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Experimental Analysis of Reuse Methods Proposed for Non-Biodegradable Waste (Plastic), including Solution for after Use with Technical, Sustainable, Economic and Social Consideration

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Abstract: ***In era of 21 century study of environment and pollution has become major concern in developing countries like India. Urbanisation and Industrialisation with huge population drag our attention towards practical problems like Waste Management, their scientific solution also to find possibilities to reuse and recycle them to save our resources and energy. With present knowledge and possible resources we have tried to find some of the optimal solution to Non-Biodegradable waste like plastic (specially waste PET Bottles). Also we have find after use solution of products and article. Economical consideration, Social impact, Capacity building and Technical experiments are done during research work on this topic.***
In our small inspection of some of the major institute, offices, hotels and local areas of Jagdalpur city (Chhattisgarh), we found that major portion of Non-Biodegradable waste are plastic. In which PET waste bottles have big amount of portion, so tried to investigate reuse options to them. After studying journals, online articles and other internet sources we tried to make Furniture from them. In continuation with that we made two stools and a table shape article with approximately 65 waste bottles. Further for economical consideration we estimated their cost which was below 250 rupee, that falls at lower range of industrial products available on market and online platforms. For finding social impact we estimated how this can affect people? So we found that micro level employment generation can be done with this work with help of local government support it can be extended. Then for technological understanding of work we tested them in CIPET, Raipur which is leading Central institute in our state Chhattisgarh for works related with plastic. We tested our products stool, single leg of table and bottle. Their strength Report is discussed in respective section below. After the life span of this product, plastic will again come out. So we further investigated that plastic can be converted to flakes, which can be used as raw material for plastic industries. Or it can be converted to fibers, which can be used for making winter jackets to replace normal cotton and wool because of its versatile nature and characteristics against weather and water resistivity. Also it can replace other commonly used insulators because of lower value of conductivity (k). So we investigated thermal conductivity of polyester fiber available in our market. We found that our test value for conductivity k ranges from 0.097 to 0.1207 W/mK. Also this fiber made from waste plastic has better characteristics and freedom with geometric constraints. It can be used as insulator in industries as well as in domestic and large scale air conditioning equipment. Also with capital investment around 50 lakh we can setup a recycling plant to make flakes and fiber, which can make profit in between 50000 to 100000 Rupee per month, depending upon availability of waste and size of city near which plant is being setup. Also industries around that location can effect the profit. In present near Rajnandgaon, in khairjhiti village plastic park is being setup by government, so many recycling possibilities has grown near these highly populated areas like Durg, Bhilai, Raipur and Rajnandgaon city. These municipal corporation cities can supply waste at high amount and at constant rate, which make favourable conditions for installing a plastic recycling plant near this area. Also industries of Plastic Park will demand flakes as their raw materials. With best of our knowledge all these technical, economic and social impacts are investigated in this research project. Which justifies our contribution to society with technological knowledge we have gained. Also we have tried to find some of future scope regarding to this project, so that further investigation can be done related to this major issue.
Keywords: Biodegradable, Non-Biodegradable, Conductivity, PET bottles, Waste, Recycled Polyester fiber, Insulation.

I. INTRODUCTION

"Engineers like to solve problems. If there are no problems handily available, they will create their own problems." -Scott Adams
"Never try to solve all the problems at once — make them line up for you one-by-one. -Richard Sloma

1) *History:* Plastic was first invented in 1907. Bakelite was the first fully synthetic thermoset made by chemist Leo Baekeland using phenol and formaldehyde. During World War-1 (WW1) and WW2 demand of plastics, fiber, and plastic products increased dramatically. Polystyrene (PS) was produced in 1930, Poly Vinyl Chloride (PVC) was produced in late 1920,

Polyethylene was produced in 1933 After WW industrialization started then demand of plastic increased again Plastic was required in each sector like packaging, bottling, furniture industry till the home appliances, toys, carry bags, daily life stuffs.

2) *Waste:* According to Basel Convention 1989 (Art. 2-1) "Waste are substance or object which are intended to be disposed or are required to be disposed by the provisions of national law". Wastes are majorly classified into two categories, Biodegradable and Non-Biodegradable waste.

a) *Biodegradable Waste:* These can be composed by microorganism such as bacteria, fungi and enzymes. E.g. Human and animal waste, plant products, wood, paper, food, leaves, remains of living creatures etc.

b) *Non-Biodegradable:* Waste: these cannot be decomposed by microorganism into organic and environmentally safe waste products. E.g. Plastic, metal, glass, medical waste, electronic waste etc.

