SEW EURODRIVE

White Paper

FOOD FOR THOUGHT

Reducing operating costs, spares inventory and maintaining hygiene in food and beverage manufacturing

Introduction

The food and beverage industry is a vital component of Australia's economy, representing the largest manufacturing sector in the country and making significant contributions both financially and in terms of employment[1]. The financial pressures on small and medium food suppliers, such as deflationary price pressures and demands for increased production, however, are unsustainable and have the potential to threaten domestic food security[2].

The relentless nature of manufacturing and the trend towards extended production hours means aged and heavily-used equipment is likely to consume a vast amount of energy, require more frequent cleaning and sanitising and need replacement at some point. This disrupts overall production schedules and inevitably impacts production on a number of levels.

The Need to Optimise Operations

Food and beverage manufacturers are taking a close look at their operations to see where they can find savings – be it energy, space, down-time, cleaning efforts or through optimisation of processes. An improvement in any of these areas will translate into cost savings, leading manufacturers to review their investments in these primary areas.

The manufacturing and processing industries are two of the world's large energy consumers, with up to 90% of costs that occur during operation over the lifecycle of the equipment attributed to energy costs. Food and beverage processing plants in particular are large users of energy for processing machines, refrigeration, cooking, heating, and sterilising[3]. With energy costs continuing to rise, a reduction in energy consumption can contribute to significant cost savings.

There are a number of ways to reduce energy consumption and improve overall operations in motor / drive applications, which in some cases can be combined to magnify the saving potential. How effective these aspects are will depend on the application and looking at "whole system" efficiencies.

Electromechanic Drive System

Industrial machines are made up of four different components: Energy supply/control, motor, transmission and the working machine.

The first three components combine to form an electromechanic drive system. The fourth component, the working machine, is driven by the drive system, which transforms electrical energy supplied from a power supply into mechanical energy. Machines are used to alter the properties of material or to transport material from one point to another.

Material handling machines such as "conveyors" fitted with traditional motor-gear unit drive train combinations, can experience high losses (example in *figure 1* - overall system efficiency of only 56%). Putting this example into perspective, when in operation, a process that demands 9.1kW of mechanical power can potentially consume approximately 16.1kW of electrical power. By using a modern electromechanic drive system plant owners and operators have an opportunity to save considerable amount of energy. However, in order to optimise the efficiency of the entire system, it is important to consider the efficiency of individual components. Each component will inherently have some inefficiency and these energy losses multiply together to provide overall system efficiency.

Electric Motor

AC motors, particularly squirrel cage motors, are the "driving force" of the food and beverage industry. Often coupled to gear units, their extensive use is evident in machines used for movement of materials, pumping of liquids, heating venting and air conditioning.

Today Minimum Energy Performance Standard (MEPS) mandate that new motors sold must meet the minimum efficiency levels based on AS1359.5:2004-Tables A2 or B2. Prior to 2006 motor efficiency was mandated and legacy motors were designed to a standard similar to today's IE1 efficiency standard. Many of these motors are still in operation today.

In view of recent changes to International IEC 60034-30-1 standard that defines the IE efficiency levels for online motors, motor manufacturers have a readily available line of motors to IE3 Premium Efficiency standard.

In an effort to offer the most efficient motor series, many manufacturers are currently investing to develop and/or optimise various technologies that meet IE4 Super Premium

motor efficiency. Some designs substitute the traditional squirrel cage rotor with a permanent magnet design.

When upgrading to a motor designed to higher efficiency class numerous applications have a potential to save energy. Maximum gains are expected in applications where motors are constantly driving uniform loads demanding more than 75% of installed motor power and operating for prolong periods of time.

