Bringing Back the Shine to Copper

Introduction

Copper has been a very important metal in the evolution of human civilisation. In history books, we have read that extraction and use of metals led to the end of Stone Age. Use of metal tools started with copper from roughly 5000 BC. The use of copper was known in almost all sites of ancient civilizations like the Egyptian, Chinese, Mesopotamian, Native American, and Indian. In India, several ancient copper tools, coins, and weapons have been found, which tell us about the flourishing copper industry in ancient India. Some notable examples are the hoards found in the Gungeria village (Madhya Pradesh), the huge copper statue of Buddha discovered in Sultanganj (Bihar) (dated between 500 and 700 CE) and the copper plates of Kalachuri dynasty (12th century CE, Karnataka). The modern era of copper industry in India started in 1967 with the formation of Hindustan Copper Limited by the Government of India. Many regions of India have deposits of copper minerals, from where it is mined.

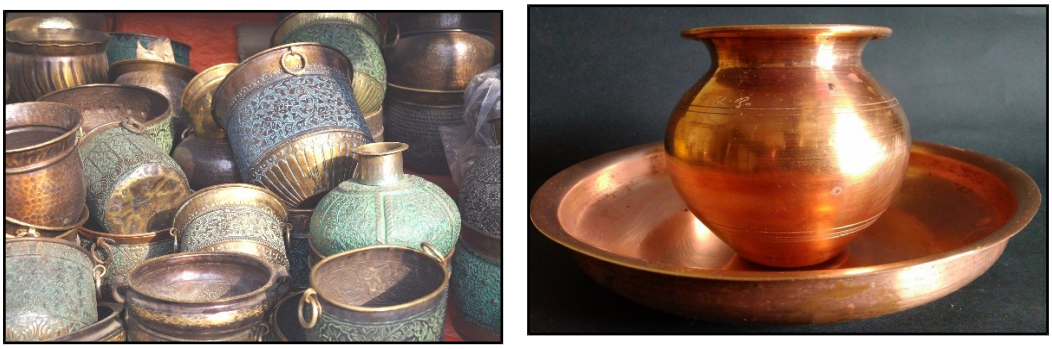

Image 1: *Household copper vessels*

Today copper finds its uses in telecommunication, electrical wiring, transport, utensils, construction, etc. In our homes, copper objects are used as wires, utensils for storing water and for eating, etc. However, due to a particular problem with copper, its use has been decreasing in our lives. This unit relates to the problem of copper that has caused the decline in use.

Image 2: *Statue of Buddha discovered in Sultanganj, Bihar (left); Copper plates of Kalachuri dynasty (right)*

Materials

Task 1*:* Small-sized tarnished or dull copper items (plates/strips), vinegar, baking soda, lemon juice, common salt, tamarind (*imli*) juice, liquid detergent, detergent powder, coal or wood ash, curd, and sand paper (zero grade).

Task 2: Tarnished copper plates/strips, hand gloves, used toothbrush, watch glass/ saucer,

droppers and small spoons/spatulas, water. Three or four of these cleaning agents: Talcum powder, baking soda, detergent powder, sand (or white rangoli powder), dry soil, common salt, ash.
Task 3: Solid cleaning agents used in Task 2, used toothbrush, watch glass/saucer and any two or three cleaning agents from this list: vinegar, lemon juice, curd, tamarind (*imli*) juice.
Task 4: Three to four of each of the solid and liquid cleaning agents (as used in tasks 2 and 3), litmus papers (red and blue), turmeric powder or turmeric paper, watch glass/saucer), droppers, and small spoons/spatula.

Task 1: Recollecting what we know

Q1. What copper objects have you seen in your home and your surroundings?

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Q2. What are the colours of their surface?

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In countries like India, with a hot and humid climate, copper objects get easily tarnished, making them look dull and unattractive. Pollutants in the air also increase the tarnishing. Surface tarnish leads to large losses in business for the traders and the economy. Therefore, cleaning of the surface tarnish of copper (and other metals) is a need in many professions. In this Learning Unit, we will try to clean such dull/tarnished copper utensils using some common household materials, and learn the science behind this process.

Take a small copper object or strip.
Q3. What is the colour of its surface?