3) *Non-Biodegradable Waste:* Whenever we discuss non-biodegradable waste first thing that comes in our mind is synthetic polymer which is plastic. People often use and throw these things, then it directly goes to dust bin, then bigger dump box of area and then to the landfills or dump yard. If it is not taken from there it may go and stuck to sewerages which will block them completely and water from sewerage stops flowing and comes out from it which creates problem for municipal bodies. In last year 2018 during Summit on World Environment Day this year's theme was "beat plastic pollution". This meet was held in New Delhi India, UN chief Antonio Guterres said "Our world is swamped by harmful plastic waste from remote islands to the Arctic, nowhere is unaffected. If present trends continue by 2050 our oceans will have more plastic than fish". He also invited countries to work on "Plastic Pact" which will be magnacarta for future.

II. PROBLEM IDENTIFICATION

A. *Problem Identification*

In the present era of year 2018 we have to make balance between

1) *Sustainable Development:* development that meets the needs of the present without compromising the ability of future generations to meet their own needs

2) *Environment:* Non-Biodegradable waste contains majorly "Plastic", further studies told that it may take 450-500 years to decompose.

3) *Industrialization:* In sustainable development we have to make balance between industrialization, improvement in lifestyle and present status of resources as well as ecosystem.

4) *Cleanliness (Swachhata):* Nationwide movement has been started on 2nd of October 2014 namely "Swachh Bharat Abhiyan".

5) *Economical Solution To Pollution:* On which we are working in this research

6) *Jobs:* International Labour Organisation (ILO) released a report "World Employment and Social Outlook" and as per of trend it is projected that in India 18.6 millions are unemployed as per 2018 which is more than 18.3 million in 2017. And it may go upto 18.9 million in 2019.

In this project work we are suggesting some sort of Reusable ideas with engineering tips which can provide economical and easy solution to plastic waste. Also it can help to generate money and revenue from the zero cost waste. It's the duty of engineers to help society to the current problem by using all the technical knowledge which we absorb from our books. Further studies told that it may take 450-500 years to decompose.

B. *Possibilities*

Keeping all these aspects in mind, following objectives are setup to be achieved in this research

1) To find out useful solution of non-biodegradable waste.

2) To generate Micro scale employment in rural areas without any capital investment.

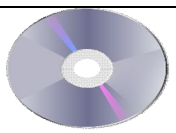
3) To establish small source of income from zero cost waste.

4) To make useful or reusable products from the waste

C. *Preliminary Work and Research*

At first we have to have a idea of types of plastic. Which will help us to sort, classify, identify and select appropriate type of processing for each type.


Table-2: Types Of Plastic With Example

SYMBOL	POLYMER NAME	USE	RECYCLABILITY
1 PET	Polyethylene Terephthalate	 	YES
2 HDPE	High-Density Polyethylene	 	YES
3 PVC	Poly Vinyl Chloride	 	YES,But not easy
4 LDPE	Low Density Polyethylene	 	YES,But not easy
5 PP	Poly Propylene	 	YES,But not easy
6 PS	Poly Styrene	 	Approximately NO
7 OTHER	N/A		Approximately NO

Source : https://www.unenvironment.org/interactive/beat-plastic-pollution/

From the study of John N Hahladakis, Eleni Iacovidou. Under title of "Closing the loop on plastic packaging materials: What is quality and how does it affect their circularity". Published in Science of total environment (630, 2018) following conclusions are made –

TABLE: Complications during plastic recovery and reprocessing:

Type of Plastic	Mechanical Recycling	Results
PET	Blend with HDPE using extrusion, Adding small amounts of virgin polyester fiber	HDPE reduces viscosity, and virgin polyester gives higher thermal sensitivity
HDPE	Blend with virgin polyamide	Mechanical properties remains almost same, polyamide improves thermal stability.
PVC	Via tribo-electrostatic technology, Blend with wood fiber	Recovers from waste , Wood improves recyclability and composite property
LDPE	Extensive extrusion	Improve extrusion property can withstand at 40th extrusion
PP	Reprocessing, injection cycles	injection cycling decreases viscosity and small loss in material strength
PS	Reprocessing with 5 percent organophilic clay	increases reprocessing ability

