Innovative Power Distribution for the Edible Oils Industry

Cost-effective and reliable power distribution

Totally Integrated Power

Answers for infrastructure.
The demand for vegetable oils and fats is growing steadily. The reason for this increased demand lies both in the popularity of convenience food and in rising population numbers. A growing concern for the environment and high fuel prices also promote the use of bio-fuels produced from vegetable oil.

Besides proteins and carbohydrates, edible oils and fats are the main components of our food. They belong to the most sophistically produced groceries. For the manufacture of vegetable oil, for instance, thermal and mechanical processes such as pressing, mixing, extracting, rinsing and vacuum drying are used. After production, oils and fats are delivered in large bunches to the manufacturers of ready-to-consume food like sweets or convenience food manufacturers.
Only a century ago, vegetable oils and proteins became edibles for large sections of society. Today, vegetable oils and fats take a share of about 55% in the world production of edible oils and fats. For many years, vegetable oil production has been growing in almost double-digit numbers, last not least due to their use as fuel, oil seeds and the vegetable oils extracted from them are traded globally with heavily bouncing prices.

The edible oils industry resides at the border between the food and chemical industry and places very special requirements on the quality of processes and the efficiency of production. The most important claim is the increase of plant productivity – across the entire life cycle of a plant.

High-quality power supply plays a decisive part in the entire process of edible oils production. It is the basis of high process quality and low plant downtimes. It is a simple calculation: the less scraps and the shorter the downtimes in production, the faster targeted investment into high-quality power supply and distribution will pay off.
Areas of Edible Oils and Fat Production

The production process of edible oils and fats can be divided into three different subsections with very specific requirements:

**Oil mill**

Whether canola, sunflower seeds or soy – in order to transform oil seeds into valuable edible oils of constant quality, all processing steps must engage smoothly: in the thermal conditioning of the oil seeds in steam-heated conditioning apparatus as much as in their subsequent mechanical processing.

**Refinery**

The vegetable oil produced in the oil mill is improved in the refinery. One part of the improved oil is then further processed, the largest part of the oil is already handed over to the customers after refining. The refinery thus needs large tanks for intermediate storage, as the refining process shall run as continuously as possible and the finished product shall be handled as quickly and efficiently as possible.

**Special fats and oil modification**

Whether frying fat or special fat for icing and ice cream – hundreds of different products are manufactured in modern factories for special fat and oil production with a high product quality which is kept as constant as possible. In this context legal requirements must be observed which demand a sustainable process optimization and the right judgment on the feasibility of production orders.
Technology Platform
Totally Integrated Power

Integrated power distribution from the feed-in to the consumer

Totally Integrated Power™ (TIP) refers to integrated electrical power distribution in commercial and industrial buildings; from the medium voltage supply fed in by the utility company right up to the final electrical consumer.

Totally Integrated Power is underpinned by an array of helpful tools and support for accurate design, dimensioning and configuration of electrical power distribution within buildings. A coordinated product and systems portfolio for the construction of these systems is rounded off by standardized interfaces between the system components and the higher-level human-machine interface systems as well as for the connection to control and management systems.

In this way considerable savings can be made across the whole project cycle – from the planning stage, installation and start-up right through to operation. The necessary investments in the electrical infrastructure of the edible oil production plant can be optimized in line with demand and also with subsequent operating costs in mind. This optimization potential represents significant added value for everyone involved in the project.

Optimum planning for cost and time-effective solutions

An optimally dimensioned power distribution system is a key economic factor in edible oils production. Unused capacities cost money. The tried-and-tested, TÜV-certified SIMARIS design® dimensioning software from Siemens provides electrical engineering consultants with an indispensable tool for dimensioning the electrical network for a new construction or expansion of a production plant.

SIMARIS design brings many benefits, including simpler network calculation and selectivity verification. The software also recommends suitable coordinated devices from the integrated Siemens power distribution product portfolio. Electrical network upgrade reserves can be incorporated right from the planning stage to allow for later changes of use or extensions of production. Electrical engineering consultants can make time savings of up to 100% by using SIMARIS design for the various network planning stages.

