

University of Wales Trinity Saint David

Wales Institute of Science & Art



Engineering Problem

Engineering Design (ACHA4001)

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1 Introduction

1.1 Aims and Objectives

This project aims to redesign the lid for safe, single person operation, while maintaining the tanks dimensions and material constraints. The new lid must provide good vertical clearance to allow parts to be safely loaded and unloaded.

The objective is to develop a solution that improves safety and usability, without compromising durability and compatibility with the current tank setup. The final design should be suitable for production in batches of around one hundred units.

1.2 Background

Anodisation process is commonly used in engineering to enhance the surface durability, corrosion resistance, and appearance of aluminium components. In this specific facility, aluminium parts are anodised using stainless steel tanks filled with 30% sulphuric acid maintained at a temperature of 25°C. these tanks require a secure lid to prevent the release of harmful vapours and to meet health and safety standards when not in operation. Currently, the tanks are sealed with a 5mm thick stainless-steel lid. While durable, this lid is heavy and cumbersome, requiring two people to lift it into place. This results in operational inefficiencies and potential injury risks due to poor ergonomics and manual handling.

2 Design constraints and legislation

2.1 Design Constraints

- Tank dimensions and material (Stainless Steel) must remain the same.
- The lid must not block vertical clearance, as aluminium parts are lowered in from above.
- The new lid must allow for safe and single person handling.
- New lid should be durable, corrosion- resistant and cost-effective to manufacture.
- Target production volume: low hundreds.
- Overall cost must be reasonable while ensuring safety and reliability.

2.2 Legislation and safety

2.3 Control of Substances Hazardous to Health Regulations 2002 (COSHH)

The anodisation process involves the use of 30% sulphuric acid, a hazardous substance under COSHH, employer must assess the risk associated with chemicals and take to control exposure. The redesign lid helps minimise acid vapour release, reducing the risk to workers health.

Key requirements under COSHH:

- Identify and assess health hazards.
- Implement control measures to prevent or reduce exposure.
- Monitor exposure and provide health surveillance if needed.
- Inform and train staff on chemical risk and safe practices.

2.4 Manual Handling Operations Regulations 1992 (MHOR)

The current stainless-steel lid requires two people to lift it, creating a risk of back injury or strain. MHOR requires employers to avoid hazardous manual handling tasks where possible or assess and reduce the risk.

Key requirements under MHOR:

- Assess unavoidable manual handling operations.
- Reduce the risk of injury through design, training, or mechanical aids.

2.5 Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)

LOLER applies where lifting operation or equipment (like hoists) are used. While the lid itself is not a lifting device, its design must not interfere with lifting operations. The lid must allow clear vertical access for safe hoisting of anodised aluminium parts.

Key requirements for LOLER:

- Equipment must be strong, stable, and correctly positioned.
- Lifting areas must be kept free of obstacles.
- Equipment must be clearly marked and regularly inspected.

3 Specification

The redesigned lid must be operable by a single person and compatible with the existing tank dimension. It should allow unobstructed vertical clearance for loading aluminium parts using a hoist. The lid must be made from lightweight, durable and corrosion resistant material to withstand exposure to 30% sulphuric acid vapours and daily industrial use.

Designed for low volume production (approximately one hundred units), the solution must be cost-effective and simple to manufacture. The lid should require minimal maintenance.

4 Concept

To solve the safety and handling issues of the existing tank lid, several design concepts were developed. Each concept aimed to improve usability, safety, and efficiency, while compatible with the current tank structure. The three main ideas included a hinged lid with gas struts, a sliding lid on rails and modular folding panels. These concepts were evaluated based on things such as ease of operation, manufacturing complexity, maintenance requirements and cost effectiveness. The most promising concepts are described below.

4.1 Hinged Lid and Gas Struts

Design overview: This concept uses a hinged lid mounted on one long side of the tank, assisted by gas struts like a car bonnet. The gas struts reduce the lifting force need and hold the lid open at a fixed position, providing a safe and controlled movement.