III.METHODOLOGY

A. Why Reuse?

"There must be a reason why some people can afford to live well. They must have worked for it. I only feel angry when I see waste. When I see people throwing away things we could use"

1) *Mother Teresa:* Raw materials of earth are depleting day by day. Reuse extends the life of things that have already used once. It helps us to conserve the resources, time and money as well as reduce waste and pollution. Reusing these things can also generate some amount of money and job. Reuse is the simplest of these 3R's of the Waste management of environment which is Reduce, Reuse and Recycle. Reduce needs much research on finding alternative, Recycle needs big investment to change the shape and form of the product. But reuse is simple and economical. Reuse consist of using it once more with little processing or cleaning, selling or buying it second hand. There may be many types of Reuse namely:-

a) Creative Reuse- Not much technology required. from best of knowledge and imagination, one can make creative items from waste material

b) Processed Reuse- Needs some instrument technology, time and money. Also expert help can be taken as per required processing type. This can generate better reliable and finished products.

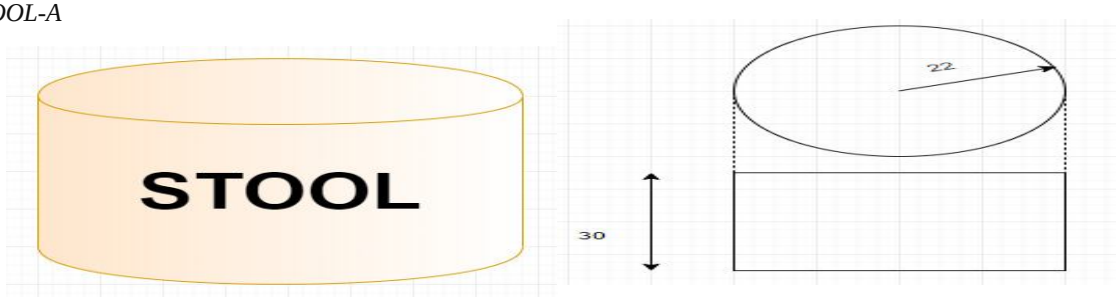
c) Repair and Reuse – instead of throwing a part of plastic thing to dustbin, at least try once to repair and reuse them. It will save money and resources to make new product, as well as it will save old product going to landfills or in dump yard.

d) Refurbishing Reuse- Technological process and work required.

B. Furniture Making

We will make some reuse products like stool and table from PET waste bottles. Steps of making with pictures and cost calculations are given below. Cost calculations are done on the basis of product availability and their market cost, which may vary city to city as well as their price may go lower when person will buy them in bulk.

1) *STOOL-A*



(Drawn online on www.draw.io)

a) *Requirement:* 19-20 PET waste bottles, Glue, Tape, Plywood sheet, Thermocol or cloth strips or cotton to make cushion, and printed cover for making outer portion

b) *Cost Of Making:* Special mention that, these costs are calculated as per market value of the product which was purchased. Quantity of glue, length of tape used, are also calculated roughly by inspection of used and unused portion level. Their use can also vary as per the person making it, his technical skills, ability and knowledge. Costs may vary city to city as well as when these products will be bought in bulk, prices may go much lower also.

TABLE: Cost Estimation of STOOL-A

S No.	Part	Quantity	Cost per Unit in ₹	Total Cost in ₹
1	PET waste Bottles	19 piece	1	19
2	Plywood	1520 cm^2	0.03027347 per cm^2	46
3	Glue(HEXON-800)Synthetic Rubber solution	200 ml	0.25 per ml	50
4	Tape	20 meters	0.50 per meter	10
5	Thermocol	5664 cm^2	0.00897021	50
6	Outer finishing	5664 cm^2	N/A	50 (depends upon personal choice)
TOTAL COST				225

c) *Steps Of Making Stool From Waste Bottles:* Steps are elaborated as we done work for making a useful stool. They can be changed by any individual as per their choice, convenient and availability of materials.

i) *Step1:* Collect as much bottles as you can and clean them, because they are used by many people for various purpose. Clean from outside and inside remove the rest liquid from inside portion, remove dust, wash them and then give proper time to get dry.

ii) *Step2:* Make proper choice with sizes. It is advised that, Select same size bottle for one purpose. Arrange them as per design of product.

