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Engineering Problem

Engineering Design ACHA4001

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1 Introduction

In this report, a removeable cover for an adonizing tank has been reported as challenging to correctly place on and a health and safety officer states it is a risk to staff working with it. In its current design, the lid has to be operated by two members of staff and slides on top of the tank. A redesign of the lid is needed as the company has many of these tanks across different facilities.

There have been several factors taken into consideration for the redesign. The lid must be safe to operate and be able to be operated by one member of staff. The dimensions of the tank itself must remain the same, but modifications to the tank are allowed. However the tank lid can be overhauled, but there must be some clearance above to allow parts to be placed inside the tank.

2 Background

The original dimensions of the removable cover where 1770mm for the length, width of 1020mm and a height of 20mm. One each side of the lid there were two handles, each with a width of 300mm. The lid was also made up of a 5mm stainless steel plate.

Anodizing tanks are used to improve certain properties of materials, primarily Aluminium. These properties include wear and corrosion resistance, heat dissipation, adhesion and aesthetic purposes (*What Is The Purpose Of Anodizing? - Valence Surface Technologies*). The anodization process involves placing the materials inside of the tank, which is filled with 30% sulphuric acid and gets heated to 25 degrees Celsius.

Whilst doing research into other anodizing tank lids to see what other manufacturers offered, a few other designs were similar to the original lid.



Figure 1 - A stainless steel dip tank lid available from Teknomek

As seen in figure 1, this lid from Teknomek is quite similar to the original design. However, the two handles are placed on top of the lid instead of on the side which could make handling of the lid a bit easier, although there is still a large distance in between them. This tank lid also has a higher depth, which could help secure the lid to the tank more easily. The lid is made up of 304L-grade stainless steel which will keep the tank clean, and the material is robust and durable (*Stainless Steel Dip Tank Lid | Teknomek UK*).



Figure 2 - A tank lid available from Raptor Supplies

A different approach can be seen in figure 2. Instead of the lid sliding on with two handles, the lid is bolted to the tank by several bolts. This would mean the lid would be firmly secured and should be slightly easier to place on top of the tank. However, some modification to the tank itself would be needed to accommodate the bolts.

Key legislation also needed to be looked at before designing the new tank lid. A lot of the legislation is to do with the environmental agency. For example, there are restrictions on how much chemical fluid can be stored. Also, there are rules on finishing to remove rust on the tanks or using heat scale before chemical preparation (*How to Comply with Your Environmental Permit Additional Guidance for: The Surface Treatment of Metals and Plastics by Electrolytic and Chemical Processes (EPR 2.07)*).

After these factors had been analysed, it was time to move onto the design process.

3 Design

After looking through other anodizing tank lids, three sketches were drawn up of potential designs.

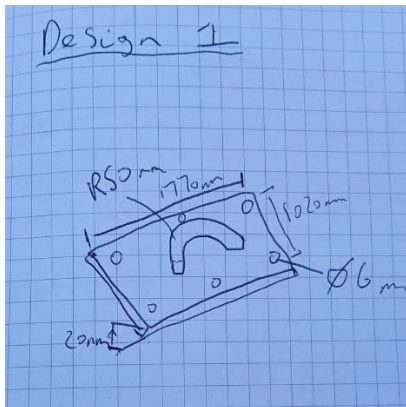


Figure 3 - Sketch of design one

As seen in figure 3 is the sketch of the first design. In this sketch, the overall length, width and height remain the same from the original design. However, the top of the lid has been modified. There is a singular handle which is 100mm in diameter and has been placed in the middle of the lid. Also to help the lid be secured to the tank there are 6mm drilled holes. This means the lid can be bolted to the tank to be secured. This will improve safety when securing the lid.

