How can my bioethanol plant produce efficiently?

Using integrated solutions for automation and power management.

Answers for industry.
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The development of alternatives to mineral oil as a raw material has become increasingly significant in recent years. One exciting option is the use of renewable raw materials to produce biofuels. Bioethanol is one of today’s attractive and cost-effective solutions.

Ecologically and economically profitable

As well as greater independence from expensive oil, there are other arguments that speak strongly in favor of bioethanol: reductions in greenhouse gases when the entire CO₂ cycle is considered, as well as toxic emissions when burning sulfur-free bioethanol.

Tailor-made solutions

With a perfectly coordinated portfolio that is precisely matched to the different areas of the bioethanol industry, we can implement customized solutions for all the production processes. This also applies to second-generation bioethanol plants. On the basis of Totally Integrated Automation (TIA) and Totally Integrated Power (TIP), our uniquely integrated range of products and systems, we can make a significant contribution towards optimizing company-wide performance. Through the development and production of hardware and software from a single source, we can increase availability over the entire life cycle. This also reduces the total cost of ownership (TCO). You are guaranteed future-proof solutions every time because we are a leading innovator in many diverse areas.

Industry-specific know-how across the globe

We have accumulated a wealth of experience over many years in different sectors of the process industry all over the world. This cross-sector knowledge is the basis for top-performance automation solutions. Thanks to our industry-specific competence, we have an intimate knowledge of local standards and regulations, so we can offer an appropriately adapted product portfolio. Working closely together with you, these are the best prerequisites for smooth project handling, all over the globe.
Global concepts for the bioethanol industry

Based on TIA and TIP, we implement tailored solutions throughout the entire production process – from supplying the raw materials right through to storing the final products. In this way, all plant components such as fermentation and distillation as well as steam generation or cogeneration can be operated in an optimum way.

Bioethanol manufacturing in today’s and tomorrow’s world

In first-generation bioethanol manufacture, starchy or sugar-rich plants were used as the basis, with regional variations: corn in the U.S., sugar cane in Brazil, grain and sugar beet in Europe, and in Thailand increasingly cassava, a starchy root crop. In the second generation, cellulose in the form of grain straw, corn straw, cane trash and other waste products, is also used as the raw material.

Integration and sustainability when setting up and operating your plant

The high level of integration of TIA and TIP coupled with the optimal interaction of all components used enables fast start-up and smooth, profitable production. In the area of automation, we cover
The benefits of an integrated range of solutions

With TIA, Siemens is the only vendor to offer a comprehensive range of products and systems for automating bioethanol plants – from the field level through the production control level, right up to the corporate management level.

On the basis of TIP, Siemens implements end-to-end, cost-effective and safe solutions for power management. Power distribution systems cover everything from the medium-voltage supply to wall outlets. The merging of TIA and TIP and the optimal interaction of all components used offer technical and economic benefits:

- Centralized engineering, operating and monitoring of the field technology as well as the motor control center and switchgears with a single system
- Increased plant availability and reduced maintenance expenses through integrated asset management functionalities and innovative online diagnostics
- Low installation costs thanks to the use of bus technology
- Lower engineering costs thanks to cross-system software tools
- Shorter commissioning time and time to market through flexible automation solutions
- Reduced TCO and improved competitiveness

Cost-optimized solutions throughout the entire life cycle

Hardware and software from a single source, as well as preconfigured and pre-tested components ensure transparent investment costs, the long-term success and availability of your plant. You also profit from reductions in the total cost of ownership (TCO) and you can significantly improve your return on investment (ROI). Using the most up-to-date bus technology significantly reduces your installation costs, for example. System-wide software tools reduce engineering costs and, of course, any related costs. Our flexible solutions and many years of experience in the industry reduce commissioning times in new plants. With existing plants, you profit from online monitoring, asset management and predictive maintenance and thus reduce your operating costs over the entire life cycle of your plant.
Integrated automation from the field level to the control level