iii) *Step3:* Connect all with help of “Brown Tape” starting from below till the middle of the bottle. Maintain proper tightness in this step.Too much tension may deteriorate the circular shape as well as the bottom leveling of bottles. Bottles located at corner may be lifted by excessive amount of tension. Too loose taping will also effect the strength of stool.

iv) *Step4:* Cut the plywood of the circular or the shape of lower portion of the bottle taped body. It is advised to use plywood sheet of thickness more than 10mm.For better strength reliability and results.

v) *Step5:* Apply glue or the binding solution to the lower side of the bottle. And fix the plywood sheet. Put some weight upon it and give 48 hours to get dry properly.

vi) *Step6:* Take measurement of top and side surface area of stool (geometrically cylinder). To apply thermocol sheet or foam to give a proper shape. It also offers “CUSHION” effect to the top surface. We can use variety of the Foam, cotton strips of cloth, wool to make cushion. So one can use anything depending upon availability and the budget.

vii) *Step7:* apply glue to the top surface as well as side surface and then wrap the thermocol or the foam. Then use tape to wrap thermocol or foam agin.it will help to fix with glue and strengthen the shape. Give at least 24-36 hour again to fix this.

viii) *Step8:* Apply the colorful 3D plastic cover, cloth cover etc. to this as per choice. And the stool is fully ready to use.

Step by step procedure is shown in pictures below. We converted this much of waste to useful product by this procedure.

Fig. : At starting point we had this much amount of waste bottles, collected from many sources like hotel, collage, nearby homes etc.

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Fig. : As shown in above set of picture, step by step we converted many waste bottles to a useful product (here stool).

Fig. : Last steps where we are providing some cushion and outer cover to the stool made from waste bottles. Hard thermodol used in making bike seat cover is used in this purpose.

2) Stool-B: Another stool with better grade bottle (1 litre oil bottle).

a) Requirement: 14 PET waste bottles, Glue, Tape, Plywood sheet, Thermocol or cloth strips or cotton to make cushion, and printed cover for making outer portion

b) Cost of making

TABLE-5: Cost of making STOOL-B

S No.	Part	Quantity	Cost per Unit in ₹	Total Cost in ₹
1	PET waste Bottles	14 piece	1.5	21
2	Plywood	1320 cm^2	0.03027347 per cm^2	39.96 =40
3	Glue(HEXON-800)Synthetic Rubber solution	200 ml	0.25 per ml	50
4	Tape	20 meters	0.50 per meter	10
5	Thermocol	5182 cm^2	0.00897021	46
6	Outer finishing	5664 cm^2	N/A	50 (depends upon personal choice)
TOTAL COST				217

C. Steps Of Making Stool From Waste Bottles: Same as Stool-A

3) Table

a) Requirement: 32 PET waste bottles, Glue, Tape, Plywood sheet, Sunmica sheet for top surface finishing

b) Cost of making

TABLE-6: Cost of making TABLE from Bottles

S No.	Part	Quantity	Cost per Unit in ₹	Total Cost in ₹
1	PET waste Bottles	32 piece	1	32
2	Plywood(Top+4 Plates)	(4650+3456)=8106 cm^2	0.03027347 per cm^2	245
3	Glue(HEXON-800)Synthetic Rubber solution	400 ml	0.25 per ml	100
4	Tape	40 meters	0.50 per meter	20
5	Plastic table cover	4650 cm^2	0.011039964 ₹ per cm^2	52
6	Thermocol top cover(Non Flexible Cheaper one used)	4650 cm^2	40 per sheet	40 (depends upon personal choice)
7	Pipe to connect Bottles	160 cm	0.1 per cm	16
8	Nuts,Bolts and Washer	350 gm(8 set)	0.1 per gm	35
TOTAL COST				540

