Department of Electrical and Computer Engineering

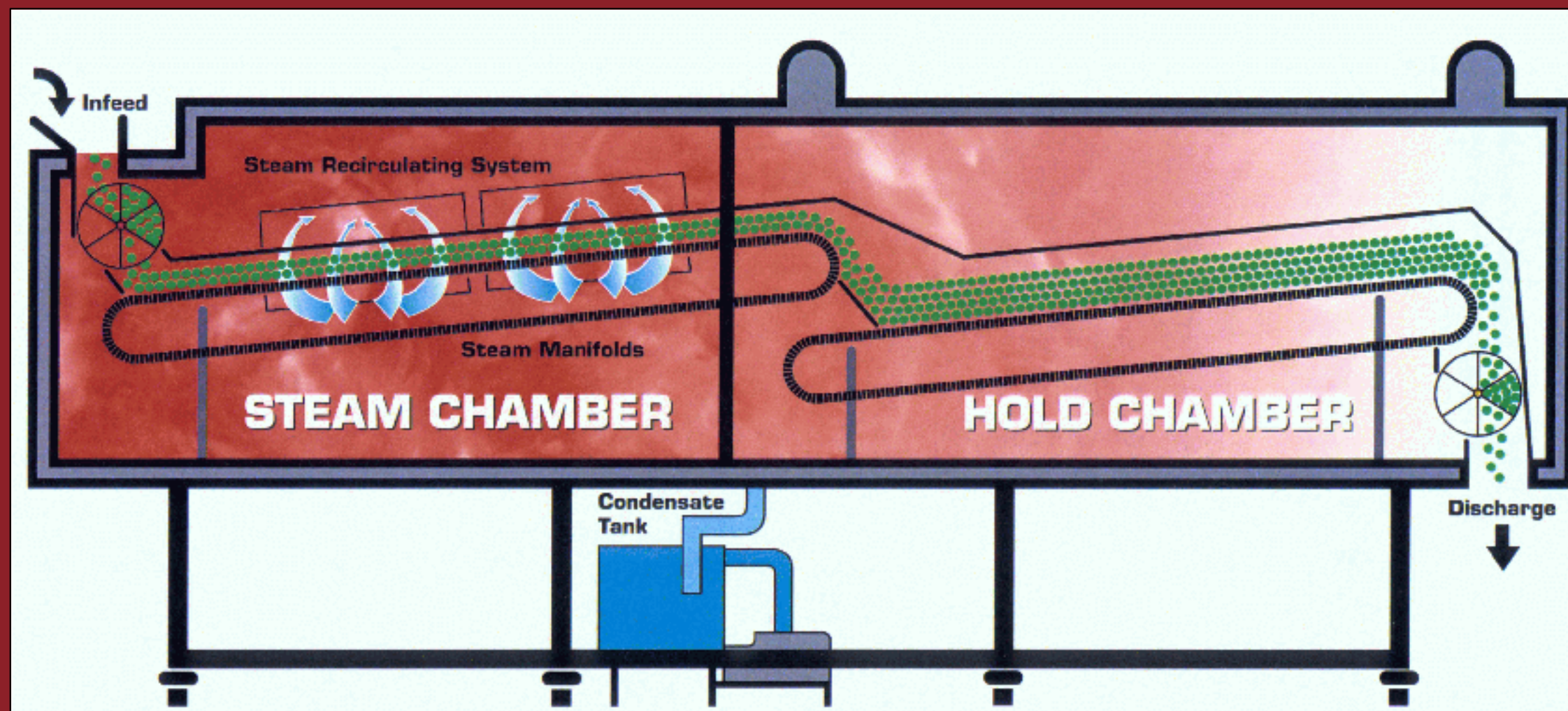# ABCO Food Machinery Sensor Upgrades

Introduction

- ABCO is a well-established manufacturer in the food processing industry.
- A blancher is a piece of food processing machinery to pre-cook food using steam.
- Our focus is to help advance their blancher product line, so they can stay ahead of their competitors.

Current System

- ABCO's blanchers have a HEAT/HOLD section so the food spends less time in steam.
- Currently, 4-20mA Automax sensors mechanically control a set of paddles that are used to measure bed depth.

Project Objectives

- The first objective was to explore sensor options to update the existing bed depth sensor in ABCO's blancher machines.
- The second objective was to find preventive maintenance sensors for the motors that power the conveyor belt system.

Bed Depth Sensor Specifications

- Bed depth refers to the product height on the conveyor belt. The aim for the sensors is to provide accurate detection of the product depth in a steam environment.
- These sensors must comply with three main specifications:
  - Enclosure rating of NEMA 4x or IP66 minimum.
  - Operate in temperatures up to 100°C.
  - Absorb the vibration produced within the blancher.
- Our team decided that ultrasonic sensors are the ideal choice. They perform better in dust and humidity. Moreover, they are also cost-effective.

