Scientifically Hygienic

Improving Machinery Design through Improved Component Design

KOLLMORGEN

Because Motion Matters™

White Paper

Hilary Whiting, Manufacturing Engineer, Advanced Manufacturing

Food and beverage companies and their machine suppliers constantly fight to keep our food supply safe. These microscopic battles are fought with large quantities of water and chemical sanitation processes. Hygienic machine design is critical even down to the sub-component level in order to allow these processes to be effective in removing product residues, removing pathogens, and destroying bacterial intruders.

Both the North American Meat Institute (NAMI) and the European Hygienic Engineering Design Group (EHEDG) have published lists of Hygienic Machine guidelines *(Table 1)*. One of the challenges in meeting these guidelines is the design of components such as motors, gearboxes, and sensors.

Can the hygienic design of these machine components affect the ability of sanitarians to sanitize the entire machine?

Logic suggests yes, but Kollmorgen sought scientific proof to verify this answer. With the understanding that tremendous value can be gained by the food and beverage industry if hygienic design parameters are verified scientifically, Kollmorgen collaborated with the Virginia Tech Department of Food Science and Technology (VT FST) to verify the premises behind hygienic machine design as applied to servo motors.

Machine Sanitary Design Principles	
Principle #1	Cleanable to a microbiological level
Principle #2	Made of compatible materials
Principle #3	Accessible for inspection, maintenance & cleaning/sanitation
Principle #4	No liquid collection
Principle #5	Hollow areas hermetically sealed
Principle #6	No niches
Principle #7	Sanitary operational performance
Principle #8	Hygienic design of maintenance enclosures
Principle #9	Hygienic compatibility with other systems
Principle #10	Validated cleaning & sanitizing protocols

Table 1: *NAMI guidelines table of continence*
** referenced from Fact Sheet, Sanitary Equipment Design, American Meat Institute, 2012*

Scientific Testing

VT FST performed a series of tests to determine the sanitizability of three servo motor designs. The three motors tested were an industry standard IP67 wash down servo motor designated as Motor W, a stainless steel motor used in the food and beverage industry designated Motor C, and a stainless steel servo motor designed to comply with the NAMI hygienic design checklist and EHEDG design parameters designated Motor H. These motors represent the types of motors commonly used on food and beverage equipment *(Table 2)*.

Motors Tested	
Motor W:	Kollmorgen Wash Down Motor
Motor C:	Competitor Motor
Motor H:	Kollmorgen AKMH Motor

Table 2: *Test motors were a representation of commonly used motors on food and beverage equipment.*

Each motor was inoculated with ATCC 25922 strain of *E. coli*. The study focused on determining the sanitizability at areas of concern on the motor's surfaces: Labels & Surface Finish, Seals & Fasteners, and Cabling. The team focused on these areas to see how design features affected the ability of the servo motor to be sanitized of *E. coli*. These areas were marked and isolated, then, put in contact with 10 µl of *E. coli* for 1 hour. During this time, the motors were run at amperage that kept their surface temperatures between 33°C and 38°C, non-lethal temperatures for *E. coli*.

Sites were inoculated with *E. coli* and sampled prior to the cleaning and sanitation procedure (pre-wash) to determine a baseline. A typical industry cleaning and sanitation procedure supplied by a leading food production company was used to clean and sanitize each of the motors. The marked sites were sampled again post-wash to determine if the area was successfully sanitized. Three repetitions of this process were performed to provide an appropriate data sample size. The reported study findings can be seen compiled below *(Table 3)*. This data could then be used to draw conclusions about the impact of design features on the sanitizability of the three motors.

> Each test motor was inoculated with ATCC 25922 strain of *E. coli*.

