Parabolic Trough

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Team 14

Tracking system
Document

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Introduction (Saad Almonnieay and Jairo Rivera)
Currently, the parabolic trough tracking system is inoperative. The team's goal is to bring the tracking system for the parabolic trough back into service. Our team has delivered information about solar energy in general, variety of tracking systems, defined the problem for our project, environment testing and planning the project using both a quality function deployment and gantt chart. After our team completed the problem definition and project planning, we did not proceed to the concept generation and selection stage since the parabolic trough is already built. The parabolic trough has physical damage to the parabolic surface as well as inoperative and missing tracking components, which are necessary to conduct an effective energy extraction. The team's first milestone was to determine the extent of the damage and replace/repair missing or inoperative parts.

Tire Information (Jacob Seitzer)
In its current state, the parabolic trough is stationary due to the condition of the tires and wheels. Eventually the trough will need to be removed from the solar-shack in order to have a suitable working and testing environment, so these issues must be fixed. Each tire is deflated, as seen in Figure 1, and the conditions of the wheels are unknown, but most likely they are unable to be reused. As a result, new tires/wheels were ordered.

Figure 1-Current State of Wheels

Based on the tires that are currently on there, it was found that they are Marathon 20011, 4.10/3.50-4, 4 ply,with a 10.5" Diameter. The load capacity for these tires is 300 lbs, which indicates that the trough must weigh less than 1200 lbs. The cost of each wheel and tire is about $14.50, giving a total of $60.00 before shipping.
From the information gathered on the current wheel/tire assembly, new parts have been ordered to replace them. Each wheel will have to be removed and replaced one at a time using a hydraulic-jack for each corner because the height and weight of the trough. The new wheels/tires are currently being shipped and will be arriving soon. Once the parts have arrive, installation of the new wheels/tires will begin so the trough can be moved to a more suitable working and testing environment.

Chain Information (Christopher Mesko)
When researching chains, the specifications needed were the length, pitch, and roller width. We measured the length using a tape measure around the large sprocket, seen in Figure 2, and small sprocket (not pictured). The measured distance our team found was 75 inches or 6.25 ft. From McMaster-Carr, the chain lengths are rounded up to the nearest foot. Therefore, the chain length we need is 7 feet. Also, we measured the pitch and roller width needed with a tape measure. The values we came up with are ⅝ in pitch and ⅜ in roller width. With these values, we came back to McMaster-Carr's website and found the ideal chain for our scenario. The chain we purchased is a standard steel ANSI 50 roller chain and links, with a pitch of ⅝ in and roller width of ⅜ in. This chain has a working load limit at 561 lbs and costs $5.98 per foot leaving us with a total $41.86 before shipping.

Figure 2: Big Sprocket with missing chain

Gearboxes (Daniel Chief and Saad Almonnieay)
One of the team's tasks was to check the interior of the gearbox to determine the condition of the parts by removing the rust and oil from assembly. We started the process by disassembling the gearbox part, which contains an upper and lower level gearbox.

The upper level gearbox is connected to the motor which can be seen in Figure 3. The motor shaft and the worm gear is secured together by a rectangular key. After disassembling the cover plate we found that the lubricating oil turned black, the original color of the lubricating oil was golden. There was minimal amount of oil left in the upper level gearbox, since the system has not been operated or maintenance over 15 years. Most of the lubricating oil drained down to the lower level of the gearbox. The interior surface and the worm gear holding the horizontal shaft show some rust.

Figure 3: Motor connected to the upper level gearbox

Figure 4 shows the helical gear secured by a bolt and a washer has some rust and will be replaced. The helical gear has minimal rust but can be cleaned by a wire brush. However, the shaft was able to rotate, but we still to decide if it can work efficiently in the near future.

Figure 4: Upper gearbox with the cover off

The rubber gasket has stretched and deteriorated from the weather of Flagstaff. The gasket will need to be replaced before the system is put back online. The defective gasket was the cause of the rusted parts in the upper level gearbox which are pictured in figure 5. Moisture and condensation found its way through the gasket and the addition of minimal lubrication oil, the results was rust. There is a possibility that the cover plate will need to be replaced, but until it has been cleaned and tested, the team will make its decision. The six bolts securing the cover plate will be replaced. The pink, once red in color, filler cap is made of plastic and will be a group decision if it needs to be replaced. The drain plug located on the upper level gearbox is in good working condition.

Figure 5: Upper gearbox cover

After disassembling the side cover mounted to the gearbox to observe the interior of it. We found that it contains a vertical worm gear connected to the vertical shaft that rotates a helical gear in the same shaft located at the upper gearbox. The worm gear is connected perpendicularly to another helical gear located in the horizontal shaft that rotates the outer small sprocket. The vertical gear coming down has a roller ball bearing attached to it. As seen in figure 6 the bearing sits between the upper level gearbox and the lower level gearbox to reduce friction and secure the vertical shaft. The roller ball bearing and the vertical shaft are in good condition. This is due to the lubricating oil protecting the parts from condensation and moisture.

Figure 6: Vertical worm gear connecting the upper level to the lower level gearbox.

The sprocket and shaft assembly from the lower gearbox is in good condition. The assembly was also protected by the lubricating oil. The shaft assembly is made up of taper bearing, helical gear, spacers, shaft and a sprocket at the end, figure 7.

Figure 7: Sprocket and shaft assembly

Overall, the upper level gearbox and the lower level gearbox are in good condition. The team will reuse the gearbox. After a good cleaning the worm gear and other parts can be further inspected.

Motor Assembly (Jacob Seitzer and Christopher Mesko)

The motor, figure 8, used in this tracking system did not come with any documentation, so our information we have on it is based off observations after disassembly, and what the experts at US Bearings and Drives have told us. The motor is a DC motor because of the brushes that go over the vertical shaft. From the experts at US Bearings and Drives, we got an estimated horsepower of 1-2 HP and an estimated cost for the motor itself of $200-300. From opening the gearbox and testing the gear ratio, we came up with 292 revolutions of the motor will turn the small sprocket one full revolution. The next step would be to solve for the required torque of the motor which will be possible when we calculate the weight of the parabolic trough.

Figure 8: Uncovered Motor

The current motor is not in working condition, and will have to be replaced. We can replace the motor once we solve for the specifications of torque, power, and rpm of the motor.

Conclusion (Robert Blaskey)

The parabolic trough's current condition is inoperable and not mobile. The analysis of the tires, chain, and gear box assembly will change the condition. Once the tires are acquired, the new tires will be put on and the entire will be mobile. The location of the trough will be moved from within NAU's energy yard to outside the gated area. This will make it easier for the group to work on the trough more often. The chain will be installed once the motor is replaced and the gear box assembly is put back on the trough.

The cover plate and gasket on the top gearbox needs to be replaced. The cover plate may be reusable, but the gasket is in poor condition. The biggest obstacle has been the motor. There was no documentation left behind for the parabolic trough and no serial numbers left on the motor itself. In order to find a specific motor, the gear ratio, torque, power, and angular velocity needed to be found. The power required to track the trough can be assumed to be between one and two hp. Once the group can finalize a sustainable torque then we can order a specific motor for the entire assembly. The next step is find a motor and control box. The current control box is set to operate the trough manually. The team is seeking out a more update control box that can be ordered along with the motor. The control box needed is to have capability to program the trough to track. Once these parts are ordered or installed, we can concentrate on repairing the parabolic surface.

References (Jairo Rivera)

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