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_____

Rub the surface using sand paper (zero grade).

Q4. What is the colour of its surface now? Has it changed on rubbing with sand paper? What property of sand paper is responsible for it?

_____

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_____

Q5. Is any copper lost in this process?

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_____

Now, keep this shining copper object near a sink or in a chemistry laboratory near where chemicals are stored. After two-three days, you will use this in task 2.

Q 6. What substances have you seen being used for the cleaning of copper objects/utensils?

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Q 7. Table 1 lists some substances. Before performing any trial, guess which of these substances can clean the tarnished copper objects and why (because it dissolves many impurities/has lot of solid particles/is soapy to touch/produces a lot of foam/any other reason)?

Table 1 *Predicting the action of different substances on copper*

Substance	Will it clean? (Yes/No)	Why do you think it will clean copper?
Vinegar		
Baking soda		
Lemon juice		
Common salt		
Tamarind juice		
Liquid detergent		
Detergent powder		
Coal or wood ash		
Curd		

Now, let us find out whether our guesses are correct. The following tasks (Tasks 2 and 3) can be performed in groups of 3-4 students.

Task 2: The action of solid cleaning substances on tarnished copper

Q 1. After two-three days, did you observe any change in the surface of the copper object you cleaned in task 1?

_____

_____

Safety Measures!

DO'S

✔ Use hand gloves to cover hands when performing the task.

✔ Use the cleaning substances carefully and in the amount mentioned in the instruction.

✔ Use only toothbrushes (or similar scrubbing tool) for rubbing.

✔ Make sure to wash hands properly with water and soap after performing the activities.

✔ If any student's hand is itching, wash it with water immediately.

DON'TS

✗ Make sure you do not spill the cleaning agents on the skin, clothes, or on the table.

✗Do not touch any part of your eyes, lips, mouth or nose, when using the cleaning agents.

Procedure

Add 1/3 of a small teaspoon (approx. 0.5 g) of the selected cleaning substance to a small area on the plate/strip and rub the substance gently using a toothbrush for a minute.

Note: At a time, apply only a single cleaning substance on dark/tarnished spots of the

copper surface. If there is no change, the same plate/strip can be cleaned with a tissue paper/cloth and then washed with a little water to remove the previous cleaning agent before performing the next test. If there is a change, then another plate/strip or unused area of the same plate should be used to perform the next test. After performing a test, the tooth brush should be kept dipped in water and then dried before using it again, to prevent cross contamination.

Table 2 *Results of using (dry) solid cleaning agents on copper surface*

Solid cleaning agent	Observations (Cleaned/Not cleaned/Scratches formed/Other)

Q 2. Which of the solid cleaning agents removed the tarnish?

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Q 3. Did you observe any scratches on the tarnished surface for any of the cleaning agents? What do the scratches tell you about the nature of the cleaning agent?

_____

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Q 4. Is rubbing of a solid substance on a copper surface a physical or a chemical action?

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Task 3: The action of liquid cleaning agents on tarnished copper

Each group may take the solid agents used in task 2 and prepare their pastes by adding a few drops of water to each. In addition, take two to three cleaning agents from this list: vinegar, lemon juice, curd, tamarind (*imli*) juice.

Take some water, and the various liquid cleaning agents in watch glasses or in saucers. Dip the tarnished copper object in the cleaning substance and observe for 2-3 minutes. If no change is observed on the surface, then use the toothbrush to gently rub the copper surface (clean the brush under water after every use). Note down your observations (colour change/evolution of gas/any smell) in the table given below.

Note: If the copper item is big, then a small area can be used for testing. In that case, about 0.2 mL or 5 drops of the cleaning agent can be applied on the copper surface for the testing. If no change is observed, then the same copper object can be used for trying the next cleaning agent after cleaning the area with water, else another object or an unused area of the object may be used.

Table 3 *Results of using cleaning agents (with water) on copper surface*

Cleaning agent	Observations	
	Dipping the surface in the liquid/solid-water paste	Rubbing the surface with liquid/paste and toothbrush
Water		

Q 1. From your observations, which of the cleaning agents cleaned your plates/wire strips?

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Q 2. To clean the copper surfaces, was it necessary to rub the surface in all cases?