Mechanical System Components

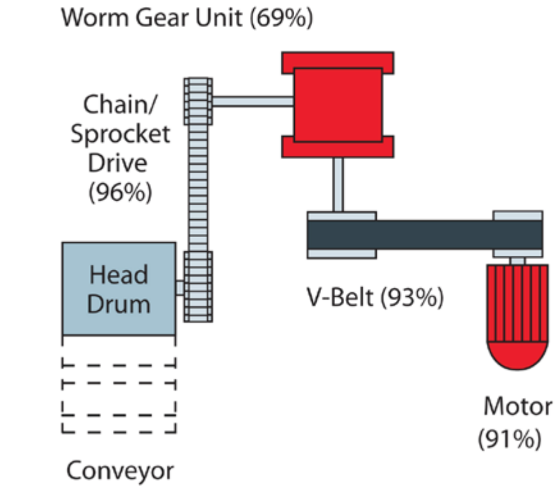
An AC motor is a primary component in the electromechanic drive system. However, installing a high efficiency motor may not necessarily reap the most benefits. Replacing inefficient mechanical component(s) driven by AC motors can subsequently lead to greater efficiency gains, for instance replacing an inefficient worm gear unit with a helical-bevel design. Worm gear units are mostly used for conveying of materials, but, are considered inherently inefficient, as the gears are essentially sliding against one another causing heat (energy loss). A typical high-ratio worm gear unit experiences up to 50% energy loss while in operation.

Sure there are some instances where worm drives are suited to the application (heavy shock loads or providing back driving resistance). However, most conveying applications have been and continue to be

Figure 1

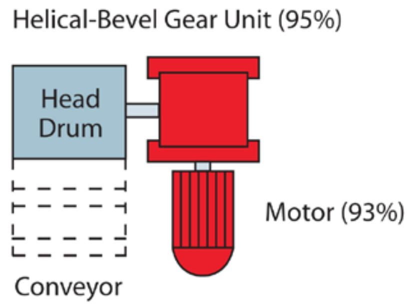
Standard vs. Optimised drawing

Standard



Overall drive train efficiency = 56.1%
Conveyor power requirement = 9.1kW
Power required from utility = 16.2kW
Energy used = 64.8MWh per year
Cost of energy = $9720 per year
Power loss from inefficiency = 7.1kW

Optimised



Overall drive train efficiency = 88.3%
Conveyor power requirement = 9.1kW
Power required from utility = 10.3kW
Energy used = 41.2MWh per year
Cost of energy = $6183 per year
Power loss from inefficiency = 1.2kW

Comparison Summary:

- 32% efficiency increase
- 23.6MWh energy savings/yr
- $3537 savings/yr

Given conditions:

- Motor operated 16 hrs/day, 250 days/yr
- Application requires that 9.1kW be delivered to conveyor head drum
- Cost of energy = $0.15/kWh
- The replacement motor in optimised example is 11kW Premium Efficiency IE3 motor

fitted with the worm gear unit purely due to their purchase price; the worm gear is the least expensive "right angle" gear unit on the market.

To gain even more efficiency, considerations must be made to changing or eliminating the external (to the gear unit) transmission elements, such as replacing a v-belt with a direct drive or a shaft mounted gear unit.

Variable Speed Drive

The modern electromechanic drive system is often controlled by a variable speed drive (VSD). The VSD as a stand-alone system component produces heat (losses) from electricity conversion, switching frequency and harmonics, and will actually decrease system efficiency. The key to energy saving is to utilise the inherent and programmable functions of a VSD to optimise historical control methods, replace redundant components and facilitate process adaptation:

HVAC: Typical systems used in HVAC contain mechanical dampers with motors that run continuously. Using a VSD to turn off the motor or to optimise the motor speed is much more efficient, especially since the load decreases more than four times at half the speed.