Features:

- Hinges welded or bolted to the tank.
- Gas strut mounted diagonally from the tank wall to the lid.
- Integrated manage to assist opening and closing.

Advantage:

- Simple, safe, and familiar to users.
- Require minimal effort to operate.
- Gas struts help hold the lid in place and prevent the lid from closing accidentally.

Disadvantage:

- Hinges must be securely mounted, which may require welding or bolting the hinges to the tank.
- The gas struts must match the lid's weight and may require replacement over time.

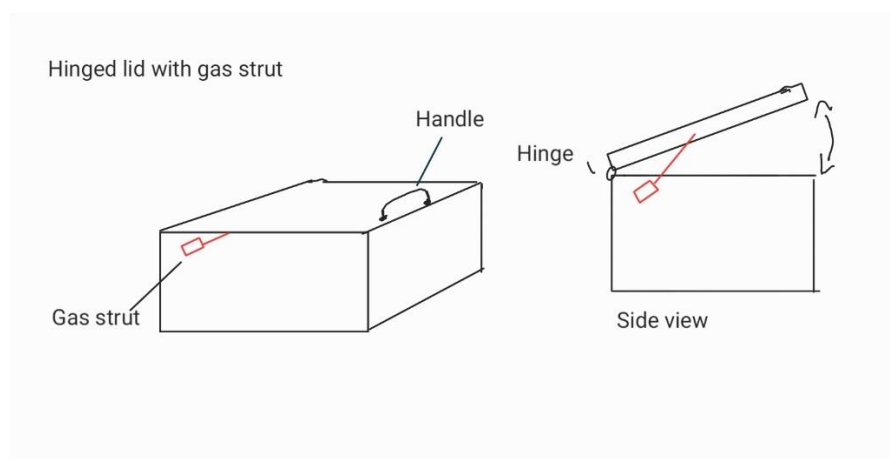


Figure 1. Sketch of hinged lid with gas strut concept (sketched by student)

4.2 Sliding Lid on Rails

Design overview: This concept involves a lid that slides horizontally across mounted rails along the sides of the tank. The lid could be one piece or split into two panels to reduce size and weight.

Features:

- Roller or sliding tracks system mounted to the tank edges.
- Panel slides from each the centre to each side.
- Can be stored in an open position without obstructing overhead access.

Advantage:

- Simple to operate and no vertical lifting.
- Ideal for operator with limited strength.
- Little space needed above the tank.
- Keeps overhead clearance free for the hoisting equipment.

Disadvantage:

- Rails system could collect debris or corrode, requires regular cleaning.
- requires more maintenance.
- More complex to manufacture.
- Takes up space around the tank

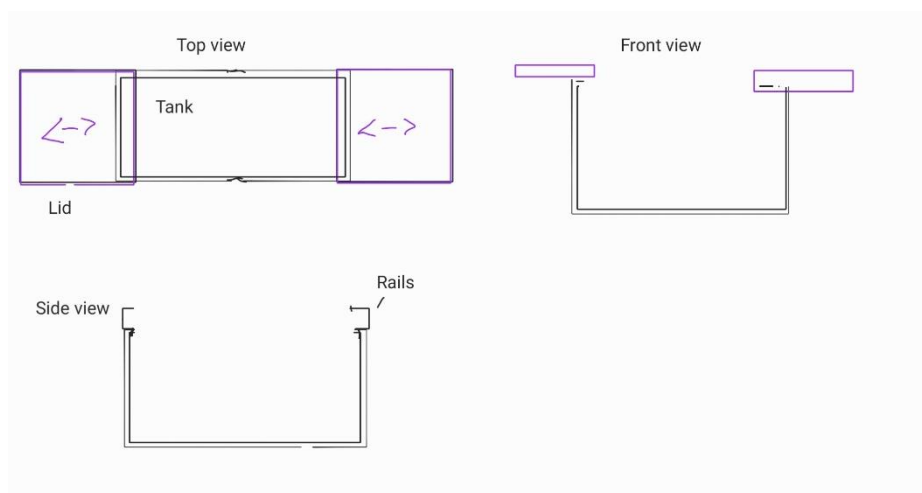


Figure 2. Sketch of Sliding lid concept (sketched by student)

4.3 Folding Panels

Design overview: This concept uses multiple panels that interlock or fold. Each panel is individually handled and placed onto the tank, reducing the weight lifted at one time.