The core of the automation system is SIMATIC PCS 7, our innovative distributed process control system. Thanks to its modular and open architecture based on selected SIMATIC hardware and software components, SIMATIC PCS 7 can be optimally adapted to specific requirements. Expansions and modifications are possible at any time – even online. The engineering environment of SIMATIC PCS 7 offers all the tools needed to graphically configure the process control system, parameterize the field devices, and set up the electrical components.
Fermentation is the core process of a bioethanol plant and it runs either in parallel fermenters as a batch process, or continuously. For optimal batch control, we offer the SIMATIC BATCH solution. SIMATIC IT, our Manufacturing Execution System, ensures transparency between the production control level and the plant control level. Both systems are fully integrated into SIMATIC PCS 7 for system-wide automation of your plant.

Safety is fully integrated

Ex protection and functional safety are fundamental to the safe operation of bioethanol plants. Remote I/O ET 200iSP, for example, can be installed directly in Ex zone 1 / Class 1 Division 1. Requirements to safety integrity level SIL 3 can be simply integrated into SIMATIC PCS 7 to increase functional safety. For this purpose, the standard components are supplemented with the necessary safety components and programmed using the same engineering tools. In addition, the Safety Matrix is a tool for creating a simple and clear cause-effect matrix of the protection functions in the configuring, operating and maintenance phases.

Communication on the basis of field-proven standards

Our automation solution uses open communication standards. All the control commands and diagnostics data are integrated into SIMATIC PCS 7, and all the necessary operator faceplates and function blocks are also available here as a library. The components with communication capability, such as the I/O and the controller, use the high-speed PROFINET. The distributed I/O can thus be optimally spread over the relevant plant sections. This shortens cable paths to the field devices and thus reduces installation costs and commissioning times. Another benefit of SIMATIC PCS 7 is the option of remote operation and monitoring of the bioethanol plant, for example over the intranet/internet. Plant operators or external system partners can easily access the process control system and immediately detect and remedy any faults.

Savings potential thanks to plant optimization

The control system includes integral advanced process control functions for process optimization. These ensure consistent quality, increased throughput, or reduced energy consumption. Significant cost reductions are achieved, whether in distillation, vapor recompression, or drying of residues. Other potential savings are to be found with control system simulation tools for engineering and for training plant operators.

From asset management to predictive maintenance for increased productivity

An optimal overview of your plant – that’s precisely what asset management concepts and strategies for preventive maintenance offer. At Siemens, asset management also includes the controlling of mechanical plant components such as motors, pumps, valves and heat exchangers. The active power data of the drive or the load spectrum of the centrifugal pump are among the possible indicators of optimization potential. In addition, the cost-effectiveness of your bioethanol plant can be improved with optimal maintenance and condition monitoring, thus reducing the total cost of ownership.
Flexible power distribution from medium-voltage to the low-voltage motor

We offer a host of medium-voltage and low-voltage components. If these are connected via PROFIBUS DP to the process control system, absolute integration is guaranteed with regard to the electrical protection concept and the communication standard. The range of drives for pumps, dryers or centrifuges covers the spectrum from standard motors, through energy-saving motors in accordance with eff1, right up to explosion-proof motors for Ex zone 1 / Class 1 Division 1.

Medium-voltage fitting the requirements of the industry

With a typical system output of approximately 5 to 10 MVA and a rated voltage of 7.2 kV, the NXAIR M air-insulated and metal-clad medium-voltage switchgear is the ideal low-cost solution. In Europe, the switchgear frequently receives its power supply via the power supply company’s incoming ring feeder unit. The bays are monitored and controlled using SIPROTEC protective devices. Thanks to the modular structure of NXAIR M, the terminal compartment, module compartment and low-voltage cabinet within one switch bay can be replaced separately, thus ensuring minimum downtimes.

