



Growing Importance of Efficient, Durable and Hygienic Machinery Components for Food Processing and Packaging Applications

Discussion on how the industry can satisfy public safety concerns while delivering a superior, high-performance and cost-effective product

KOLLMORGEN[®]

Because Motion Matters™

The food processing and packing industry has a major role in the food safety process and making sure the final product is safe and secure for the consumer. While food safety is a serious requirement, it also presents significant challenges for manufacturers. They must use reliable equipment and machinery and comply with changing federal regulations and standards, all while remaining competitive in an increasingly demanding marketplace.

Machinery components such as instrumentation, motion controls, electrical motors and gearboxes are important to food safety as they perform hundreds of critical tasks in direct contact areas. Though they are generally developed to provide maximum performance in a compact package that is cost-effective, increased durability or ease of cleaning have not necessarily been integral parts of the design. But increased food safety regulations and the need to increase the overall effectiveness of food processing and packaging operations is changing all that.

This white paper discusses the limitations found in many machinery components and their designs while presenting rich insight and more robust alternative solutions. The discussion will focus on instrumentation, motion controls, electrical motor, gearbox and actuator designs but it is also applicable to sensors and HMI instrumentation used in machinery that operates in wash-down environments.

Industry Insights

Kollmorgen took steps to understand the challenges that the food processing and packaging industry were facing and what could be done to address the challenges. Findings from the industry pointed to general dissatisfaction with the products available in the marketplace. Standard products were reported as non-durable in wash-down environments, difficult to clean, contained toxic paint, and the cable material was incompatible with use in the product zone. Products labeled as food grade were slightly better. The paint was non-toxic and the motors had a higher ingress protection rating but they were still difficult to clean and not significantly more reliable than standard motors.

And upgrading to motors made from stainless steel or “wash-down” rated motor alternatives were expensive, larger than standard equipment, had significant restrictions on how they could be washed, were still difficult to clean, and failed in the wash-down environments as well.

Another interesting finding was there were rows of inoperable motors and gearboxes on repair shelves that represented thousands of dollars in material and repair costs and much more in lost production time.

The conclusion was clear: developing high quality machinery components, from motion controls, electrical motors to gearboxes with a hygienic design that is durable and could be cleaned easily and without restriction provides significant value to the food processing and packaging industry



Food processing and packaging applications play a critical role in the food safety process.

Growing Food Safety Regulation and Sanitary Requirements Effect on Machinery and Equipment Design

Undoubtedly, producing food products at high sanitary levels is the number one priority of food processing and packaging manufacturers. Integrity and commitment to social responsibility are the primary drivers for food safety but the risk of bad publicity and increasing government regulations are just as important. The standards for acceptable levels of pathogens continue to change. Examples of this change can be seen in the approach to prevention of *Listeria monocytogenes* contamination in ready-to-eat foods. While high standards have always existed in these areas, machine "cleanability" requirements continue to change.



At an American Meat Institute (AMI) workshop titled "Advanced *Listeria monocytogenes* Intervention and Control Workshop" a group of 75 sanitation experts examined "cleanability" design changes made by a couple of leading slicer and thermoformer machinery

manufacturers. They reviewed previous generation machine designs to current machine designs. Examination included product contact surfaces and non-contact adjacent areas with particular emphasis on eliminating niches and dead spots that could not be cleaned properly and inspected.

On the newer machines, sensitive equipment like instrumentation and motors were moved out of enclosures/guards that created potential dead spots and were put into the open where they could be cleaned during the normal sanitation procedure. The second session was topped off with a demonstration of steam immersion cleaning where the entire machine was covered with a plastic tent and immersed in steam. Increased machine "cleanability" scrutiny and new sanitation methods will continue to increase in the future.¹

These activities are expanding outside of the ready-to-eat production environment. One example of increased scrutiny is the USDA proposal to decrease levels of *Campylobacter* and *Salmonella* levels in fresh poultry. The USDA announced a new proposed standard on January 21, 2015 that would reduce the levels of these pathogens significantly, with consumer groups demanding that the acceptable levels be pushed to

zero. While product contact surfaces are aggressively cleaned in fresh poultry facilities, many times non-contact surfaces and adjacent areas are not considered. In 2013, the USDA documented "fecal material on carcasses" along with "poor sanitary dressing practices, insanitary food contact surfaces, insanitary non-food contact surfaces and direct product contamination" as components causing a *Salmonella* outbreak that sickened more than 600 people.² In order to reduce the pathogen levels, increased sanitation and scrutiny of non-contact surfaces and the general environment will need to be addressed by equipment builders and food processors.