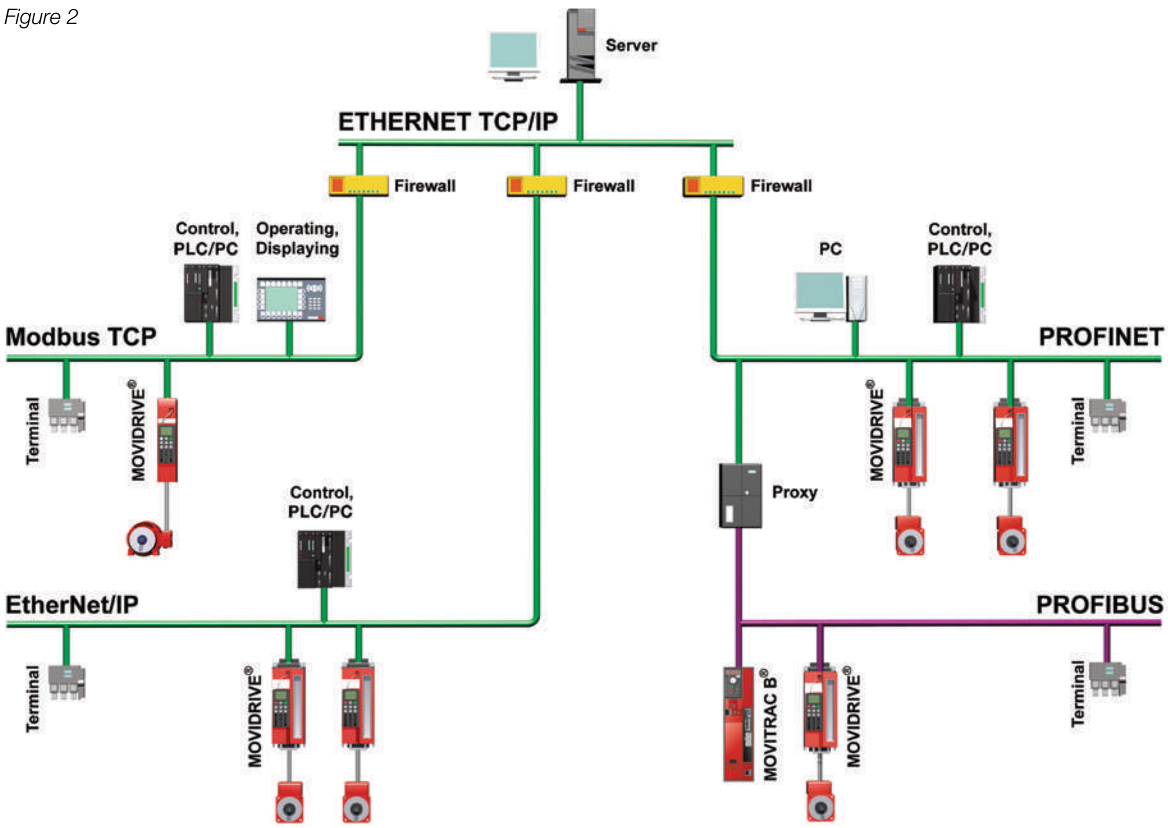
Soft Start: Using a VSD to control the acceleration on a cycling application lowers the motor starting current. Inherently the motor runs cooler since less energy is converted to heat.

Motor Efficiency Correction: The efficiency value on a motor's nameplate is usually rated at 80% loading. Therefore, when a large motor is applied to a small load, its actual efficiency decreases considerably. Using a VSD with vector control optimises the motor efficiency regardless of the loading.

Speed Adaptation: The speed of an electromechanic drive systems often requires adaptation to suit the production volume or size of materials being moved. Changing processing speed by the traditional mechanical method is very inefficient and cumbersome. Control of electric motor's rotational speed is an inherent function of a VSD. It can simply be achieved by turning a potentiometer knob or via a fieldbus system connected to a higher level control system (PLC or SCADA).

Industry 4.0: The modern VSD equipped with an Ethernet interface has the ability to gather "real-time" component and system performance data. The process data is relayed to a cyber-physical system via the internet of services. Decisions made may result in the adaptation of control parameters. Industry 4.0 is predicted to be the next major upheaval in modern manufacturing. The utilisation of compliant components can contribute towards the creation of a "smart-factory".

Figure 2



Hygiene and Cleaning Efforts

A crucial consideration for food and beverage manufacturers is the need to maintain strict hygiene standards. Traditional components are not only difficult to clean thoroughly; they also generally require production to shut down – at least in part – for cleaning activities to take place. This places strain on production timeframes, which can lead workers to ignore safety guidelines in order to expedite cleaning.

Machine components mounted in the production or processing area experience frequent exposure to harsh cleaning chemicals. The shape of the component, its material composition and the method of substrate protection all play a large role in the cleaning efforts, likely hood of contamination source and product longevity.