Rugged and maintenance-free transformers

GEAFOL cast resin transformers made entirely of flame-retardant, inorganic insulating material remove many restrictions, such as constructional measures for repelling oil. GEAFOL cast resin transformers are also largely maintenance-free, but have electrical values and noise levels comparable to those of conventional oil-immersed transformers.

Tailored low-voltage distribution

The SIVACON switchboard comprises the low-voltage distribution system and also the function of the motor control center (MCC). SIVACON can be realized as a drawout/withdrawable unit, as a plug-in unit or as a fixed/non-withdrawable installation unit. The drawout design is preferred particularly for bioethanol plants because the units can be replaced at any time without having to deactivate the switchgear. Even the size breakdown of the withdrawable panels can be modified during operation. Thus SIVACON switchboards can be changed to suit needs during commissioning or optimization measures while the plant is in operation.
Flexible and modular motor management system

SIMOCODE pro monitors and controls all low-voltage motors with constant speed. The drawout unit of the SIVACON low-voltage switchgear accommodates the short-circuit fuse, the SIRIUS contactor and motor protection/control unit, and SIMOCODE pro with current/voltage acquisition module. Besides motor control, SIMOCODE pro also handles transfer of all diagnostics data such as switching status, operating hours, phase currents, motor temperature, and electrical active power to SIMATIC PCS 7 via PROFIBUS. This means that dry-running protection for pumps can be monitored much more efficiently and cost-effectively than with level switches in the pump's intake area, for example. The motors are also protected against the risk of ignition and are thereby certified for hazardous areas such as tank farms and distillation units.

Frequency converters for all requirements

The compact frequency converters, such as MICROMASTER 440/SINAMICS G120, cover the performance range from 0.12 kW to 250 kW. They are integrated fully into SIMATIC PCS 7 via PROFIBUS DP and pre-defined faceplates, and they are perfectly suitable for use in dosing pumps, particularly in the saccharification and fermentation area. At low power values (< 3 kW, 4.5 PS), it is advisable to place the converters directly in the MCCs drawout unit.

Advantages of a container solution

As an alternative to installing the MCC and I/O directly into the buildings, Siemens offers a modular container solution. The ready-to-use containers include the necessary cabinets and hardware for MCCs and the I/O. They are equipped with air-conditioning and are already fully wired and pre-tested at the factory. Site construction now only entails connection of the low-voltage electricity network, the bus interfaces and the field devices. The result: significantly reduced construction costs and faster commissioning.

Power management systems: more transparency and efficiency in energy supply

Power management plays a significant role in cost-effective plant operation. Energy-intensive loads can be identified and effective measures implemented for optimized energy use. For plant-wide transparency and optimization of power distribution, we offer maximum-efficiency tools including software add-ons such as SIMATIC PCS 7 powerrate and b.data energy management, as well as the SENTRON PAC3200 power monitoring device for energy logging – to name but a few.
The whole spectrum of instrumentation

With a comprehensive instrumentation portfolio, we support the cost-effective production of bioethanol both in the explosion-proof distillation area, and in other, less safety-critical plant sections. Information from the weighing systems, and figures on temperatures, flow volumes, levels, pressure or valve statuses are needed on a continuous basis. When integrated into the process automation system, such data forms the basis for optimizing yield and thus for increasing profitability.
Lower costs thanks to centralized engineering

All field devices have the relevant interfaces and drivers both for connecting to PROFIBUS PA and for conventional interfacing using the overlaying HART protocol. Since the automation bus (PROFIBUS DP) and the fieldbus (PROFIBUS PA) use the same protocol, all field devices can be parameterized and uniformly configured via central engineering.

Increased availability thanks to innovative diagnostics options

Our field devices are characterized by reliability and durability, as well as being easy to operate and maintain. A fast and smooth supply of spare parts for emergencies is also available. Faults can be analyzed accurately using a number of innovative diagnostics functions. The information is gathered, analyzed and made available to the user in a clear form in the asset management system of SIMATIC PCS 7. When making capacitive level measurements, for example, the sensor’s degree of soiling is determined and forwarded to the control system.

