Mojonnier tube overhead shaker with wire rack

Engineering Development Project MG7101

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The Engineering Problem

During milk fat determination testing at Oceania Dairy, mojonnier tubes are required to be inverted for one minute to mix various solvents with the milk sample up to six times per test, with several tests conducted per day. The required motion for mixing is a gentle rotational motion, during which the liquid must move between the smaller and larger bulbs of the mojonnier tube.

Currently the lab staff must shake the mojonnier tubes manually, eight at a time, in a stand between a person's arms. This method is less consistent than a mechanical shaker and can cause back pain when done frequently.

The Solution

This Engineering Development Project aimed to design and manufacture a fully functional prototype of a mechanical overhead mojonnier tube shaker with a removable wire rack.

The wire rack consists of a stainless-steel wire frame which holds eight mojonnier tubes securely for transporting around the lab, use during testing and shaking, and to be used as a drying rack when hand washing the mojonnier tubes.

The shaker has a cradle to firmly hold the mojonnier tubes inside the rack and enable it to be rotated to shake the contents of the tubes. The cradle consists of a base and an adjustable lid. The base provides a surface for the rack to sit on and to provide a mounting point for the shaft to connect to the motor. The adjustable lid allows a secure fit to put sufficient pressure on the mojonnier tube tops and can be raised to move the rack in and out of the shaker.

The base and housing are the static components of the shaker which the cradle and rack rotate in. The housing contains the motor and electrical control circuit.

The motor that was used to rotate the shaker mount was a car windscreen wiper motor. The motor control circuit consists of a transformer, a timer relay, three relays, and a magnetic proximity sensor. The motor will run for one minute, after which the magnetic sensor will stop the motor when the sensor meets a magnet on the side of the rotating mount, ensuring the mount will always return to the upright position after use.

Testing of the prototype consisted of mostly user testing and feedback as well as some repetitive durability testing and SolidWorks stress analysis to ensure the shaker is fit for purpose.