Heightened Awareness

Food safety and sanitation experts are increasingly being included in the machinery procurement decision process along with engineering, operations, maintenance and purchasing staff. Whereas in the past, they were not involved until the actual machine arrived on site. Through this collaborative decision making process food safety and sanitation needs are being addressed in advance of the purchase so that hygienic requirements can be met to prevent significant modifications or machine failures.

Designing machines that will meet existing requirements and be flexible enough to meet future requirements from both a "durability" standpoint (able to withstand evolving cleaning methods) and a "cleanability" standpoint (easy to inspect and clean) will be very important to machinery builders and their customers going forward. Careful consideration of the purchased components used in these machines will be critical in ensuring success.

Ingress Protection Ratings and Wash-down Environments

Ingress protection ratings are defined in the international standard IEC 60529. The standard defines the protection provided against the intrusion of solid objects, dust and water in electrical enclosures. The commonly used rating consists of "IP" followed by two digits. The first digit is the rating for solids or dust. The lowest dust rating that will be considered here is "6" which indicates completely dust tight. The second digit represents the degree of protection against liquid ingress as detailed in the table located in Figure 1 on the next page.

¹ Sutton, W. (2014, October) Notes taken from Advanced *Listeria monocytogenes* Intervention and Control Workshop at the meeting of American Meat Institute Kansas City, Missouri

² The Associated Press (2015). U.S. government proposes standards to reduce salmonella. *The Telegram*. Retrieved February 3, 2015, from <http://www.thetelegram.com/Business/2015-01-21/article-4015932/U.S.-government-proposes-standards-to-reduce-salmonella/1>

Level	Object size protected against	Effective against
0	Not protected	-
1	Dripping water	Dripping water (vertically falling drops) shall have no harmful effect.
2	Dripping water when tilted up to 15°	Vertically dripping water shall have no harmful effect when the enclosure is tilted at an angle up to 15° from its normal position.
3	Spraying water	Water falling as a spray at any angle up to 60° from the vertical shall have no harmful effect.
4	Splashing water	Water splashing against the enclosure from any direction shall have no harmful effect.
5	Water jets	Water projected by a nozzle (6.3mm) against enclosure from any direction shall have no harmful effects.
6	Powerful water jets	Water projected in powerful jets (12.5mm nozzle) against the enclosure from any direction shall have no harmful effects.
7	Immersion up to 1m	Ingress of water in harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of pressure and time (up to 1 m of submersion).
8	Immersion beyond 1m	The equipment is suitable for continuous immersion in water under conditions which shall be specified by the manufacturer. Normally, this will mean that the equipment is hermetically sealed. However, with certain types of equipment, it can mean that water can enter but only in such a manner that it produces no harmful effects.

Figure 1: IP Rating Chart Second Digit: Liquids. Note. From DSM&T. (2015) Retrieved February 3, 2015 from <http://www.dsmt.com/resources/ip-rating-chart>

Note: 9k IP rating indicates protection against powerful high temperature water jets and is effective against 1450 PSI, 4 gallons of water at 176°F from 15cm.

While all of the ratings indicate some protection against water ingress and are useful in selecting products they do not adequately simulate the wash-down environment in many food production facilities. Day after day extreme temperature ranges created by refrigerated environments, volumes of hot or cold liquids used in sanitation, and heat produced by electricity (especially in motors) occur regularly. Caustic or basic solutions are sprayed onto equipment and left to soak and then removed with high pressure wash.

IP66, 66K, or 67	IP69K
First "6" indicates: • "No ingress of dust; complete protection against contact (dusttight)"	First "6" indicates: • "No ingress of dust; complete protection against contact (dusttight)"
IP66 – Water Spray 14.5 PSI from 3m IP66K – Water Spray 145 PSI from 3m IP67 – Immersion of device to 1 m	IP69K – Water Spray 1450 PSI from 15cm, water at 80°C

IP rating tests that are conducted to confirm ratings range in time from 30 minutes to 2 minutes for specific ratings. Since these test times and conditions cannot accurately simulate actual manufacturing conditions we must think beyond IP ratings and engineer machines that use components designed for the environment where they will be functioning.