Measured values with maximum precision

As well as temperature, pressure and level measurement, flow measurement is also important in bioethanol plants. Magnetic-inductive flowmeters (SITRANS FM) are often used in aqueous saline solutions of high conductivity. In many cases, the superior precision of the coriolis flowmeters (SITRANS FC) enables them to replace analytic concentration measurements in liquids such as alcohol, and they also measure the density of the medium as well as the mass flow.

Seamless integration of weighing and process control technology

The complete integration of SIWAREX weighing technology into the SIMATIC PCS 7 control system is unique. Users thus profit from significant savings in comparison with conventional weighing systems. The evaluation electronics are supplied in the form of modules for the distributed ET 200 I/O. Weighing modules are available for simple tasks (e.g. level measurement in silos), as are dosing modules. The individual combination of sensors (SIWAREX R weighing cells) and electronics modules offers users clear advantages with regard to accuracy and calibration capability.
Our IEC/NEMA-compliant solution

The solutions presented here comprise the SIMATIC PCS 7 process control system, field technology, power distribution, and drives engineering. Whereas Europe is in favor of the IEC standard, the NEMA regulations are used for the Americas – mainly for electrical engineering and the automation concept.

IEC-compliant solution

The entire plant is operated and monitored via two single-user operator stations. The low-voltage power distribution system and the automation system have a distributed configuration in accordance with the three main plant areas. All the engineering is carried out from a central station with one uniform graphical operator interface – using PROFIBUS for actuators and sensors in the field as well as for the power distribution and energy management components.

Control and monitoring

Binary field devices are connected via the ET 200M distributed I/O. PROFIBUS PA is recommended as the fieldbus for the analog signals. It guarantees the full range of diagnostics options, asset management functions and, of course, centralized parameterization. Corresponding to the three main plant areas, three controllers of the SIMATIC S7-400 series are used. These can also be redundant. Communication with the human machine interface level takes place via Industrial Ethernet. This also enables simple connection of other network components such as network printers or the industrial SCALANCE Wireless LAN access points. PROFIBUS DP is used as the central automation bus for downwards connection to the distributed I/O and to the motor control center. Decanting centrifuges and the burners on steam boilers, dryers and, if installed, the thermal exhaust air purification systems, are controlled locally using the supplied SIMATIC S7-300 controller, or centrally using the SIMATIC PCS 7 control system – also with fail-safe controllers.

Power distribution and management in the low-voltage area

The motor control center and low-voltage power distribution board are combined in the SIVACON low-voltage switchgear. One switchboard is installed in each of the three switchrooms – comprising a central infeed panel, drawout units for motor connection, and a fused feeder panel for lighting, building power and the compensation panel. MICROMASTER/SINAMICS frequency converters are used for variable motors. Motors with constant speed are controlled and monitored mainly with SIMOCODE pro, due to its diagnostics capabilities. The motors of the hammer mills are connected via SIRIUS soft starters and reversing contactor combinations.

The optimal solution in the area of medium-voltage

The large motors of the compression and refrigeration systems are supplied directly by the NXAIR M air-insulated medium-voltage switchgear. They too are integrated into the automation system via PROFIBUS DP.

NEMA-compliant solution

One central controller is usually used instead of several controllers for the individual plant areas. The redundant design guarantees plant availability. The ET 200M I/O is distributed across the three main plant areas. Since PROFIBUS DP can also be implemented using fiber-optic cabling, large distances between the plant sections, line resistances, and electromagnetic compatibility (EMC) does not matter. Third-party controllers, such as burner controls, are connected at the human machine interface level via Modbus or OPC link. AS-Interface is often used for binary sensors and actuators to reduce cabling overhead in the case of fewer diagnostics options.