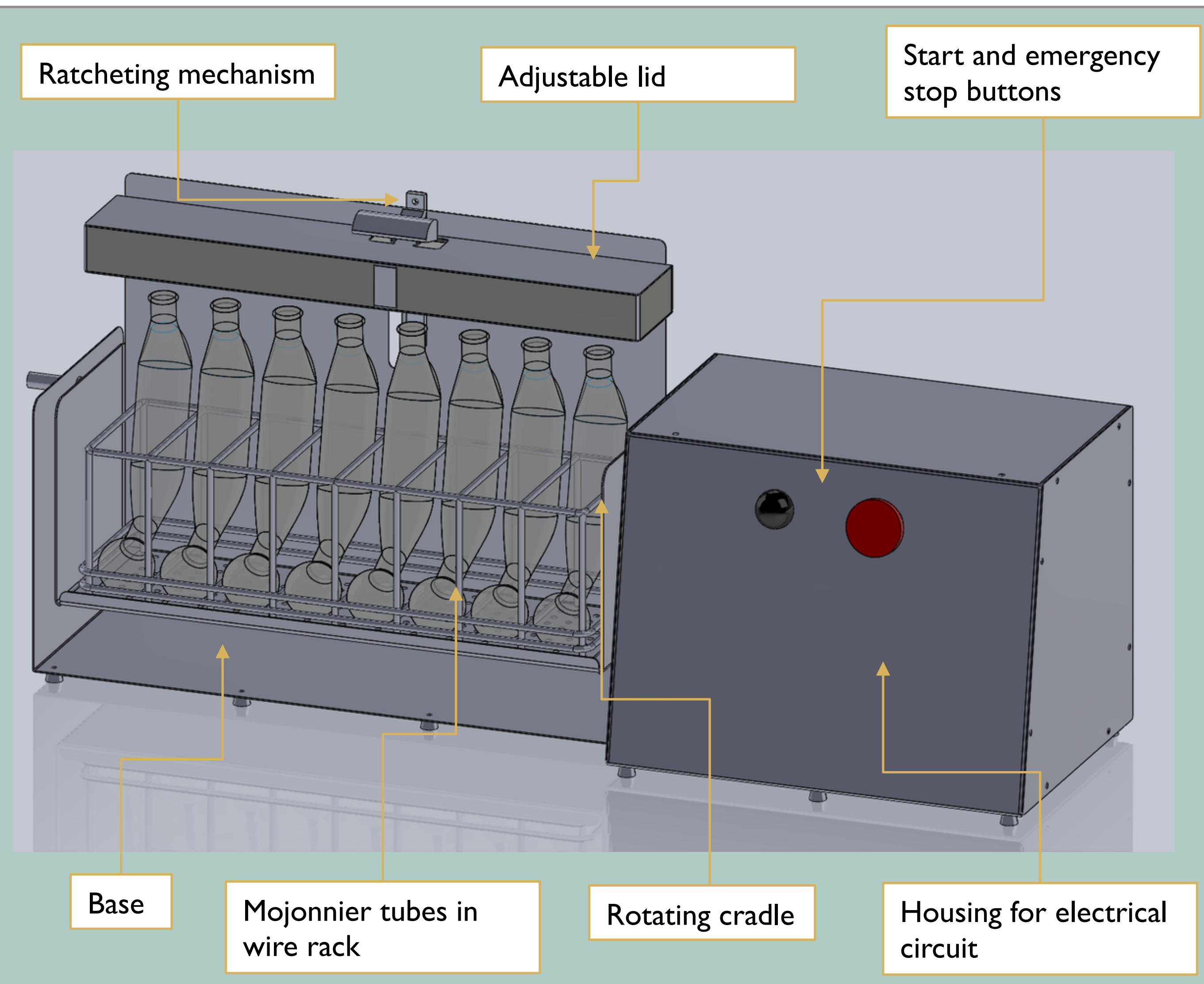

Figure 1: Final SolidWorks model of full assembly

Figure 2: Final prototype of mojonnier tube overhead shaker

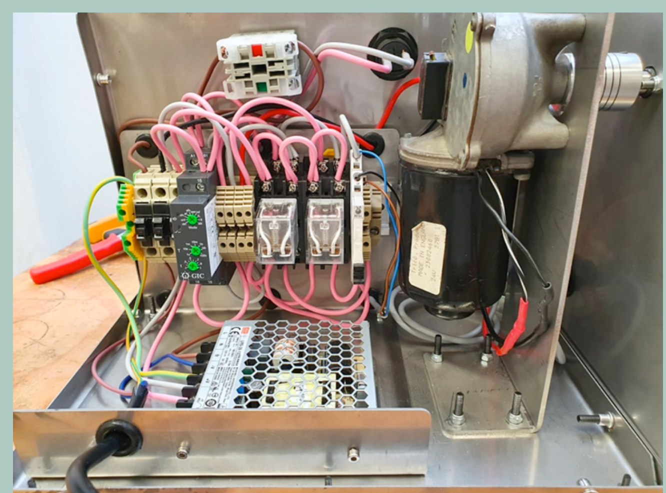

Figure 3: Final electrical circuit mounted inside housing

SolidWorks Analysis

Strength analysis was conducted using SolidWorks in order to identify weak points in the model and compare different design variations. This analysis showed the reduction in stress that could be achieved by adding fillets and other features to minimise the high stress points in the design.