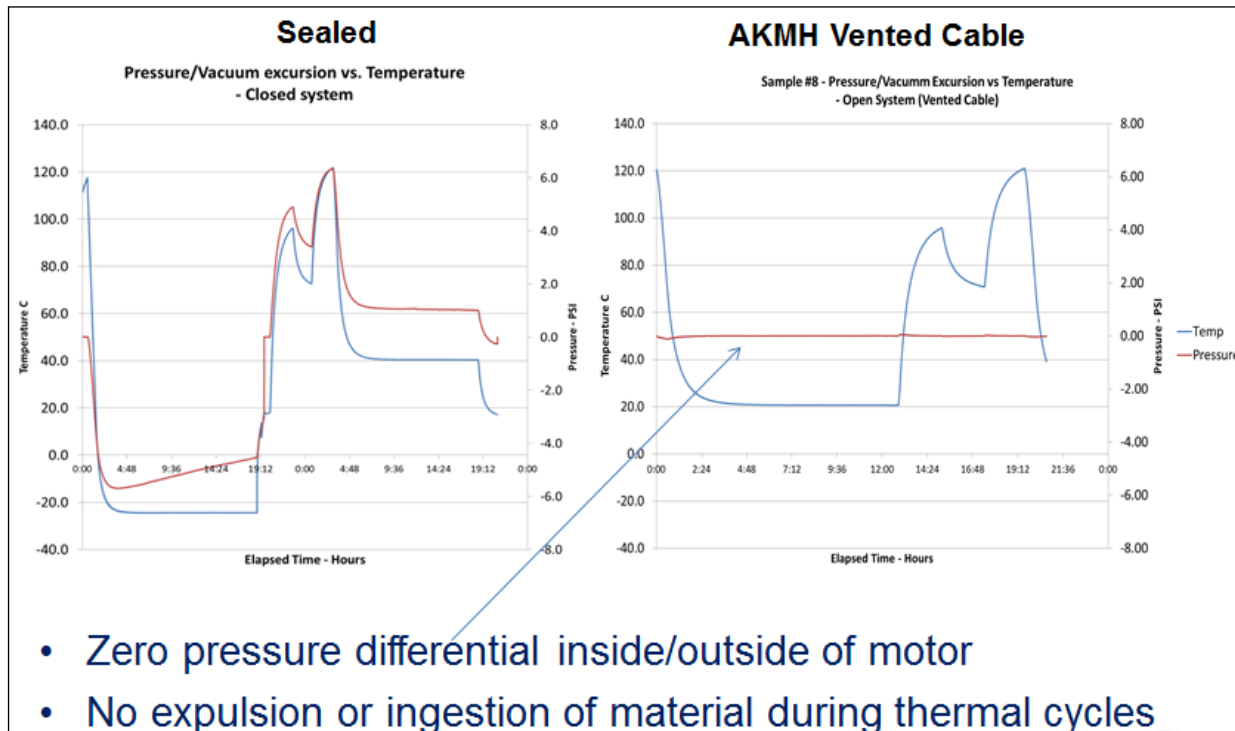
The AKMH™ from Kollmorgen meets the IP69 rating.

Motor Considerations

There are a couple of issues concerning electric motors that should be considered. First, when an electric motor, or for that matter, any electrical device is operated, it creates heat and the temperature of the device increases. When the device is turned off, the temperature decreases. This temperature cycle causes the small volume of air inside the device to expand and contract. It seems logical to "completely" seal any device used in a wash-down environment, but when the air inside of a completely sealed device heats and expands, the air exerts pressure on the seals which eventually pushes through the seals, causing wear.

When the air cools inside of the motor, it contracts causing a vacuum to form inside of the device. This vacuum eventually pulls air through the seals, causing wear which over time allows moisture and cleaning solution through the seals and into the device. In the case of motors, the moisture and chemicals will ultimately cause failure of the bearings, windings insulation, or the feedback device. Some method to negate this cycle is required to increase the life of electrical devices used in wash-down environments.

The chart on the next page shows testing done with a servo motor. The graph on the left shows the temperature and corresponding internal pressure cycle of a "completely" sealed servo motor while the graph on the right shows a servo motor that is "completely" sealed with the exception of a small vent tube running inside the power/feedback cable to the electrical cabinet. The temperature cycle is shown with the relative pressure inside the motor remaining at zero.



A second issue to be considered is the cabling used in the wash-down environment. The cable should be able to withstand the pH range of the cleaning solutions (or product) used. The cable jacket should be chosen to withstand direct pressure spray. Finally, the cable connectors should be designed to withstand the same chemicals and environment. The main failure modes for servo motors used in wash-down environments are ingress of moisture and cleaning solution in the motor, and degradation and failure of cables and connectors. Careful selection of these components is important in increasing the overall durability of the machinery.