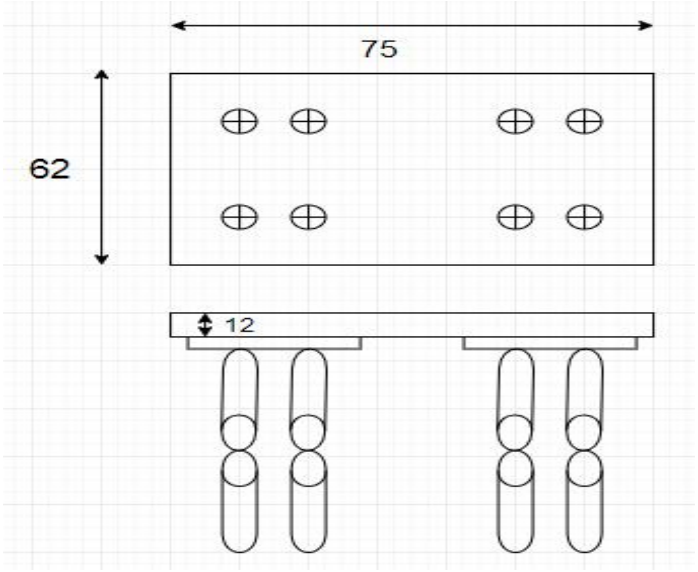


Fig. : Layout of Table made from waste plastic bottles

Note: a. All dimensions in mm

Layout of Design of table having: Plywood upper top, Plywood plates for attaching with bottles and table upper part, Nuts and Bolts for fastening plates, pipes to connect bottles.

D. Steps Of Making Stool From Waste Bottles

1) *Step1:* Collect as much bottles as you can and clean them, because they are used by many people for various purpose. Clean from outside and inside remove the rest liquid from inside portion, remove dust, wash them and then give proper time to get dry.
2) *Step2:* Make proper choice with sizes. It is advised that, Select same size bottle for one purpose. Arrange them as per design of product.
3) *Step3:* Connect two bottles with the help of PVC pipe and glue. For this purpose we have to remove cap of the bottle and properly apply glue at inside portion of bottle at top also apply glue on pipe (approx. 10 cm length) and gently insert its half portion in both bottles. And let it rest for 48 hours. After this time interval they will be fixed.
4) *Step4:* Make upper top portion of table as desired length and width, now make 4 plates of size roughly 24x36 cm. This size is calculated on the basis of 4 bottles putting in a square shape of 2x2. And extra portion to drill and margin in all direction.
5) *Step5:* Drill on plates and the upper portion of the table. 2 drills on each plate and same on top. We will need to fasten these 4 plates with top portion with help of the nut bolt and washer assembly. Here we used 8 sets.
6) *Step6:* Now connect 2x2 square bottle sets to each plate with help of glue and let it free for 72 hours. More time is required because this portion is going to face maximum amount of the load under working conditions.
7) *Step7:* Now connect all 4 Plate-Bottle assembly to the top portion of table using nuts and bolts.
8) *Step8:* For finishing purpose we will apply one layer of non-flexible Thermocol (generally available at stationary stores) on the top of table with glue or fevicol to smooth surface from “nut heads’. And apply one plastic cover on the top. Let the glue to work and let it on rest for 6-8 hour. Now the work is complete and table is ready.

Fig. : 16 Array of Two connected bottles, made with help of plastic pipe to join them

Fig. : Steps showing how we made leg from 4 connected bottles. And then 4 legs are made. Top of table is made from plywood sheet. Legs are detachable with help of Nut-Bolt assembly. In case of breaking, we can change that portion which increases its useful life span and reliability of product.

a) *After Use:* After use and life of these products this will create waste again. Commonly used methods to tackle them may be to convert them into pyrolysis oil or make flakes or fiber.
b) *Plastic Pyrolysis Oil:* As we know pyrolysis plants creates high pollution during the process of pyrolysis. Many new techniques are there to reduce pollution level, thus it gives high level pollution during the application in automobile [1]. To solve pollution level at exhaust we have to modify engine design which is not a feasible solution on national and international level. That's the reason we are not further working on this solution, because our aim is to reduce the pollution as well as opportunity of any type of problem generation. Also we are aiming to provide simple solution to pollution with installation of Micro level of industrial sector[2]. Which will help rural areas to generate small level of employment.
c) *Fiber of Flakes:* Polystyrene: it is obtained from virgin fiber as well as recycled from waste PET bottles. It is used in construction of wall, roof floor in cold storages. Also used as pipe insulator in industries for commercial purpose. These are used because of their cheap cost and availability. They have many similar properties by which it can replace regular cotton used in textile industries as well. They can incorporated to make warm clothes for winter season where regular natural cotton is used. This is lighter in weight as well as washable. Air particle content in between particles are also higher that's why it provides better results in temperature insulation and shock absorption Use of insulators in Industries: insulating materials are very basic requirement of any industry operating with heating process and units. It is important to reduce heat loss as well as maintain lower temperature of many food processing plants. Many packaged products like ice cream are supplied to rural areas by the means of transportation where we have to maintain lower temperature inside the chamber also in air conditioning units ducts are made fully insulated from the outer environment, where as in power plant industries and steel processing units higher temperature has to be maintained to get higher efficiency. Because from the pipes of hot flowing liquids are often exposed to environment which losses heat frequently. Other uses of insulators may be defined as
   i) Accurate control of process temperature and protection of our product under consideration
   ii) To save energy as well as money on fuel also greenhouse gases
   iii) Protection from small amount of shock and vibration
   iv) Minimizes formation of condensate, corrosion and rusting on pipe exposed directly to humid environment