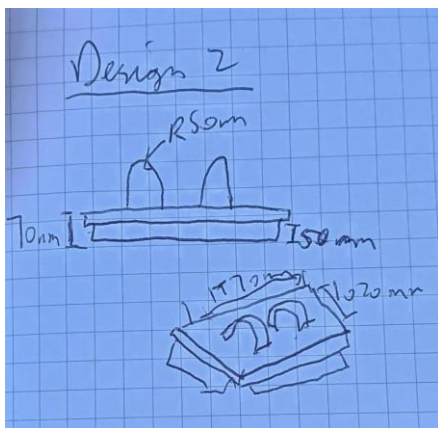


Figure 4 - Sketch of design two

As seen in figure 2 is the second design. In this design, there have been two handles added to the top of the lid, each with a radius of 100mm. They have been located in the middle to help with lifting the lid onto the tank meaning only one person should need to lift it. The length and width of the lid remains unchanged, however there has been a lip of 50mm added underneath to help secure it. The lip is this depth to make sure it does not interfere with the materials that get placed inside of the tank.

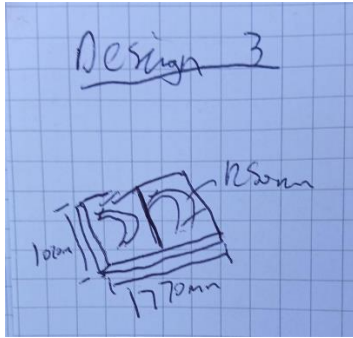


Figure 5 - Sketch of design three

As seen in figure 5 is the third design. In this design, the lid has been split into two parts with a handle placed in the middle of each section. Each section of the lid is 885mm in length with a width of 1020mm. With the lid split into two sections, this makes the task of lifting the lid onto the tank much easier. This design may be the easiest to mass produce, as both the section are identical and smaller than the other designs. This means that all the other sites at which these tanks are used can get this design made and sent to them quicker than the other two.

After reviewing the three designs, the choice was made to pursue with design number two. The sketch was then made in SolidWorks as a CAD model. After the CAD model had been produced, an engineering drawing was made.