In addition, Siemens also provides advice and support for electrical engineering consultants through virtually all the planning stages.
Basic Network Operation Types

The following diagram shows the key components of electrical power distribution in the edible oil industry and the way in which they interact. They ensure optimum reliability of supply and operational safety for all electrically operated fittings and consumers. This power distribution concept can, of course, be adapted to the specific requirements of each application.

The diagram demonstrates the supply of a typical production facility with independent network operation types: the normal power supply (NPS) and the separately laid safety power supply (SPS).

Normal power supply (NPS)

All electrical consumers in the production and office environment are connected to the NPS. NPS starts at the utility company’s transfer point and ranges to the load circuits. Siemens offers comprehensive electro-technical solutions for normal power supply with optimally coordinated products and systems: this consistency of solutions ensures optimal reliability of supply and thus a reliable production process. The excellent matching of the individual system components is also a synonym for an extremely profitable solution.

Safety power supply (SPS)

But what if normal power supply really fails some time? In many countries like Germany, Austria, Italy and France, it is a minimum requirement under the stipulations of protection against personal injury that a safety power supply must be available in this case. It can pay, however, to additionally design an SPS in such a way that the performance of the most important production steps is ensured without any interruptions.

Which production areas must be supplied uninterruptedly? Where is an interruption of power supply permissible? In compliance with the specific requirements of edible oil and fat production, SPS design warrants that uninterruptible power supply (UPS) is also ensured where necessary. This includes process instrumentation and control and the automation systems, for example. In this way a power blackout has comparably little effect on production.
Power distribution

Schematic view of the Edible Oils production process

NPS = Normal power supply
SPS = Safety power supply
LVMD = Low voltage main distribution
Current flow
Electrical Power Distribution Design

In integrated planning, the requirements for the production of edible oils and fats are not simply broken down to the individual installations, such as medium voltage, transformer and low voltage systems, and analyzed separately. For the implementation of a reliable power supply in line with a profitable solution it is rather necessary to match the individual installations carefully when designing the power distribution system. The following must be observed in this context:

- The electrical power which is available must be divided between the different power sources in line with the use of the building, the stipulations of the installation company and the defined standards and guidelines. In particular those components which are to be connected to the SPS require special consideration.

Note: In order to attain a high level of efficiency, system components should work with a utilization coefficient of approx. 70–80% of their maximum capacity: under-dimensioning may result in malfunctions, over-dimensioning in excessive cost.

- Being failsafe is an important criterion for a power distribution system. Electrical loads are divided between three to four transformers at the power feed-in. In order to be able to supply system components even when one transformer fails, couplings to the other transformers are provided. These couplings are installed in the low-voltage main distribution board. A changeover can be performed manually or by means of an automation system, e.g. SIMATIC S7-300, and signaled to a process control system. Depending on the question whether the full load of the failed transformer must be covered or not, the maximum load of the transformer is designed. A GEAFOL transformer can be dimensioned according to its maximum possible capacity or, when a cross-flow fan is installed, it can be operated with up to 150% of its normal load. If, for example, a transformer is sufficient that provides an output of 630 kVA during normal operation, a transformer with an output of 1,000 kVA can be planned for reserves. Among other things this will result in increased acquisition cost and greater space requirements. The alternative is to use a cross-flow fan, as by the installation of cross-flow fans the output of GEAFOL transformers can be increased up to 140 to 150% in degree of protection IP00. It must be noted, however, that the short-circuit losses of the transformer will rise to double or 2.3-fold the value of a 100% load. Depending on the specific application, a transformer should be selected and dimensioned with or without a cross-flow fan installed.
Power distribution