Feature:

- Panels made from lightweight material such as Aluminium composite sheets.
- May fold onto each other or stored nearby when not in use.
- Interlock edges

Advantage:

- Lightweight and simple to fabricate.
- No mechanical parts that need to be maintained.
- Each panel can be replaced individually if damaged.

Disadvantage:

- Slower to operate, more effort needed to place or remove multiple panels.
- Panels need a place to be stored when not in use.
- Less convenient for frequent use of the tank.

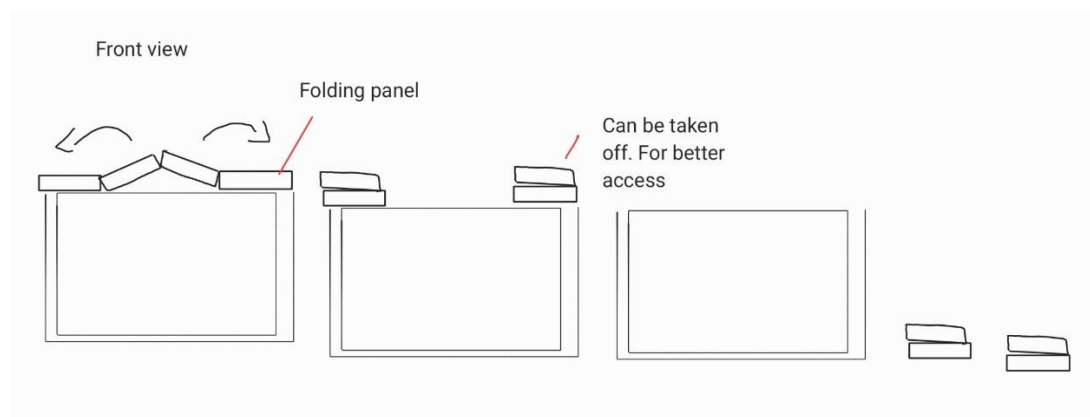


Figure 3. Sketch of folding panel concept (sketched by student)

5 Final Design

The final lid design features a 10mm thick aluminium composite panel (ACP), selected for its light weight, high strength, and its resistance to corrosion cause by sulphuric acid vapours. Its durability and ease of fabrication makes it a cost-effective choice for low volume production using standard workshop tools.

The lid is mounted using four stainless steel hinges, welded along one long side of the tank. It opens to angle of 80-90 degrees, providing full access to the tank while keeping clear of the hoisting equipment. This ensures safe and efficient operation during the loading and unloading of aluminium parts.

To assist with the lifting, two gas struts are mounted diagonally between the tank and the lid. These reduce the physical effort required, allowing safe single person operation and preventing the lid from accidentally closing. The struts are matched to the lids weight and can be replaced easily during routine maintenance.

Integrated handles are positioned at the front of the lid to allow ergonomic and comfortable handling. The lid can be opened smoothly and securely by one operator, reducing the risk of strain or injury.

Overall, the final design provides a safe, durable and effect solution that improves daily operation while meeting health and safety requirements.

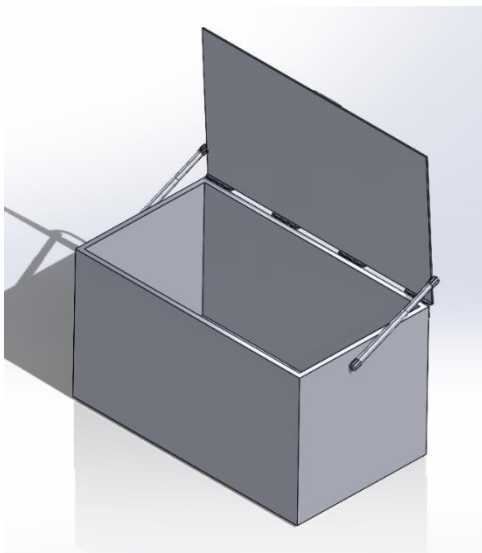


Figure 4. Isometric view of CAD assembly of final concept (created by student).