Motor control center in accordance with ANSI standards

TIASTAR, our motor control center for the Americas, is frequently connected via AS-Interface. This simple and low-cost alternative to the European solution with SIMOCODE pro is always of interest when the SIMOCODE pro diagnostics options are not paramount. Usually, three signals per motor are exchanged with the process control system: motor on/off, the status of the contactor and status of the overload relay. The space-saving, distributed digital I/O module SLIMLINE is built into every motor compartment of the TIASTAR MCC. Larger and process-critical motors can, of course, also be connected via SIMOCODE pro.

Power distribution specific to demands

The motor control center and the power distribution are usually separate as they have a distributed/decentralized design.
in accordance with the three main areas of a bioethanol plant. The WL switchboard handles power distribution. All WL-type circuit breakers conform to the American specifications – with regard to dimensions, electrical design and UL certification. As far as communication is concerned, there is no difference with respect to the European SENTRON devices. Integration into TIA and TIP is realized via PROFIBUS DP.
Successful projects based on years of experience

We have been delivering solutions for the bioethanol industry for many years now. The reason for our significant role in this industry is seamless integration of automation, drives and power distribution. A host of successfully implemented projects is evidence of this.

Usina Alto Alegre Group, Brazil

The most up-to-date Brazilian bioethanol plant was equipped entirely with Siemens products and systems based on Totally Integrated Automation and Totally Integrated Power. At full capacity, it will process four million tons of sugar cane each year and turn it into 165,000 tons of sugar, 200 million liters of bioethanol, and 21 MW of power (“cogeneration”).

NCERC, USA

The National Corn-to-Ethanol Research Center (NCERC) helps to test new technologies for improving economic effectiveness and sustainability in the production of renewable fuels. The NCERC has entered into a partnership with Siemens to foster the development of alternative fuel technologies. “Customers come to our research institute for its absolute cutting-edge technology,” says John Caupert, Head of the NCERC, “and with their SIMATIC PCS 7 distributed process control system, Siemens helps us to maintain this high standard.”
Jilin Fuel Ethanol, China

The world’s largest plant for the production of bioethanol from grain, with 750 million liters a year, was constructed by the company Vogelbusch AG and is automated entirely using our SIMATIC PCS 7 process control system. The user-friendliness of the system, the operator stations with Chinese displays, and the Siemens on-site support have proven to be clearly beneficial to the customer.

fuel 21, Germany

After just 12 months of project run-up time, the first bioethanol plant belonging to the German company Nordzucker AG, fuel 21, went into production and will produce 130 million liters of bioethanol a year from sugar beet, as well as generating power and steam. Siemens’ contribution to the project included: transformers, SIVACON panels with SIMOCODE load feeders, drive engineering for 250 drives, SINAMICS frequency converters, SIMATIC PCS 7 with redundant servers, F technology for the Ex area, SIMATIC S7-400 automation systems, PROFIBUS DP/PA connection for approximately 1600 measuring points as well as instrumentation and analytics. The services were provided by the Siemens Solution Partner company on/off engineering GmbH.

Agrana, Austria

At Agrana Beteiligungs-AG, Siemens implemented the first bioethanol plant in Austria based on the technology of Katzen International Inc. Grain and sugar beet are used as the raw materials. The capacity of the plant is 240 million liters per year. All the engineering of the plant, with more than 15,000 I/Os, comes from Siemens. The complete range of the TIA/TIP portfolio was successfully implemented here.

PLP, Czech Republic

Chemoprag implemented a complete grain-based bioethanol plant for the bioethanol producer PLP a.s. The plant was fitted with the most up-to-date Biostill and Siemens technology. The core of the plant is the SIMATIC PCS 7 process control system. The customer was convinced above all by the simple operation and the seamless integration of the process technology, as well as for the Ex areas, fire protection and plant safety features. TIA and TIP enabled production output to be optimized with simultaneous reductions in operating costs.
Further information

www.siemens.com/biofuels

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