253-258, DOI: 10.3303/CET1124043.

Souza, C. A. De; Saccol, A. Z., 2003. ERP systems in Brazil (enterprise resource planning) Theory and Cases. Editora Atlhas. (Português-Brazil).

Souza Leite M., Ferreira Dos Santos B., Lona L.M., Vasconcelos Da Silva F., Frattini Fileti A.M. 2011. Application of Artificial Intelligence Techniques for Temperature Prediction in a Polymerization Process. Chemical Engineering Transactions 24, 385-390, DOI: 10.3303/CET1124065.

Unica, 2010. Historical Sector Sucro alcohol. <www.unica.com.br> accessed 20.04.2012. (Português-Brazil).