Label & Surface Finish Testing Results

The first sets of locations to be evaluated are those pertaining directly to labeling and surface finish on the motors. Motor W has labels etched onto the surface of the aluminum housing *(Figure 1)* and the surface is covered with food grade paint. The rough finish of the etched label was identified as high risk to harbor bacteria. Motor C has stamped labeling with a brushed surface finish on its housing *(Figure 2)*. The brushed surface finish of Motor C was

Site Sampled	Pre-wash[1] (CFU/cm^2)	Post-wash
Motor W		
Motor Surface	3.71	ND[2]
Motor Surface	2.56	Detected[3]
Inner Juncture of Shaft Housing	4.21	ND
Outer Juncture of Shaft Housing	3.28	Detected
Front Juncture (no visible gasket)	3.59	Detected
Back Juncture (at screws)	3.8	Detected
Utility Cord Housing Juncture (hex nut)	3.91	Detected
Utility Cord Entrance into Housing (internal gasket)	3.58	Detected
Utility Cord	4.89	Detected
Motor C		
Motor Surface	2.92	Detected
Motor Surface	3.29	ND
Inner Juncture of Shaft Housing	4.22	ND
Outer Juncture of Shaft Housing	2.7	Detected
Front Juncture (no visible gasket)	2.83	ND
Six Screws on the back of the motor	4.31	ND
Utility Cord Housing Juncture (soldered/hex nut)	2.97	Detected
Utility Cord Entrance into Housing (internal seal)	3.17	Detected
Utility Cord	4.92	Detected
Motor H		
Motor Surface	2.47	ND
Motor Surface	2.05	ND
Inner Juncture of Shaft Housing	3.26	ND
Outer Juncture of Shaft Housing	3.29	ND
Front Gasket Juncture	2.38	ND
Back Gasket Juncture	3.25	ND
Utility Cord Housing Juncture to Motor (visible gasket)	3.92	ND
Utility Cord Entrance into Housing (visible gasket)	4.09	ND
Utility Cord	2.84	ND
[1]Populations of E. Coli in Log Colony Forming units (CFU/cm^2)		
[2] E. coli ATCC 25922 Not Detected		
[3]E.Coli ATCC 25922 Detected on each of the three repetitions		

Table 3: *Pre-wash and post-wash E.coli sampling.*

identified as an area of concern due to the textured surface finish and, therefore, was targeted as a sampling location by the test team. Motor H has a smooth stainless steel housing that holds a 32 µ-inch surface finish or better, even across the annealed label face *(Figure 3)*. In the NAMI guidelines Principal 6.1 states; “It is recommended product contact surfaces textures shall not exceed 32 µ-inches...” The housings and labeling methods of Motor W and Motor C do not comply with this guideline, but Motor H is compliant. Both Motor W and Motor C were found to have *E. coli* present on their surfaces post-wash, whereas Motor H was not found to have any. Therefore, the lack of bacterial recovery post-wash from Motor H supports the NAMI design guidelines regarding surface finish and external materials as verified through the scientific testing by Virginia Tech Department of Food Science and Technology.

Figure 1: *Motor W has an etched label covered with paint. The etching process creates a rough uneven surface that can create niches where bacteria and food product may be harbored.*

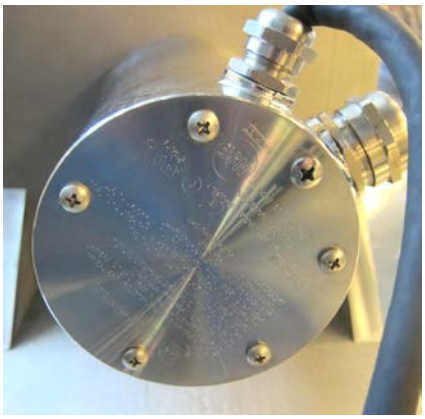

Figure 2: *Motor C has a high-risk texture surface for product trapping and bacteria harboring. The uneven surface finish creates niches where microorganisms can hide.*

Figure 3: *Motor H features an annealed label with a 32 µ-inch surface finish. Unlike etching, the annealed label preserves the metal’s surface finish. This smooth label was designed to avoid trapping bacteria or food.*