Medium voltage

110 kV substation

Central power distribution

Medium voltage switchgear

Low voltage

Transformer 1

Transformer 2

Transformer 3

LVMD NPS

SD-UPS

LVMD SPS

Emergency generator

LVMD

NPS = Normal power supply

SPS = Safety power supply

UPS = Uninterruptible power supply

LVMD = Low voltage main distribution

SD = Subdistribution boards

Automation equipment

Control equipment

Oil mill

Extraction

Desliming

Bleaching

Neutralizing

Biodiesel

Deodorizing

Filling

Emergency lighting

Rescue elevators

Sprinkler
The previous diagram shows a power distribution system in central design. For this purpose a central building is erected for the power distribution system. It houses the medium-voltage switchgear, the transformers and the low-voltage main distribution board. Power distribution to the individual load centers is performed at the low-voltage level for a central power distribution design.

An alternative to central power distribution is decentralized power distribution. Here, medium-voltage feed-in is also performed at a central location. Electrical power is, however, distributed to the load centers at the medium-voltage level depending on their geographical position. Substations contain the transformers and the low-voltage main distribution boards. The advantage of decentralized power supply lies in the considerably lower cable cross sections and cable quantities leading to the substations, the reason for this being the higher voltage level (20 kV) and the lower currents. Additionally, cable losses along the route can be reduced to approximately 1/200.

### Example

<table>
<thead>
<tr>
<th>Voltage level</th>
<th>Transformer output</th>
<th>Route of power transmission</th>
<th>Power loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4 kV</td>
<td>1,600 kVA</td>
<td>200 m</td>
<td>100 kW</td>
</tr>
<tr>
<td>20 kV</td>
<td>1,600 kVA</td>
<td>200 m</td>
<td>0.5 kW</td>
</tr>
</tbody>
</table>
Power distribution

Medium voltage

110 kV Substation

Medium voltage switchgear

Transformer 1

Transformer 2

Transformer 3

e.g.
Oil mill
Extraction
Desliming

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Low voltage

LVMD
NPS

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NPS = Normal power supply
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UPS = Uninterruptible power supply
LVMD = Low voltage main distribution
SD = Subdistribution boards

SD UPS

UPS system

Emergency generator

LVMD SPS

- Emergency lighting
- Rescue elevators
- Sprinkler

Automation equipment
Control equipment
Independent of the fact whether central or decentralized power distribution has been chosen, the following must be observed for the design of the power distribution system:

- Motor outputs up to 500 kW are required for the different processes especially in the oil mill. When power distribution is dimensioned, it must be observed that the motor, depending on its type and design may cause a very high short-circuit current owing to its power regeneration. Switchgear and protective devices must be designed for this increased short-circuit current. In addition, frequency converters are often used for these motors in order to improve or extend their start-up and speed behavior. However, these frequency converters create a high proportion of harmonic content and additionally load cables with reactive current. In order to reduce these undesired loads each substation is provided with choked reactive power compensation.

- Proper dimensioning of power supply and correct allocation of power consumers are essential quality features for trouble-free use especially in production plants. In project planning, for example, it should already be made sure that automation components are not connected to the same circuits from which frequency converters also draw their energy.

- Owing to the high transformer output and the resulting high currents between the transformers and the low-voltage main distribution board (example: a transformer with 1,600 kVA creates a rated current of 2,310 A at 400 V), busbar systems are particularly suited for this connection. Busbars may also be the more profitable and better solution for other connections depending on system requirements. Besides their previously mentioned suitability for the transmission of very high currents, the reason lies in their lower fire load compared to cables and their high operational safety (see section on “Busbar trunking systems”).

- Designing the system for a higher voltage (690V AC) at the low-voltage level reduces transmission losses. What has to be observed, however, are increased requirements on insulation. The choice of switching devices may also be restricted.

- The electrical energy of those system parts which are necessary for the protection of man and machinery, such as sprinklers or emergency lighting is provided by the SPS. Normally, an emergency generator is used to feed the SPS.