Due to its anti-corrosive properties the use of stainless steel components and fixtures are the norm for the food and beverage industry. However, due to cost pressures, weight restrictions and component availability, auxiliary equipment such as motors and gear units are often supplied with housings made from aluminium or steel.

In order to protect the component from corrosion, coating films are applied to the substrate. Based on the installed environment the anticipated corrosivity level must be determined and subsequently a suitable coating film applied. Various coating chemistries and a range of application techniques yield unique performance characteristics, such as anti-corrosion, self-cleaning, and chemical and scratch resistance[4].

Machines and electromechanic drive components are commonly coated with a "single" or "two component" paint system that dry in air, the latter being much less susceptible to damage from chemicals, weather or UV rays. Due to their enhanced corrosion-inhibiting properties and abrasion resistance surfaces finishes such as Anodising, Nickel and Teflon can be applied.

The integrity of the coating is often jeopardised due to installation, cleaning and general wear; a component may leave its production facility in pristine condition, however, if care is not taken damage to the coating can occur. Exposing a minute area of bare metal to the elements will often lead to the formation of corrosion eventually propagating under the coating, lifting it as corrosion progresses. Once the layer of coating has detached itself from the substrate

SEW-EURODRIVE's nickel surface protection is ideally suited for equipment exposed to a variety of harsh environments

it splits into various size flakes that have the potential to contaminate beverage and food products.

Reduction of Drive Variants and Spares Holding

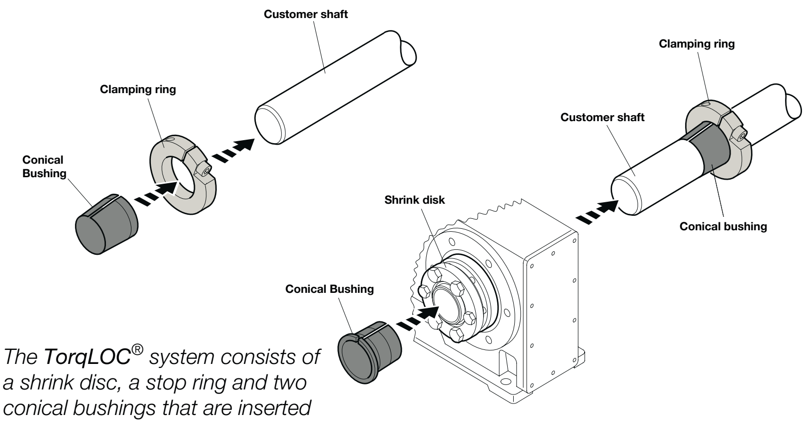
Food and beverage production facilities are characterised by numerous variants of installed equipment. The demanding production schedules maintenance activities and availability of spare parts underpin the uninterrupted operation of a production plant. Some manufacturers carry out planned maintenance programs while others take the ad hoc approach. Regardless the necessity to hold spare parts can tie up much capital and space.

The decision to hold spares is usually undertaken depending on the local availability of a replacement component and consequent flow-on effect if the equipment is out of operation for considerable amount of time. A vast number of installed combinations often lead to the necessity for extensive spares inventory. A solution to this problem is to streamline the number of variants installed throughout the production plant.

The availability of various software platforms has provided the means to catalogue the “installed base” of equipment. However, the link between installed base and spares inventory is often missing.

Once a piece of equipment is added to the spares inventory it is necessary to ascertain what equipment it can replace. It should then be catalogued and tagged accordingly. All too often spare parts will sit in an unorganised storage area and when the need arises they are overlooked leading to another spare component being ordered in a rushed manner.

Certain components such as geared motors are intricate in design and hence contain many variations and variables including: differing designs/sizes output speeds, shaft sizes, flange sizes, surface coating etc. In a replacement scenario an identical component must be available as often “make-it-fit” modifications cannot be easily realised. The necessity for rapid change over time calls for components that can be dismounted and remounted with minimal effort.



*The **TorqLOC**® system consists of a shrink disc, a stop ring and two conical bushings that are inserted on each side of the hollow shaft*

SEW-EURODRIVE’s TorqLOC® shaft mounting system inherently prevents fretting corrosion of shafts contact surface and facilitates reduced replacement times.