Seals & Fastener Testing Results

Seals and fasteners were the second group of test locations investigated. The NAMI guidelines caution against the use of fasteners above product areas in Principle 7 as well as stating that seals and O-rings must be designed to minimize product contact, Principle 2.9. Most standard fasteners create niches or spaces where microorganisms and product can be harbored. Principle 6 of the NAMI guidelines explicitly outlines the need for elimination of niches. Both Motor W and Motor C have external screws, a shaft seal, and several metal to metal joints *(Figures 4 and 5)* while Motor H has hygienically designed gasket joints instead of metal to metal joints, as well as a shaft seal, and does not use any external screws or fasteners *(Figure 6)*. Motor W was found to have bacteria present post-wash on all of its junctures except the seal surface where the shaft was spinning. Motor C was found to have *E. coli* present on the outer juncture of the shaft seal. However, on the surface of Motor H, *E. coli* bacteria were not found to be present on any external sealing surface after sanitation. Therefore, the lack of *E. coli* recovery supports the NAMI design guidelines regarding fasteners and junctures.

Figure 4: *Motor W has metal to metal joints that are covered by a layer of paint. The motor has eight screws in total.*

Figure 5: *Motor C has metal to metal joints at both ends of the motor body. The end cover joint is secured with six screws as seen in Figure 2.*

Figure 6: *Motor H does not have any metal to metal joints. Instead, all joints are mated with gaskets. The gaskets are bright blue in color to contrast against food products.*

Cable & Hardware Testing Results

The third area examined on the test motors was the cables and hardware. The NAMI guidelines do not explicitly address cables, but the general material guidelines can be applied in addition to Principle 6, the elimination of niches. Both Motor W and Motor C were found to have bacterial colonies on the cable and both cable fitting interfaces. The VT FST test team was not able to recover any *E. coli* on the cable or the cable junctures for Motor H, post-wash. The cable of Motor H was specifically designed to not harbor bacteria and withstand harsh wash down procedures. The cable connection to the motor is also sealed using a bushing interface instead of a metal to metal interface like Motor W and Motor C. Therefore, the lack of post-wash bacterial recovery on Motor H supports the NAMI guidelines regarding material specifications and niche elimination.

Note: The Kollmorgen AKMH™ Servo motor was developed after interviewing over 100 food processing companies and understanding their needs. It is designed to be cleaned without restriction using 2 to 12 pH solutions and can be sprayed with high- pressure water (1450 psi) without restriction. The motor is designed to be reliable in stringent wash down conditions, reduce cleaning time, and reduce the risk of food recall.

Motor H:
Kollmorgen AKMH™
Hygienic Servo motor

Hilary Whiting is a Manufacturing Engineer for Kollmorgen's Advanced Manufacturing Team. She was previously a Quality Engineer focusing on the Advanced Kollmorgen Motor-Hygienic (AKMH™). Hilary is a 2013 Mechanical Engineering graduate of Virginia Tech. She can be contacted at hilary.whiting@kollmorgen.com.

Detailed Conclusion featured on the next page

Conclusion

How important is hygienic design to you?

The hygienically designed Motor H clearly outperformed Motor W and Motor C with regards to hygienic design. The VT FST team could not detect *E. coli* colonies on the exterior surfaces of Motor H post-wash while Motor W and C both had multiple positive sites after the sanitation procedure. The problem sites can be directly correlated to areas where hygienic design criteria were not strictly followed. Each bacterium that survives a wash down procedure may be a risk to food safety or quality, not only to food and beverage companies, but most importantly to the end consumers.

The data collected through this study can be used to postulate the importance of system-wide hygienic design including purchased components. The importance of careful design on the servo motor component level can only be magnified when applied to entire machines and production lines.

Kollmorgen in collaboration with the Virginia Tech Department of Food Science and Technology has shown that deviation from hygienic design standards corresponds to decreased motor sanitizability leading to increased contamination risk and the need for additional costly and time-consuming interventions. These risks translate to real world costs, whether it is added sanitation time, increased numbers of cleaning interventions, reduced production time or increased risk of consumer harm when safeguards fail.

When fighting microscopic wars we must give ourselves every advantage because the enemy cannot be seen, therefore hygienic design must be demanded.

ABOUT VIRGINIA TECH FOOD SCIENCE AND TECHNOLOGY

Engaging Minds to Meet Global Food and Health Challenges

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Invent the Future®

Virginia Tech Department of Food Science and Technology is at the forefront of food safety through its industry-relevant research supporting its mission of protecting public health and enhancing food quality.

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

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