- For fault-free operation, automation and control equipment requires a fault-free power supply without voltage peaks and interruptions. Therefore, the energy required for automation is safeguarded by an uninterruptible power supply (UPS).
Electrical power distribution is responsible for supplying all power consumers with electricity. With normal power supply in mind, it is, for example, the medium-voltage switchgear, the distribution transformers and the low-voltage main distribution board that are required for this purpose.

A detailed overview of the main components in normal power supply is given below.

**Medium-voltage switchgear**

The medium-voltage switchgear is the backbone of power supply. The type-tested and gas-insulated Siemens switchgear NXPLUS C is particularly suited for the requirements of the oil and fat industry. Gas insulation of the switchgear enables an appreciably more compact design compared to air-insulated switchgear and thus requires little space. No maintenance for life, owing to gas insulation, provides for low operating cost.

- Type-tested acc. to IEC 62271-200
- Hermetically sealed pressure system with SF6 filling for its entire life cycle
- Safe-to-touch encapsulation and standardized connections for pluggable cable sealing ends
- No gas works required for installation and expansion
- Independent of environmental and climatic impact
- Very compact design
- No maintenance
- Safe for operator personnel
- Reliable and operationally safe
Siemens GEAFOL transformers are the first choice for use in plants for edible oil production. Thanks to their loss-optimized characteristics they are energy-saving, and they have been specially designed for economical long-time use. Moreover, they are hardly inflammable, self-extinguishing and do not emit any toxic gases in case of fire. By using the transformers in the load center, a high efficiency is attained, which is an important key to reducing operating cost.

- Highly profitable in continuous operation due to loss-optimized characteristics
- The choice of the installation site is facilitated because transformers comply with the highest safety classes regarding surroundings, climate and fire (e.g. hardly inflammable and self-extinguishing)
- Performance increase by up to 50% possible by the installation of cross-flow fans
- Installation in the switchgear room permissible together with the low-voltage main distribution board due to separation by means of fire protection walls F90A (no additional firewalls necessary)
- Low noise thanks to high-quality magnetic core design
- Long service life due to minimized air and dirt inclusions in the coil core
- Pre-assembled, type-tested transformer connection pieces for busbar connection to optimize operational safety (EMC, fire load, short-circuit capacity etc.)
Low-voltage main distribution boards

If possible, the production process should run without interruptions, which means that electrical power supply must be constantly ensured. Type-tested SIVACON low-voltage switchboards provide an especially high degree of safety for the function of low-voltage main distribution. Partitioned functional areas ensure a high degree of safety for man and machinery and in the event of a fault, they limit the effects of arc faults and fault propagation to a minimum.

Flexible, withdrawable-unit design or plug design is a further advantage of the SIVACON switchboard, as it provides for fast and easy component replacement without longer operational interruptions. For this reason, SIVACON is also suitable for use as a motor control center.

- Highest installation safety due to type-tested switchgear assemblies
- Flexible adaptation of the internal partitioning to individual needs
- Space saving with installation areas of 400 mm x 500 mm
- The degree of protection is maintained (up to IP54) in switch test and disconnection positions when the door is closed
- Maximum safety of persons due to an arc-fault-proof lock system
- Variable main busbar position (top/rear)
- Cable/busbar connection from the top, bottom or rear
- Combination of different mounting techniques possible within one panel

A network of SIVACON partners safeguards:

- Worldwide availability of type-tested IEC switchgear
- Regional service
- Partners having know-how of the local technical supply conditions
Busbar trunking systems

A busbar has a high short-circuit strength, a minimum fire load and a high degree of flexibility regarding subsequent modifications or expansions. Above all, it is more cost-effective than comparable solutions using cables. SIVACON busbars are the first choice for connecting the low-voltage main distribution board to the transformer, as their connection to the SIVACON switchboard is type-tested. This saves expensive and elaborate test proofs.

SIVACON busbars are also a cost-effective solution for central power distribution to connect the load centers (substations) to the low-voltage main distribution board.

