

# Semi-Automated Defect Detector

Sponsored by MTH Pumps

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**Abstract— MTH Pumps manufactures industrial pumps. The facility in Plano, IL, is involved in constructing pumps for numerous industries such as boiler feed, water services, chillers / temperature controllers and refrigeration. The castings and covers of the pumps must go through a testing process to determine whether the parts might have a crack that will result in leaks. The new design focuses on improving the setup time of the testing process by semi-automating the setup. Aside from reducing the set-time, the cycle time between tests is also decreased in the new design. Finally, the new design increases the success rate of leak detection by relying on pressure sensors instead of sight to determine leaks or cracks within the castings or covers.**

## I. INTRODUCTION

Ensuring a pump can hold pressure is arguably the most important feature of a pump. Our senior design project focused on the T31 pump model. The T31 pump model is made from two bronze castings fastened together. One half is the motor cover, with the other half being the motor bracket. The current process for the inspection step utilizes a machine that consists of a large metal plate suspended above a tub of water. Eight individual part slots lay across the plate where the castings are placed. Then any drain or inlet port the casting has are manually threaded. Two posts sit opposite each part slot that a clamp and screw mechanism are slotted into. Then they are manually tightened to secure the castings to the plate. After this, the plate is dropped into the water. A small hole in each of the individual part slots sits along the fluid track of the castings and supplies pressurized air into the closed system for about twenty seconds. The operator then raises the plate out of the water and conducts the visual test.

The visual test consists of the operator observing the tops of the castings for bubbles that would indicate a defect in the casting along the fluid track where air could be escaping. The current process is very time consuming, taking 15 to 20 minutes to test only one half of a pump at a time, allowing defective castings to get through the process. MTH wants a new process with the goals of eliminating the manual labor for the process and providing automated aspects, while producing more consistent results through a more scientific testing method. This system often results in pumps reaching

consumers and failing to meet their needs. Our team was assigned to design a semi-automated system, which will assist in detection of failed pumps and decrease cycle times. We selected the decay test method to satisfy our objectives, mainly because it was a quick and easy process that allowed us to easily incorporate a Programmable Logic Controller (PLC) to control the components.

Other companies also create leak detection systems, but by creating our own, we can fine tune the process to trim unneeded features. However, because a decay test is conducted the same across the board, we can use the same formulas that name-brand manufacturers use [1]. This gives our system credibility, as well as the ability to provide accurate data as a benchmark.

## II. MATERIALS AND METHODS

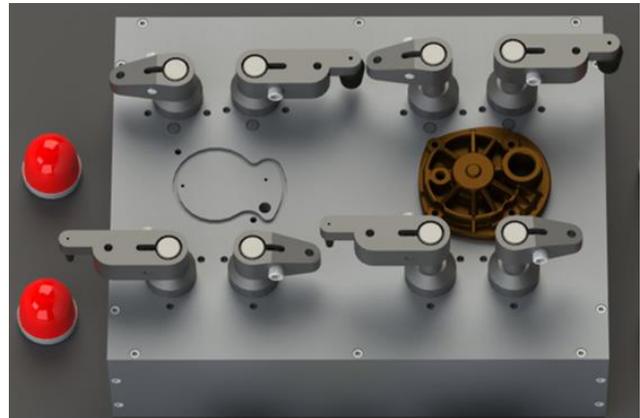


Figure 1

Our prototype was designed to test two cover castings at the same time via pressurizing the air track of the castings themselves. Two pressure transducers (rated up to 100psi) were placed in the pressurized zone, picking up the current castings' pressure. There are four Enerpac hydraulic clamps holding each casting, one on each corner. This is an improvement on the current setup where there is only one contact point holding the casting down. The castings themselves are clamped onto a surface ground aluminum plate (Figure 1), which has O-ring grooves cut out to ensure they are sealed properly. To start the system, the operator pushes two green buttons, which starts the PLC

program. A red E-stop is placed in an easily accessible area in case of emergency or if there is a need to pause the system. Red process lights will indicate if the pressure sensors are below a set value, while a yellow process light will signify that the test is in progress. Because we will be using pressurized air and hydraulic clamps, we have two pneumatic solenoids and a hydraulic pump. The previously listed components will be placed on an industrial plastic cart (Figure 2), with the system being on the flat top, solenoids and PLC on the middle shelf, and the hydraulic pump on the bottom shelf.

One major hurdle we had to overcome was that the castings have multiple threaded ports connected to the air track. This means we had to seal them before the test was conducted. Previously, the operator had to hand thread plugs into these ports, which takes time. We solved this problem by having rubber plugs attached to the clamping arms to plug the holes at the same time the arms press down on the castings. We pressurized the castings to 25 psi. At this pressure, with an area of 11.39 in<sup>2</sup> for the air track, we needed a minimum of 284.75 lbf pressing down to seal each casting. The pneumatic solenoid could build the pressure in each casting, hold at a neutral position during the test, and exhaust the pressure once the test was completed. We decided on two transducers on each casting for sake of a fail-safe. Because we were relying so heavily on the transducers to give an accurate number, we double checked the pressures from both transducers in case one malfunctioned. In case of a malfunction, red process lights would be illuminated to inform the operator of an issue.

### III. RESULTS AND VIRTUAL BUILD

The outcome of our project is to replace the manual system at MTH, but to also increase productivity. The updated system is expected to test two castings in less than 2 minutes, including charge time, settling, and work handling. This would save MTH \$5,833 just in labor for testing the annual demand of the castings.

One aspect of the previous design MTH struggled with is a lack of quantitative data. The bubble method, while being outdated and prone to false positives, is good for a low-quality quick check. The decay method will be able to produce actual data that can be cross referenced against calculations and quality standards [2]. The sensors and PLC components were handpicked with both functionality and feasibility in mind during the decision-making process. While the process of determining specific data for passing and failing castings was outside the scope of our project, the new system will be able to provide an industry standard of quality control and data acquisition.

Because of the time shortage, we were not able to test the clamps or pneumatic system to determine an accurate cycle time, and thus the 2 minutes is an estimation. All

components have been ordered for the system; however, some machining is still required to complete the system. MTH can machine all the components in house, reducing additional costs to manufacture. Once fully manufactured, the system will be ready to assemble and test.



Figure 2

### IV. CONCLUSION

It is recommended that MTH decrease the manual set up and incorporate the automated features to reduce the setup time and overall cycle time of the test. Furthermore, by eliminating the vision inspection in the original test and including some pressure sensors instead, the human error is eliminated. The addition of these sensors will increase the number of ideal castings and covers distributed by MTH Pumps. Finally, for future consideration, the company can make this semi-automated process fully automated by including a robot to increase overall efficiency.

### ACKNOWLEDGMENT

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### REFERENCES

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- [2]. "A Comparative Study of Technologies and Techniques Short Version." Leak Detection Methods.