Robogals Science Challenge

Minor Challenge Set #2
STEM Field: Chemical Engineering
Level: Senior
Challenge Name: Copper Plating
Project cost: 0-20 USD
Materials required:

- Water
- Bucket or sink
- Glass jar (jelly or canning jars work well)
- 25 pennies, euros, or any coin with copper coating, or any item with copper coating
- Other coins, iron nail or screw, aluminium bolts
- Salt
- White/clear vinegar (although lemon juice, or orange juice can be substituted)
- Baking soda
- Scouring pad
- Metal paper clips

Safety:

- Use a well ventilated area

Duration:

- About 45 minutes of hands on activity
- The final drying of the pennies takes about 3-7 days
- The hands-on time for this challenge is about 45 minutes.
- The time guideline is an estimation only, and students and mentors can complete the tasks around their schedules.

Introduction:

The older, dirty looking pennies are not shiny as they are covered in a layer called copper oxide. This copper oxide layer can be dissolved when exposed to an acid solution resulting in clean, shiny looking pennies. If the acid solution is left on the pennies as they dry they will turn a blue-green colour. This is the result of the exposed copper atoms reacting with the salt left on them and the oxygen in the air to form a malachite.

The iron item will end up with a very thin layer of copper coating it. This happens because some of the copper is dissolved in the acidic solution. When the copper is dissolved, the atoms leave two of their electrons in the penny resulting in the free atoms having a positive charge.
Some iron atoms are dissolved in the solution as well but those only leave one of their electrons behind so they have a weaker positive charge. These left behind electrons result in the piece of iron having a negative charge.

The copper atoms are more strongly attracted to the negatively charged piece of iron as they have a stronger positive charge. This results in a thin coating of copper atoms on the piece of iron.

Instructions:

1. Clean the non-galvanized iron item well using either an old sponge (one not used for cleaning food surface) and baking soda or by scrubbing it with a steel wool pad

2. Fill a glass jar with 0.5cup (or 125mL) of white vinegar (or substitute) and add 0.25 teaspoon of salt. Mix the solution well to combine.

3. Add the older/dirty pennies (or your high copper content material) to the vinegar solution and wait 5 minutes.

4. Add the cleaned iron item and let it soak for about 15 minutes.

5. What happened to the pennies? And to the piece of iron?

6. Now clean half the pennies well while letting the others air dry for a few days without being cleaned. How do the two groups differ?

Extension:

1. Do some research to see what other process you could use to create a copper layer on the piece of iron.
2. What happens if you speed up the drying process by using your oven at a low temperature? Do some research to determine why this is the case?

Reflection Questions:

- Are there any improvements you would make to this challenge?
- What real world application/s can you apply this challenge to?
- What are the key science and engineering concepts that relate to this challenge?

- What are some industries that use a process like this to coat materials in a thin layer of another material?
- What are some benefits of this process? And what are some disadvantages?

Submission Guidelines:

- Submit a photo of your experiment setup. Include a short summary that addresses the reflection questions.

> Note: Remember, if you want to upload pictures of your Minor Challenge that also include you, please check if it is OK with your mentor first.

- The submission form is on the Minor Challenges page: https://sciencechallenge.org.au/index.php/minor-challenges/ Fill out the details and make sure you upload your submission.

Learn More! Resources:

- To learn more about how copper plating works and some common applications out the link below: https://www.rapiddirect.com/blog/copper-electroplating/

Bibliography:

- IEEE (no date) *IEEE Lesson Plan: Can you copperplate? - tryengineering.org powered ...*, *UC Riverside*. Available at: https://tryengineering.org/wp-content/uploads/copperplate.pdf (Accessed: April 5, 2023).