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Q 3. Which of these cases of cleaning the copper surface involved a chemical change?

_____

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Task 4: The acidity/basicity of the cleaning agents

Let us see if the acidic or basic nature of a cleaning agent affects its cleaning action for copper tarnish. To understand this, we need to know the nature of the cleaning agents that cleaned the surface without need for a physical action and compare it to substances that did not. We will check this with the help of indicators.

For solid cleaning agents, take 1/3rd of a small teaspoon or ice cream spoon (approx. 0.5 g) of the cleaning agent in a watch glass or in a saucer, and add 2 mL of water to it. For liquid cleaning agents, take about 5-6 drops of the liquid on a watch glass (or in a saucer). Dip the blue and red litmus papers one after another in the liquid cleaning agent. Note the colour change of litmus papers in the observation table. If liquid indicators are available, then add 2 drops of one of these in the cleaning solution in the watch glass. Note the colour change of the indicator in an observation table.

Note: Wash your hands thoroughly with water before and after using each indicator

Table 4. *Acidic/basic nature of cleaning agents*

Cleaning agent	Red litmus	Blue litmus	Turmeric paper/other indicator	Conclusion: Nature of cleaning agent (acidic/ basic/ neutral)
Lemon juice				

Q 1. Based on your observations in tasks 2, 3, and 4, can you say if the acidic/basic/neutral nature of the cleaning agent has some role in the cleaning of the tarnished copper utensil/wire strips?

Yes _____ No_____

Q 2. What can you conclude about the cleaning mechanism of the agents based on all the tasks?

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Q 3. Based on the above tests, can you say whether the nature of the tarnish in the copper utensil is acidic/basic/neutral? Give reasons for your answer.

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Q 4. What kind of waste is produced in cleaning copper by the agents you used? Is any of this harmful to nature?

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Q 5. Did you have any unusual findings or observations in the above three tasks?

_____

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_____

Q 6. Which of the following food substances **cannot** be stored in copper utensils? Why?

Buttermilk, common salt, pickles, tamarind chutney, rice,.....

Add a few more food items to this list.

Can be stored	**Cannot be stored**	**Not sure**
	Buttermilk	
	Pickles	
Rice grains		

Q 7. Why do you think the use of copper utensils in households has decreased in our households over the years?

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Tarnishing has led to discolouration in many historical monuments and artifacts in the world. One of the classic examples of copper tarnishing is of the Statue of Liberty, New York (USA). This statue has a core structure of iron, with copper sheets on the surface. It was gifted by France to USA in the year 1886 and has been an icon of freedom. The statue has long lost its original copper colour and has gained different colours over the decades, presently having a greenish blue colouration on the surface.

It is almost impossible to guess that this statue might be made of copper from its appearance/look.

Image 3: *Statue of Liberty and its transition from the original (an artist's reproduction of how it would have looked like in 1886, left) to its transition state (middle) to the latest image (right)*

References

For further reading on cleaning of copper surfaces, the following readings may be helpful. These use copper coins (pennies in the USA) with various cleaning substances.

- Rosenhein, L. D. (2001). The household chemistry of cleaning pennies. *Journal of Chemical Education*, *Volume 78*, No. 4, p. 513.
- Cynthia L. B. (2008). *Amazing kitchen chemistry projects: You can build yourself.* Nomad Press.
- O'Hare, M. (2007). *How to fossilise your hamster: And other amazing experiments for the armchair scientists*. Profile Books Ltd.
- Information about historical uses of copper taken from IACS Institutional Repository.

Image sources

- Image 1: (Left)- pixabay.com/en/utensils-copper-utensils-cooking1457356/, (Right)- Chitra Joshi (HBCSE) (Creative Commons license).
- Image 2: (Left) https://commons.wikimedia.org/wiki/File:Sultanganj-budda.jpg temple-copper-plates, (Right) www.archaeology.org/news/591-130220-india-karnataka-temple-copper-plates
- Image 3: (Left) izmodo.com/what-the-statue-of-liberty-looked-like-in-1886-5800568); (Middle and RIght) www.iflscience.com/chemistry/the-true-color-of-the-statue-of-liberty-and-it-isnt-bluegreen/