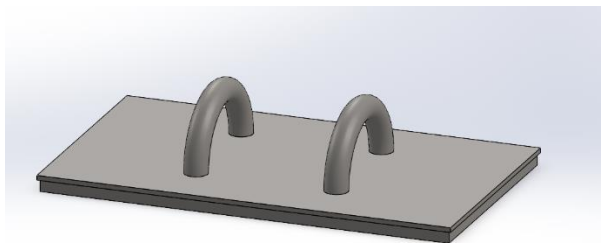


Figure 6 - CAD model of design two

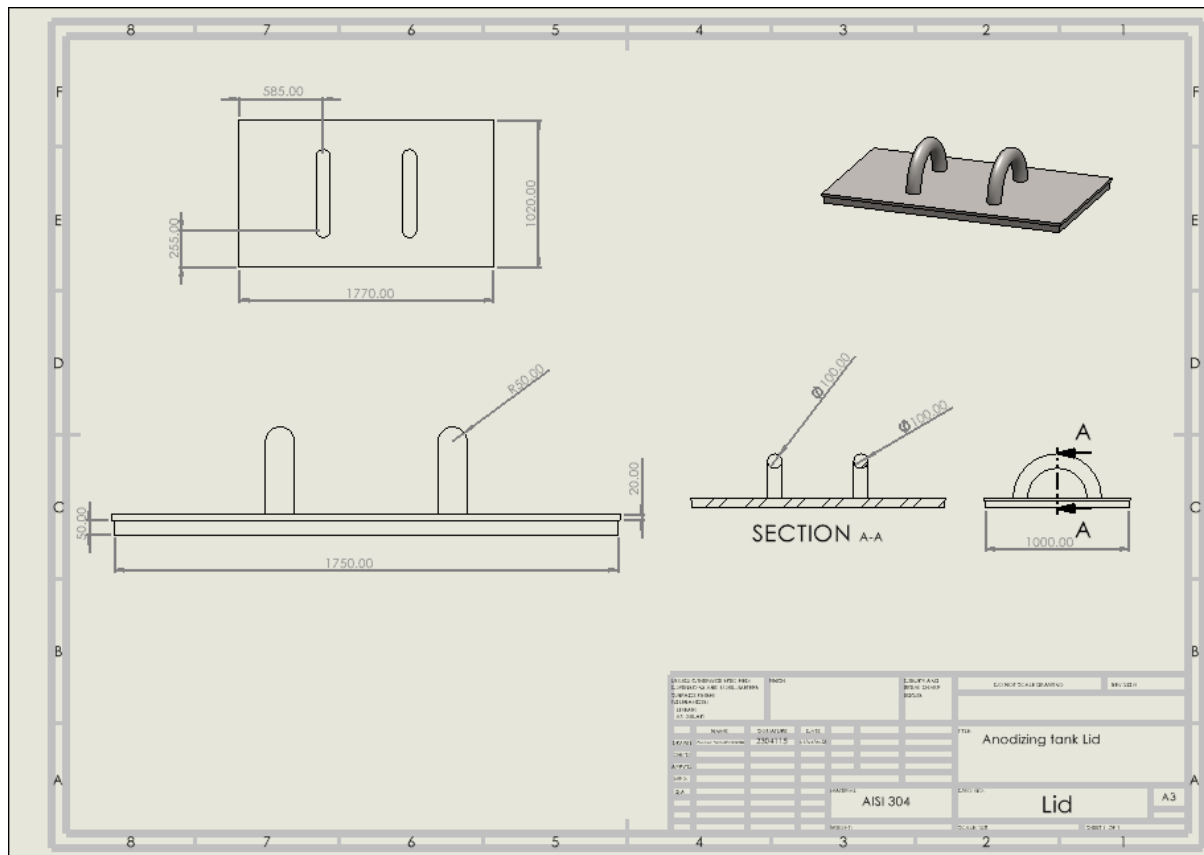


Figure 7 - Engineering Drawing of design two

As seen in figure 6 and figure 7 is the final design of the lid. The lid remains with a length of 1770mm and a width of 1020mm, however the height is now 70mm instead of 20mm. The extra 50mm comes from the base plate which creates a lip at the edge of the lid. The base plate has a length of 1750mm and a width of 1000mm. This helps secure the lid better than sliding it on as it can be lifted into place and adjusted once a slight bit of the lip is in, improving the challenge of placing it and should improve safety. The two handles each have a diameter of 100mm and are located 585mm from the vertical sides of the lid, and each side of the handle is 255mm away from the horizontal sides, once again removing the need of having a second person help lift it. The lid itself is made from 304L-grade stainless steel. This material was chosen as it has good corrosive resistance against chemicals, including sulphur which is the chemical used in the tanks. It also has good resistance to atmospheric corrosion (Stainless Steel Type 304-304L - Rolled Metal Products | Stainless, Aluminium & Specialty Alloys). 304L-grade stainless steel also has a tensile strength of 500-700 MPa and good thermal and electrical conductivity, which is vital in the application of the lid (Stainless Steel 304L - 1.4307 Data Sheet). After this, an assembly of the anodizing tank was made in SolidWorks to see how the new design of the lid would fit.

