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## IMPACT OF THE SHAPE OF THE BOTTLE ON THE EFFECTIVENESS OF COOLING AND WARMING OF WATER

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GRADE 5 SISHU GRIHA JUNIOR SCHOOL GENESIS OF THE PROJECT


The quest for eternal supply of cold water.


Which could be the ideal bottle shape to hold cool water for longer duration?


Also, does the same shape meet both the requirements?


## METHODOLOGY

- Literature survey to study the present practice
- Customer feedback for the project.
- Select plastic bottles of different shapes (round, square, decagonal, octagonal and rectangular)
- Estimate the surface area of the bottles
- Experimentally study the rate of cooling in the refrigerator
- The rate at which water gets warmer outside the refrigerator with the help of a mobile timer and digital temperature measuring instrument



## METHODOLOGY

- Analyse the data for observing cooling and warming trend with change in shape of the bottles
- Demonstrate the concept and the findings to the customers



## CALCULATION OF SURFACE AREA

## Octagonal Surface Area

One side was measured using a sheet of Adhesive Paper which was measured using a scale and cut accordingly. Then it was multiplied into 8 . Total Surface Area= Surface area of one strip x 8

$$
\begin{array}{r}
=22 \mathrm{~cm} \times 3.3 \mathrm{~cm} \times 8 \\
=72.6 \mathrm{~cm} \times 8 \\
=580 \mathrm{sq} . \mathrm{cm}
\end{array}
$$



## CALCULATION OF SURFACE AREA

## Round Surface Area

The surface area of the bottle was found by Wrapping it with a sheet of paper and measuring its length and breadth Length of the sheet $=19.2 \mathrm{~cm}$
Breadth of the sheet $=24 \mathrm{~cm}$ Surface

$$
\begin{aligned}
\text { area } & =19.2 \times 24 \\
= & 460.8 \mathrm{sq} . \mathrm{cm}
\end{aligned}
$$



## EXPERIMENTATION (SetI)



| Average Rate of <br> cooling(minutes/deg.C) | Round | Square | Octagon |
| :--- | :---: | :---: | :---: |
|  | 31.54 | 29.23 | 25.66 |
| Volume of Bottle- ml | 750 | 750 | 750 |
| Lateral Surface <br> Area(cm square) | 427.04 | 522.5 | 580 |

## Outcome:

| Average Rate of warming <br> minutes/deg.C) | Round | Square | Octagon |
| :--- | :---: | :---: | :---: |
|  | 31.55 | 29.17 | 28.12 |
| Volume of Bottle-ml | 750 | 750 | 750 |
| Lateral Surface Area(cm <br> square) | 427.04 | 522.5 | 580 |

1. Octagonal shaped bottle proves to be the best 1. Square and octagonal shaped bottles keep water cooler
option for cooling water.
2. Round shaped bottles yields lowest cooling
for longest rates. time as compared to other shapes.
for shorter time than round shaped bottles
3. Round shaped bottles retains cold water


## GRAPHICAL REPRESENTATION（Set－I）

Comparison of cooling rates on Round，Square，Octagonal shaped bottles
botles


C
4

0
60
120
180
240
300
360

Comparison of warming rate on Round，Square；Octagonal shaped bottles 0

150
240
TIME（MINUTES）
Round

## EXPERIMIENTATION (SetII)

| COOLING |  |
| :--- | :---: |

## Outcome:

1. Other shaped bottles with lower surface area take comparatively much Rectangular and round shaped bottles keep water cool for a longer time longer time for cooling as the surface area is lower than square shaped bottle
2. Square shaped bottle appear to be the best option for cooling water.
3. Further trials are required to confirm the above findings.


## GRAPHICAL REPRESENTATION (Set-II)

Comparison of Cooling Rates of Round, Square and rectangular ingular shaped bottles
 ATURE(D
TEMPERATURE(DEG.C)
16
14
12

Round $\longrightarrow$ Square Rectangular
Comparison of Warming rates of Round, Square and rectangular shaped bottle


## ANALYSIS OF THE RESULTS AND CON

Based on 14 activities conducted so far with different shapes of bottles the following conclusions have been drawn:

1. Round shaped bottle filled with water results in the slowest cooling rate.
2.Octagonal shaped bottles filled with water result in the fastest cooling rate.
3.Cooled water stored in round shaped bottles maintain water cooler for a much longer time than Octagonal shaped bottles.
2. Cooled water stored in octagonal shaped bottles maintain water cooler for a much shorter time than round shaped bottles.
5.Lateral Surface area is a vital factor for heat exchange with surroundings. Larger the surface area for the same volume, faster is the heat exchange.
(Experiments were conducted for two sets. One set was conducted at Chennai and another set was conducted at Bangalore. No. of trials hence further trials are being planned.)

## SIGNIIICANCE AND IMPACT

Our findings are in alignment with practical day to day applications as mentioned below:

- Octagonal Bottle has a greater surface area and hence cools faster than round shaped bottles
- But the cylindrical bottle having the least Surface area maintains water cool for a much longer time.
- Hence the conventional practice of using the shape of the bottle for cooling water and for keeping it cool outside is not recommended.

We must use bottles with larger surface area for cooling water and bottles with minimum area for maintaining it cool outside.

## CUSTOMIER FEEDBACK

## Some Samples of Customer Feedback

- The work done is an excellent demonstration of the fact that heat transfer is proportional to surface area given the same experimental conditions.
- The experiment, proved a thought of the relationship between surface area and cooling which we usually never consider in our day to day aspect. Good invention to adapt in daily needs.
- This project is helpful in our day-to-day life for everyone. Please update once the result has been published. All the best



## LITERATURE SURVEY

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