Project Planning Towards Optimisation and Variant Reduction

Maximum reduction in energy consumption can only be realised if project planning is undertaken during the system design stage. Calculations must be performed in order to select the most suitable components, which closely meet the design criteria. At times the adaptation of the operating parameters such as acceleration, speed and dwell times may permit a reduction in maximum power requirement. All too often motors and consequently gear units are grossly oversized because “this is how it has been done in the past”. When a large motor is applied to a small load (e.g. 1.1kW motor used instead of 0.37kW) considerable amount of energy is wasted due to additional reactive power required to magnetise the oversized AC motor and operation at fractional load where the motor’s efficiency is very low.

In order to minimise energy usage the selection of the mechanical transmission elements must be considered carefully. The type of gearing and external transmission elements will ultimately influence the inefficiency of the mechanical system and hence determine the motor power required to operate the machine. Minimising the installed motor power inherently reduces the power demand from the electrical supply system.

In order to streamline the installed component base standardisation of mechanical fitment must be given priority. Minimising the gear unit sizes, standardising on a shaft diameter and mounting method can contribute to a reduction of installed variants. Through careful project planning variances in line speeds may not necessarily require the use of different gear unit ratios. If selected correctly different output speed can be achieved with the same gear ratio by changing the output speed of a motor with a VSD.

Solution

SEW offers a number of drive solutions, including the MOVIGEAR®, which features efficiency levels exceeding those of an equivalent IE4 (Super Premium Efficiency) standard motor.

According to John Gattellari, SEW-EURODRIVE’s Food and Beverage Product Specialist, the design of MOVIGEAR® is ideal for planning efficient materials handling systems present in food and beverage manufacturing. “A systematic development approach was taken right from the start of the design process of MOVIGEAR®, which in turn helps lower energy costs,” said Mr Gattellari. “While this technology has been around for a few years, today with rising electricity costs, greater hygienic demands in production facilities, and necessity to reduce spares inventory, companies appreciate the benefits of investing in this technology."

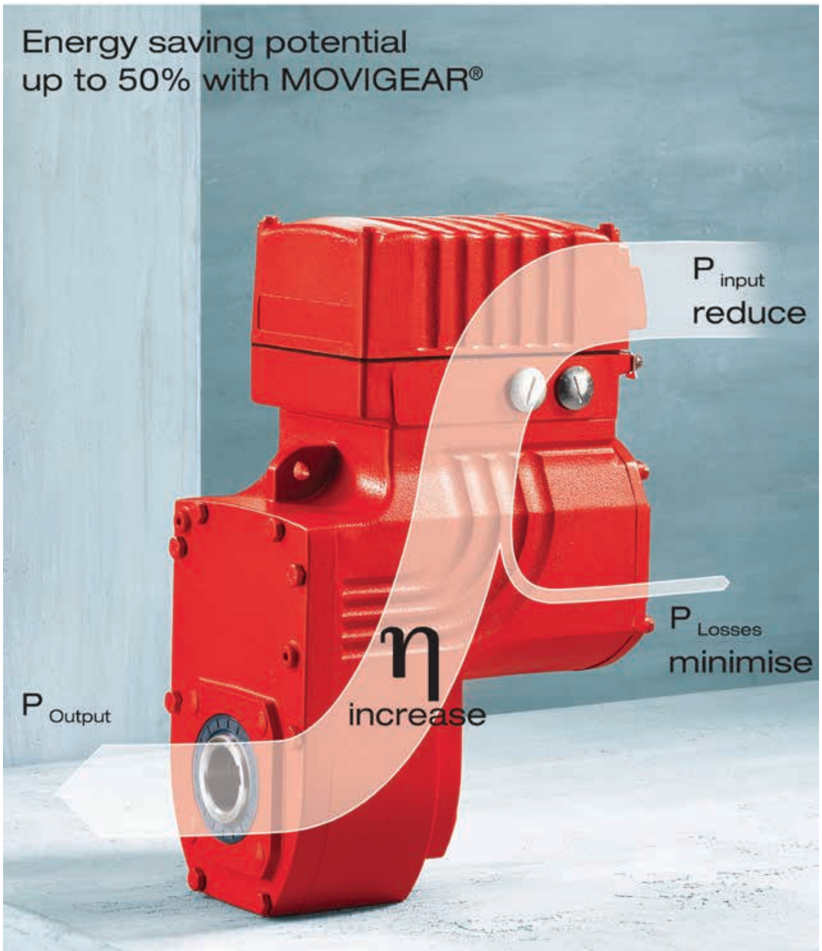
MOVIGEAR® has a number of advantages over traditional drive solutions. It combines three core products into a compact housing: gear unit, motor and electronic drive. Integrating these components extends the product's service life and reliability by utilising the technical and practical advantages of all three drive components. This allows MOVIGEAR® to be easily integrated into most materials handling applications such as conveyor systems.