Permanent and Temporary Covers

A common solution to the durability problems encountered when using electric servo motors in wash-down environments is to craft permanent stainless steel guards/covers that protect the motors from cleaning solutions and water spray. There are a few drawbacks to this approach. The covers are expensive to fabricate and they add size and complexity to the machines.

Probably the biggest drawback is that the seal around the shaft exit eventually degrades and creates a dead spot for pathogen growth or the seals fail completely and the moisture will cause premature motor failure. Some cleaning regimens will include removal of covers and manual cleaning which substantially increase cleaning time and occasionally, contrary to instructions, the covers are removed by cleaning crews and the standard motors are sprayed down often causing failures. Another common solution is to use temporary covers or bags during sanitation. There are a couple of issues with this approach.



The **AKMH™** single cable stainless steel servo drive with **AquaTRUE™** gearhead

First, the bags or covers are sometimes not used by cleaning crews and the equipment is cleaned with cleaning solution and water causing failure. Second, if temporary covers are used, the motors must be cleaned manually adding to the cleaning time and the motors may not be cleaned as well if they are not included in the regular regimen which could lead to future problems. A better solution is to use electrical components, including motors, which are engineered to withstand a full wash-down environment without restriction.

Cleanable to a Microbiological Level

In addition to being able to withstand wash-down environments, components used in these areas should be able to be cleaned to a microbiological level. Generally, standard electrical motors and gearboxes, and even stainless steel products, have not been designed with these attributes in mind. Standard motors are typically painted but these surfaces cannot be cleaned to a microbiological level because the finish is too rough and the paint itself inhibits cleaning. Many times heat sinks are employed to enable enhanced functionality but heat sink fins make inspection and cleaning difficult. Other trouble areas that are difficult to clean and promote harborage for pathogens are fasteners, rough surfaces, metal to metal seams, name plate areas and flat surfaces which allow for liquids to puddle. There are products available in today's market that meet and exceed machine design guidelines that should be considered. The selection of a motor or gearbox that can be cleaned properly is just as important as the proper sizing of the equipment.

Product Contact Surfaces, Non-contact Surfaces, and Adjacent Areas

In the variety of machinery design standards used in the food production industry, many include a distinct line between food contact surfaces and non-contact surfaces/adjacent areas. One of the differences noted for "High Hygiene - Wet Clean" machines in the harmonized standards document titled "One Voice for Hygienic Equipment Design for Low-Moisture Foods" is surface texture³. Product contact surfaces are required to be 32 μ or smoother while non-contact surfaces can be as rough as 125 μ . This distinction concerning contact surface texture makes a lot of sense; however, an informal rule of thumb seems to have developed for motor and gearbox selection. The unofficial rule is to use stainless steel if the motors are a product contact surface or located above the food line. If motors are in adjacent areas or are considered non-contact surfaces, painted motors are normally used. This practice has led to high rates of painted motor failure, chipped white paint on motors that are misapplied in wash-down areas, and difficulty in cleaning equipment in areas close to the product zone, allowing for harborage and migration back into the product.

³ One Voice for Hygienic Equipment Design for Low-Moisture Foods. (n.d.). Retrieved February 3, 2015, from Alliance for Innovation & Operational Excellence <http://community.pmmi.org/alliance/home/>

Conclusion

Motion controls, electrical motors and gearboxes are integral to the development of highly effective and efficient machinery in the food processing and packaging industry. The selection of electrical components for use in wash-down environments has been limited in the past, leading to the use of components that failed prematurely and were difficult to clean. Manufacturers like Kollmorgen have developed high-grade components that can withstand tough environments. As a result, machine builders should seek out the latest selection of high quality and hygienic machinery components and incorporate them into their designs and food processing and packaging manufacturers should make them a standard part of their machine requirements.

ABOUT KOLLMORGEN

Kollmorgen is a leading provider of motion systems and components for machine builders around the globe, with over 70 years of motion control design and application expertise.

Through world-class knowledge in motion, industry-leading quality and deep expertise in linking and integrating standard and custom products, Kollmorgen delivers breakthrough solutions unmatched in performance, reliability and ease-of-use, giving machine builders an irrefutable marketplace advantage.

For more information visit www.kollmorgen.com, email support@kollmorgen.com or call 1-540-633-3545.