- Economical power transmission of higher currents
- Part of the integrated power supply by Siemens as a type-tested unit (transformer / low-voltage main distribution board, low-voltage main distribution board / subdistribution board)
- High operational safety
- EMC-friendly
- Ca. 20% lower fire load than cables
- Low weight (aluminum conductor)
- Enables clear current routing

Low-voltage motors

The IEC low-voltage motors made by Siemens are compact and highly efficient motors in efficiency class EFF1 (High Efficiency). As they are equipped with copper rotors, they attain very high efficiency ratios at low losses. Compared to conventional motors, they can save up to 40% of the power loss.

Using plant-specific characteristic data, the Sinasave PC program additionally calculates the energy saving effect of energy saving motors or frequency converters plus the payback period for such an investment – which is often a few months only.

When the type of control and protection for motors is planned and determined, the relevant standards and regulations must be observed. These are basically IEC 60947 (Low-voltage switch-gear and controlgear and protective devices), VDE 0100, EN 60204-1 and the standards on EMC EN 61000-3-2 or respectively EN 50082.

An overview of harmonized EU standards can be found at www.newapproach.org.
Selection of protective and monitoring devices

Protective devices must safeguard the protection of the cable and the motor in a motor branch circuit. This can be attained by two separate devices or a combined device which fulfills both functions. The modular system of SIRIUS industrial controls contain all of the necessary devices and systems.

Motor protection can be attained through:
- Overcurrent releases (motor protection acc. to IEC 60947),
- Temperature sensor (always in the motor winding) or
- Electronic motor protection devices (SIMOCODE)

Selection of switching devices

The following variants are available as switching devices from the SIRIUS product series:
- Load feeder (protective and switching device, for the most part circuit-breaker and contactor)
- Motor starter (protective device and switching device in one casing)
- Soft starter
- Frequency converter

Apart from the load feeder, switching devices are available for central design (mostly IP20) and decentralized design of the power distribution system (IP54 to IP65).

Particularities of frequency converters

The harmonic currents and voltages produced in the converter distort the sine shape of the voltage. As power consumers are designed for sine-shaped voltages, a voltage distortion may lead to impairments or even destruction of power consumers and electrical equipment. Siemens equipment will prevent this. In addition, regenerative frequency converters, i.e. converters that can regenerate energy into the line supply, can help save energy. The power distribution concept must take this regenerated energy into account.
Planning electrical power distribution for commercial and industrial buildings has never been as complex as it is today. The planning process demands a great deal of specialized knowledge and experience. With an experienced partner at their side, electrical engineering consultants can implement their conceptual expertise more quickly and easily and concentrate on the important things. The software tools SIMARIS design, SIMARIS curves and technical manuals from Siemens offer comprehensive support, from the preliminary planning stage right through to implementation planning.

**SIMARIS design and SIMARIS curves**

The SIMARIS design dimensioning software supports our complete, integrated and high-quality portfolio from medium voltage technology through to wall outlets. The user-friendly TÜV-certified tool also generates the necessary selectivity verification, for instance for emergency power supply systems. It also lightens the load enormously in routine work such as implementing changes and considering variants. The free SIMARIS curves software performs comparisons between the tripping characteristics of Siemens protective devices and fuses (IEC). SIMARIS curves can simulate possible parameter settings in protective devices to determine the optimal selective behavior of two series-connected devices. In addition, characteristic let-through current and let-through energy curves are also provided. A printout documents the selected settings.

**Application manuals**

Siemens application manuals offer electrical engineering consultants a wide knowledge and information base to draw on when designing electrical power distribution systems.

There are three volumes, available from regional Siemens contact partners (www.siemens.com/tip/support):

- The application manual "Basic Data and Preliminary Planning of Power Distribution Systems" provides electrical designers with in-depth information to support them in their work during these two phases.
- The application manual “Draft Planning of Power Distribution Systems” provides useful information on this project phase.
- The application manual “Planning a High-Rise Building” documents concrete applications of the power distribution products and systems using the example of an office tower.
Further Information

You can find more information on
Totally Integrated Power on the Internet at:
www.siemens.com/tip

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