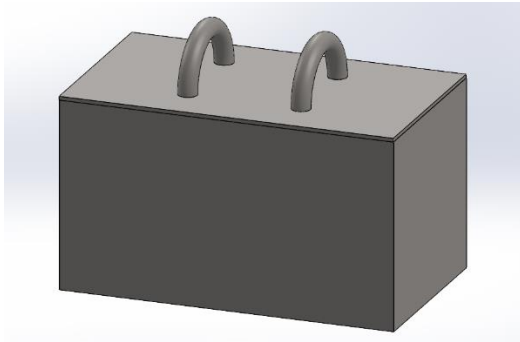


Figure 8 - CAD model of the anodizing tank with the redesigned lid

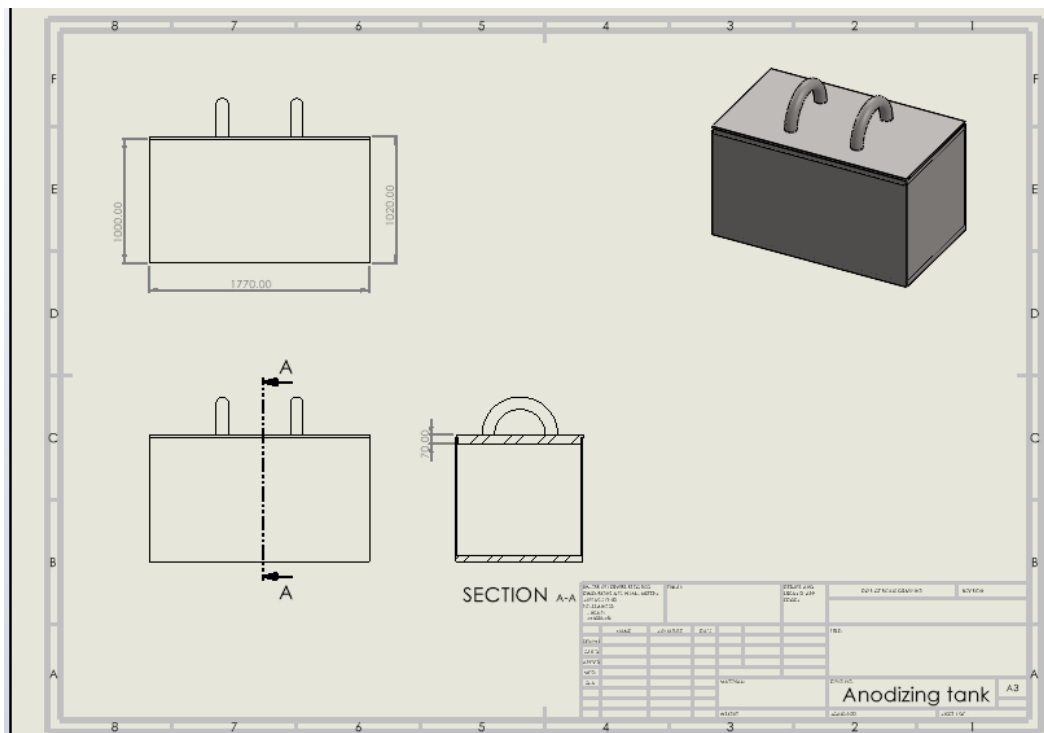


Figure 9 - An engineering drawing of the anodizing tank with the new lid

As seen in figure 9, the added depth of the lid helps secure it to the tank and in theory makes it safer to place on. The next steps were to consider how to manufacture this new design.

In terms of manufacturing the lid, there are a couple of different methods that can be used. One way the new lid could be manufactured is by modifying the old lid. Welding is a useful method as it creates strength and durability between two parts of the lid. The precision of welding makes the joints near perfect and makes it strong and secure. As the company will already have the lids, it means that the only material needed to be bought is the new base plates, which saves a lot in terms of cost rather than paying for a whole new lid to be manufactured through a different process (The Advantages Of Welding | Proweld UK).

Another way the lids could be manufactured is through casting. This is an effective way to mass produce the lids and there is little waste. Casting would be a good option as the lids are made out of stainless steel as it helps with certain properties such as corrosion resistance. However, this will likely need to be done by another company as setting up a casting jig is very expensive and would increase the costs exponentially.

4 Conclusion

In conclusion, the overall time it should take for the product to be produced should be between one and two months. The method of manufacturing likely to be chosen would be welding, as the cost of it is much less than casting and as the new design is similar to the old one, it would scale down the time frame a lot more. By moving the handles to the middle of the lid, it should mean staff operating the tank should find it easier to initially place the lid on the tank, with the extra depth making it simpler to place down.

Further work could include adding a rubber seal around the outside edge of the lid in between the lip and the seat of the tank. This would further assist in the ease of securing the lid to the tank as the lid would sit better on top thanks to the seal.

5 References

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