

O-Ring Installation Automation

Danfoss Power Solutions

PROBLEM STATEMENT

- Danfoss ICS Easley is currently experiencing a significant increase in demand for all products. However, they have not been able to increase staffing quickly enough to meet this increased demand, which has affected the on-time delivery rate to customers. Currently, all assembly processes are completely manual
- The purpose of the engineering capstone project is to develop an automated solution for the installation of O-rings and backups on a completed hydraulic cartridge assembly.

REQUIREMENTS

Req #	Requirement Description	Motivation
1	Must function using standard plant parameters (120 AC, 90 psi)	These are the standard, available resources for power in most plants, making the project nearly universal
2	Must install O-rings and backups in the proper orientation, according to the engineering drawing, without damaging the parts	If cartridges are assembled incorrectly resulting in damage or failure in testing, the process itself is a failure.
3	Can allow minimal to no contact between the valve bodies	Cartridges that contain scratches more than around 500 microns depth are considered damaged.
4	Budget must meet a 3-year minimum payback period	Meeting this requirement makes the project a valid idea. If the money is not made back the project is void.
5	Must fit within the workstation floorplan	Like the plant parameters, the project must fit in the specified work area detailed by the customer.

CONCEPTS

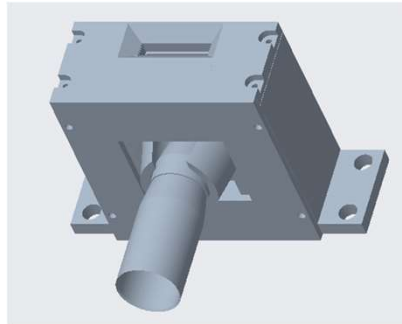
There have been multiple concepts that did not make it to the final design. Several of these were eliminated because of predicted project cost and potential production difficulty. Discarded concepts utilized the current manual method of installation that uses "cones" and "pushers" but automating the process using conveyors and pneumatics. The final concept was selected for its credible design that is based on a similar pre-existing device. The mechanism installs O-rings onto the valve by stripping the O-rings off a small mandrel and sliding them into the desired slot on the valve. The O-rings are fed into the system via a vibratory bowl feeder before being loaded onto the valve assembly. The comparable device is a good foundation, but the system should be fully automated.



Cartridge valve

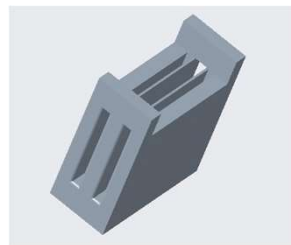
FINAL DESIGN, APPROACH, PLAN

The main objective for this project is being able to install three O-rings onto the valve assembly. The way to solve the problem was to modify the O-ring stripping device to be able to install three O-rings at once. This device is known as the iris mechanism, working similarly to an iris.

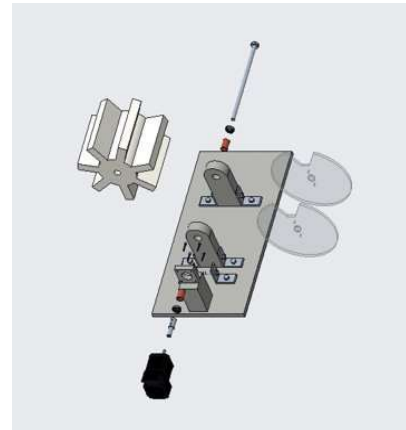


Iris mechanism outside view

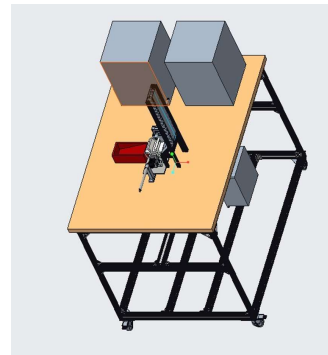
The next step of finding out how to get the O-rings installed was figuring out how to get the O-rings to the system in the correct orientation. Many ideas were discarded, but a vibratory bowl feeder was the most viable option. This will allow the O-rings to be fed automatically. Once they are positioned, they will be fed into a console that will hold them in proper orientation before being fed into the Iris. Also required was a method of aligning the valve to the proper position to be pushed into the Iris. A wheel was designed to rotate the valves in and out of position before and after O-rings are installed.



O-ring separation console



Water Wheel Cartridge Feeder



Final Design Assembly

RESULTS

- Iris mechanism successfully installs O-rings in the expected orientation
- While not integrated, bowl feeders feed O-rings
- Wheel rotates parts into position effectively
- PLC's ladder logic runs as expected to control the system
- Assembly time for the valve assembly is reduced

SUMMARY AND CONCLUSIONS

The final design completes the following task: Loads valves into a wheel to be positioned before being pushed by a pneumatic cylinder into the Iris mechanism. Simultaneously the bowl feeders will feed the O-rings into the console, and then the iris will strip the O-rings onto the part as a second pneumatic cylinder will push the part back out onto the wheel. It is ejected and then the process repeats. This process completes the installation of one set of O-rings. There are three different slots for the different sizes of O-rings and a tool change of the mandrel and O-rings inserted must be changed to achieve all three layer. The outcome will increase production speed, freeing up workers to do other tasks and increasing production of valves.

FUTURE WORK

- Proceed with test plan to ensure proper functionality and maximum efficiency
- Machine replacement parts for the 3D-printed iris mechanism model
- Purchase second bowl feeder and integrate bowl feeders into the assembly to automatically feed the O-rings into the system

TEAM & ACKNOWLEDGEMENTS

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