The hygienic surface design finished with a 'Teflon like' coating minimises cleaning efforts, which leads to reduced cleaning, reduced system downtimes and ultimately reduced operating costs. Inherently the smooth aseptic design and anti-stick properties prevent the build-up of debris making the units virtually self-cleaning. The totally enclosed mechatronic drive system applies the principle of surface cooling, eliminating the need for motor fans. Dispersing air and the spread of germs and bacteria due to air swirls are a thing of the past with MOVIGEAR®. The high degree of ingress protection ensures maximum reliability.

An added benefit of MOVIGEAR® is that the motor exceeds IE4 (Super Premium Efficiency) levels -, offering impressive energy savings. "Depending on the application, MOVIGEAR® offers customers potential energy savings of up to 50%," said Mr Gattellari. Further the MOVIGEAR® system is capable of up to 350% starting torques for those applications that are difficult to get started, meaning that oversizing of the motor just for starting purposes is not required.

As well as the energy saving benefits, MOVIGEAR® can significantly improve the standardisation of components in an application, reducing spares holding for end users. "The reduction of different sizes of gearmotors saves construction and planning, as well as spare parts and storage costs," said Mr Gattellari.

SEW-EURODRIVE also offers training on MOVIGEAR® product range so that system integrators and end users can better understand its functionality from an engineering and maintenance perspective.



[1] Australian Trade Commission, "Food and Beverage: Industry Capability Statements", 2014; http://www.austrade.gov.au/Buy/Australian-Industry-Capability/Food-and-Beverage/default.aspx
[2] Bariacto, Natazsa and Di Nunzio, Jack "Market Power in the Australian Food System", 17 July 2014: http://www.futuredirections.org.au/publication/market-power-in-the-australian-food-system/
[3] Australian Government Dept. of Industry, "Food and Beverage Manufacturing", 2014; http://eex.gov.au/industry-sectors/manufacturing/food-and-beverage/
[4] A. M. Hofer, G. Mori, A. Fian, J. Winkler, C. Mitterer, "Improvement of oxidation and corrosion resistance of Mo thin films by alloying with Ta, Thin Solid Films 599", 2016; https://www.corrosionpedia.com/2/5354/coatings-and-lining/the-science-of-anticorrosion-thin-films

Company background:

The SEW-EURODRIVE group is a global designer and developer of mechanical power transmission systems and motor control electronics, headquartered in Bruchsal, Germany. Its broad spectrum of integrated solutions includes geared motors and gear units, high torque industrial gear units, high-efficiency motors, electronic frequency inverters and servo drive systems, decentralised drive systems, plus engineered solutions and after-sales technical support/training.
The Australian division of SEW-EURODRIVE is headquartered in Melbourne and is supported by a network of offices in Sydney, Brisbane, Townsville, Rockhampton, Adelaide and Perth. A comprehensive service and technical support centre is located in Melbourne, and is complemented by production, service and assembly facilities in all mainland states.
SEW-EURODRIVE offers a full 24 hour emergency breakdown service on its products to put customer's minds at ease.
SEW-EURODRIVE can also tailor a training program to equip customers' with a comprehensive set of skills to get the most out of motor and drive technologies and applications. The company's customer base includes large-scale corporations and smaller entrepreneurial enterprises across Australia.

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