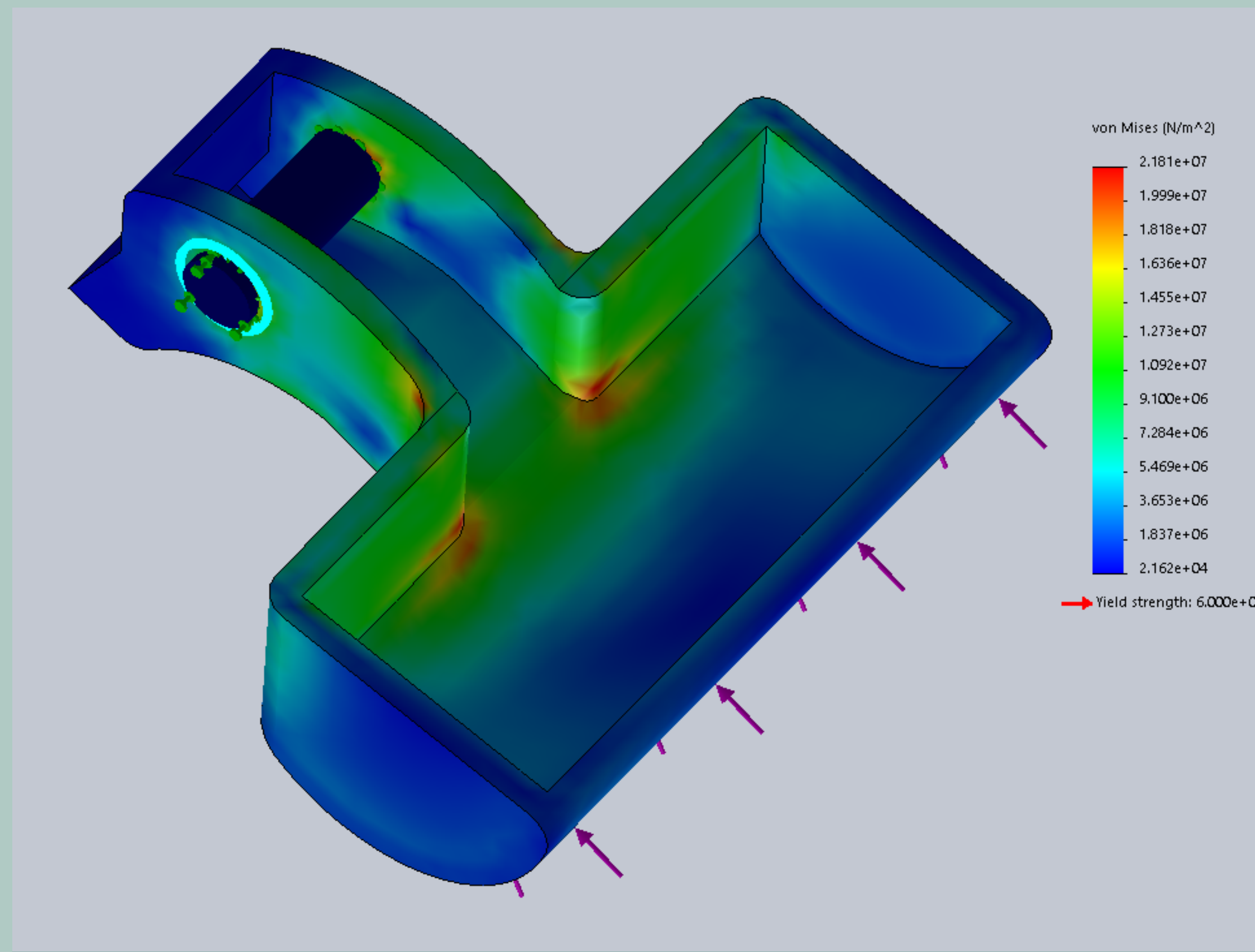

Figure 4: SolidWorks von Mises stress analysis of final ratcheting handle prototype

Conclusion

Overall, this Engineering Development Project fulfilled the objectives that were set. A fully functional prototype overhead shaker was designed and manufactured which meets the requirements of the Röse-Gottlieb Method. The total material cost of the prototype was $472.16 and total estimated prototype cost was $1 880.66 which was above the intended cost of the prototype but still lower than the cost of commercially available laboratory shakers which meets the intended aim of the project. The overall estimated cost of the prototype was only 26% of the cost of the most comparable commercially available overhead shaker.