Sensor	Details	Image
ATO-LEVS-ZP Ultrasonic Level Sensor	• $400-$600. • 5m (16ft) range. • IP68 rating. • Temp: -40 to +80°C.	
Endress+Hauser Ultrasonic Sensor Prosonic FDU91F	• $900-$1100. • 5m (16ft) range. • IP68 rating. • Temp: -40 to +105°C. • Self-cleaning effect of sensor.	

Bed Depth Sensor Implementation

- Main factors to take into consideration during sensor implementation were accuracy of readings, affordability (blancher modifications) and durability in the harsh steam environment.
- With these factors in mind, we considered two possible implementations for the sensor:
  I. The first design is to add a "viewing section" before the heat section, with the two sections being divided by a water curtain keeping the steam away from the sensor.
  II. The second implementation method is to place the sensor in the already existing heat section.

Viewing Section	Place in Heat Section
+ Avoid harsh environment. + Accurate readings. + Water curtain will keep steam out of this section. - Must extend the blancher length.	+ Simple implementation. + No exterior blancher modifications. + Affordable. - Need to clean off sensor. - Sensor needs to meet all specifications.

Conclusion and Recommendations

- After reviewing the bed depth sensors, the best choice would be the Endress+Hauser sensor as it meets the specifications and is compatible with either design.
- The ATO sensor would also be a viable solution due to its low cost and ability to meet most specifications, but it would only be applicable to the viewing section implementation.
- For implementing the bed depth sensor, our team recommends placing the sensor inside the heat section.
- We chose this design because it's the easiest, cheapest, and does not involve modifying the footprint of the blancher.
- However, if a sensor with the required specifications cannot be found, adding a viewing section is a good second option.
- For the motor sensors, the thermistors and the HS-422ST accelerometer are recommended.
- Going forward data needs to be collected on the blanchers to determine when faults are occurring. When conditions are known to cause faults, the system will alert ABCO's clients that maintenance is required.

Design Process

- Our design process was research-based. Analyzing numerous research papers, journals and product datasheets dedicated to industrial machinery and sensors, we compiled a list of solutions that were compatible with the machinery.

- Our team met with the internal and external supervisors on a weekly basis to confirm/rule-out developing technologies.

- To complete the project objectives, we divided the tasks into three segments:
  - Bed depth sensor specifications.
  - Bed depth sensor implementation.
  - Preventative maintenance for motors.

Preventive Maintenance for Conveyor Belt Motors

- Preventive maintenance is used to correct problems with machinery before they occur.
- Monitoring physical conditions of the motor can provide information regarding overall health.
- Physical conditions that can be detected using sensors are vibration, sound, temperature, and motor current. The proposed design solution will monitor vibration and temperature.

	Vibration Sensors	Temperature Sensors
Sensor Choice	An accelerometer will be used to measure the vibrations produced by the motor.	A thermistor which is a resistor that changes resistance depending on temperature.
Location	The accelerometers should be mounted on the outside of the motor case. The ideal location is the area outside of where the bearings are located.	Three thermistor sensors attached in series with the motor windings.
Detectable Faults	Bearing drag, bearing damage, load imbalance.	Power supply issues, friction in the bearings, overloading of the motor.
Proposed Sensors	**SparkFun Triple Axis Accelerometer** • Low cost. • Good for testing. **HS-422ST Accelerometer** • Higher Cost. • IP67 Enclosure Rating. • Provides local temperature as well as vibration data.	**SEW Eurodrive PTC Thermistor** • SEW Eurodrive is ABCO's motor supplier. • This option can come installed in the motors. • Measures temperature inside of the motor.

References

- AMWEI, "PTC Thermistors Limit Temperature Sensors for Motor Protection 1 PTC Single Sensor & 3 PTC Triple Sensors," [Online]. Available: https://amwei.com/ptc-thermistors/ptc-thermistors-motor-sensor/.

- ATO, "Ultrasonic Level Sensor, Output 4-20mA/1-5V/RS485, 0-40M", [Online]. Available: https://www.ato.com/ultrasonic-level-sensor-40m.

- Endress+Hauser, "Ultrasonic measurement Time-of-Flight Prosonic FDU91F", [Online]. Available: https://www.ca.endress.com/en/field-instruments-overview/level-measurement/Ultrasonic-Prosonic-FDU91F?t.tabId=product-overview.

- Hansford Sensors, "HS-422ST Accelerometer," [Online]. Available: https://hansfordsensors.com/wp-content/uploads/datasheets/TS498.1.pdf.

- SEW Eurodrive, "https://www.sew-eurodrive.ca/products/motors/ac_motors/accessories_and_options/other-additional-features/other-additional-features.html" [Online].

- Solarbotics, "SparkFun Triple Axis Accelerometer - ADXL345," [Online]. Available: https://www.solarbotics.com/product/50656?countrycurrency=CA&gclid=CjwKCAjwloCSBhAeEiwA3hVo_Wafpf92OyEWhsKL6K4CjI7YVgxnq_73r6doHS5-vs5qgBbP8AmIaRoCV2sQAvD_BwE