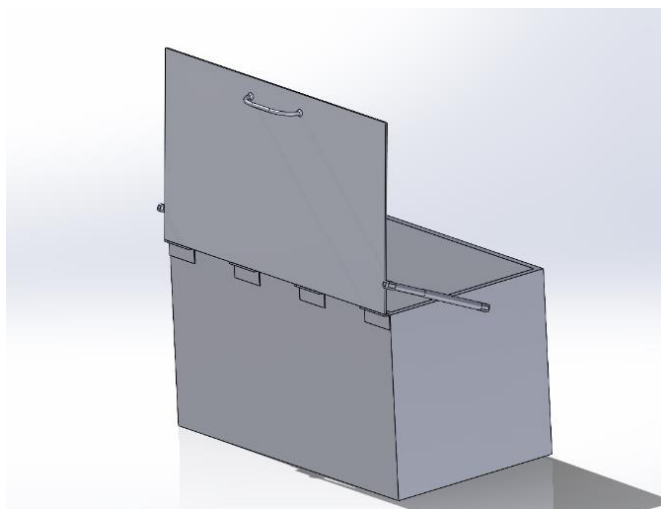


Figure 5. Isometric view of CAD assembly of the final concept from the back (created by student).

5.1 Technical drawings (BS8888)

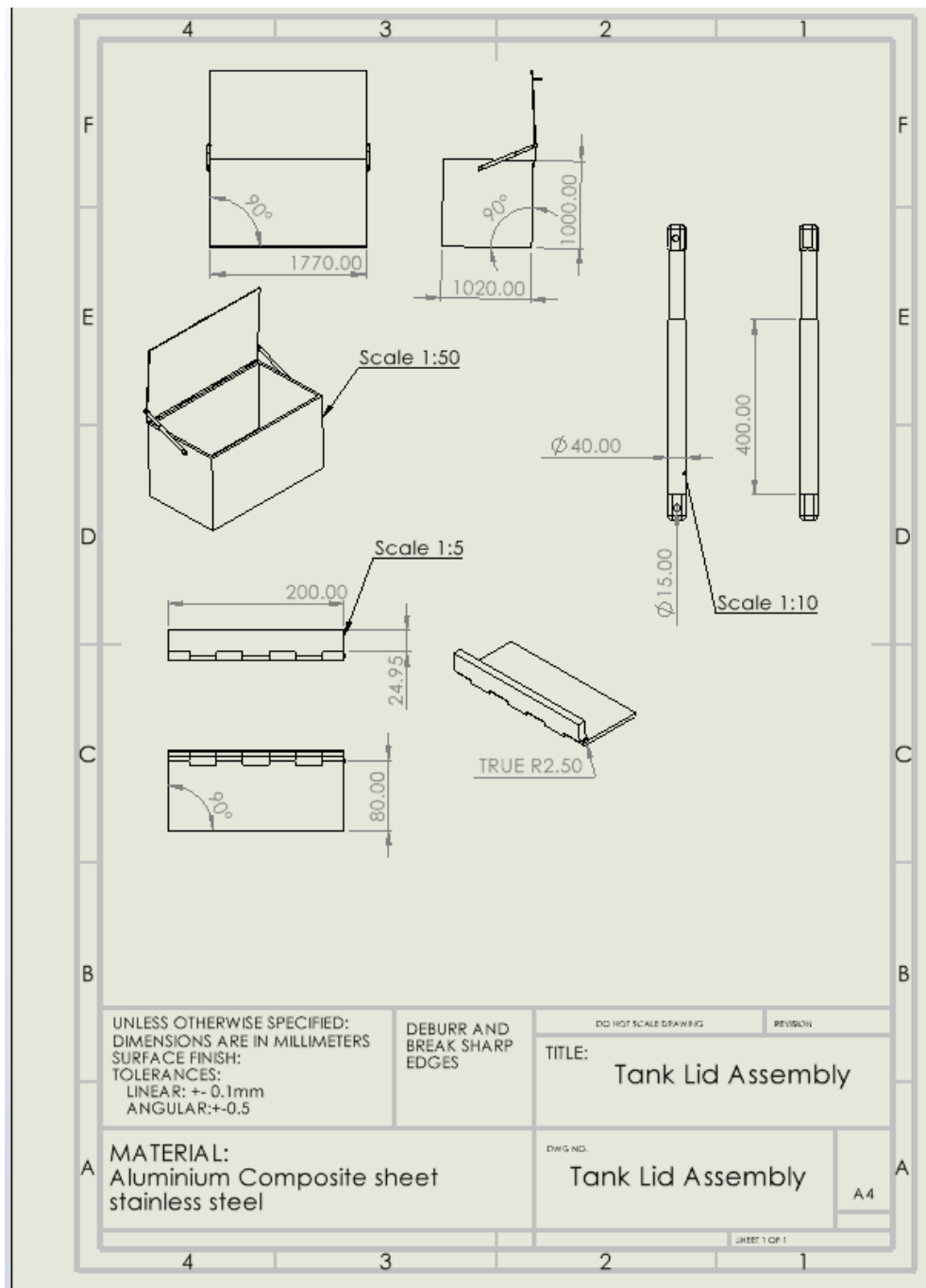


Figure 6. Technical drawing of final concept in accordance with BS 8888 (created by student).

5.2 Manufacturing and assembly process

Materials:

- Lid panel: 10 mm aluminium composite panel (ACP)
- Stainless steel hinges
- Gas struts
- Handle

Manufacturing and assembly process:

1. CAD Design and technical drawing
 - Finalises all dimensions and tolerances using SolidWorks or other CAD software.
 - Produce technical drawings for fabrication.
2. Panel cutting
 - Cut ACP sheet to exact dimension using CNC machine to ensure accuracy and clean edges.
 - Drill holes for handle.
3. Assembly
 - Install stainless steel hinges along one long side of the lid.
 - Mount gas struts between the lid and the tank, ensuring proper alignment.
4. Installation on tank
 - Secure the hinges to the tank by welding.
 - Attach the lid to the tank hinge.
 - Connect the gas struts and test movement.
5. Testing and quality control
 - Perform functional testing to confirm that the lid opens smoothly and stays open without support.
 - Check for any interference with hoisting operations.

6 Conclusion

the redesigned anodisation tank lid successfully meets the objective by improving safety, usability, and operation efficiency. The new hinged design, supported by gas struts, allows the lid to be operated safely by a single person, eliminating the need for manual two person lifting and reducing the risk of injury.

Using aluminium composite panels ensure the lid remains strong, durable, and resistant to corrosion in the acidic anodisation environment. The final design also maintains full compatibility with the existing tank dimensions, meaning that it can be easily implemented across multiple tanks without significant modifications.

This project demonstrates how practical engineering solution, even when its relatively simple can have an impact on workplace safety, efficiency and compliance, all while being cost effective and easy to manufacture in low volumes.

7 Evaluation

The final design shows a significant improvement over the original stainless-steel lid. The addition of the gas struts significantly reduces the physical effort needed. Addressing the key health and safety concerns complying with manual handling regulations. The placement of handles and the use of hinges allow for smooth and controlled lid movement by a single person.

Using aluminium composite panel provides a strong, corrosion-resistant, and lightweight solution, making it ideal for the anodisation environment. The design is both functional and economical, as it uses standard components and common fabrication techniques such as CNC cutting and welding, making it suitable for low-volume production.

Furthermore, the modular nature of the design makes it easy to maintain and adaptable to other tanks size or layouts. Components like gas struts and handles can be replaced individually, extending the products lifespan.

Overall, the final design meets the technical, safety and production goals of the project while offering a reliable and scalable solution for industrial uses.

8 Reference

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