Types of insulators: [3]

1) On the basis of their physical structure

a) Fibrous insulators: it consist of air finely divided into interstices by smaller fiber. They may be perpendicular or parallel to the surface being insulated. Examples are-ceramic fibers, glass, wool, rock

b) Cellular insulators: it consist of air or some other gas within the foam of small bubbles and formed into boards, blankets and hollow cylinder. Examples are-polystyrene, polyurethane, polypropylene

c) Granular insulators: Examples are-calcium silicate, perlite, vermiculate

2) On the basis of application

a) Hot insulators: glass, mineral, wool, cellulose glass, calcium silicate, ceramic fiber, melamine foam, perlite, vermiculate

b) Cold insulators: cork, nitrile rubber, polystyrene, polyurethane foam, polypropylene

IV. RESULTS AND DISCUSSION

A. Testing Of Stool

TEST RESULTS: Stool and One lag of table made from waste PET bottles were tested in Central Institue of Plastic Engineering and Technology (CIPET), Raipur. Peak load and Strain percentage graph plots are generated by UTM testing machine. With cell load of 100KN speed of 1.6 mm/min. Summary of Test results are as bellow –

TABLE: UTM testing results

S No	NAME OF TEST	METHOD	PEAK LOAD (in N)	PEAK LOAD (in k. g.)
1	Compressive load on Stool of waste bottle	ASTM D695	3735	380.85
2	Compressive load on a single leg of table made by waste bottle	ASTM D695	216	22.02
3	Green cold drink 2.25 Litre bottle (better strength)	ASTM D695	200	20.39
4	Waste Water 1 Litre Bottle (low strength)	ASTM D695	73	7.74

B. Conductivity Test Of Polyester Fiber

PET bottles are mainly converted into flakes or fiber after use. Which are used as fibber in winter jackets as an insulating material as well as they can be used in industries and replace asbestos (0.16 W/m ºC), Timber (0.12-0.16 W/m ºC), Wool oak (0.17 W/mºC), Rubber natural (0.13 W/mºC), Sand dry (0.15-0.25 W/mºC), PVC (0.19 W/mºC). [4]; because of its its flexibility and low water absorption versatile characteristics. In experiment we have used Polyester fiber available in market which is made from virgin fiber mixed with recycled fiber. Fully Recycled fiber will give us less conductivity value means more resistance to heat flow due to its rearrangement of molecular structure. That will be more useful in insulation purpose.

1) Experimental Setup: Two co centric steel cylinders are taken for experiment. The space between these co centric cylinders are filled with insulating material like Cotton and Recycled polyester fiber. Inner cylinder is heated by the apparatus and the consecutive readings of V (voltage) and I (current) are noted down to calculate the value of heat supplied. Heat will be conducted from inner cylinder to outer cylinder by the mode of “Conduction”. Temperatures of inner and outer surface are taken by use of thermocouple and at last their average mean value s taken to reduce the possibilities of error during the experiment process.

Fig. : Pipe assembly

Pipe assembly consist of two concentric steel hollow pipe (cylinder). Between their radial spacing fiber is filled. Inner pipe will contain Heater. So heat will flow from inner pipe to outer pipe through fiber. Fiber will resist this heat flow because of its lower thermal conductivity *k*.

2) Assumptions

a) Insulating material is isentropic.
b) Heat flows in one dimensional.
c) Spacing filled with insulating fiber is constant between the cylinders.
d) Density of fiber filled between the cylinders are constant throughout the length.
e) Readings are taken when temperature values are not changing and they reached steady state.
f) Heater efficiency is maximum, so temperature of heater and inner cylinder surface is same.
g) Setup is completely insulated from environment with help of glass covering.

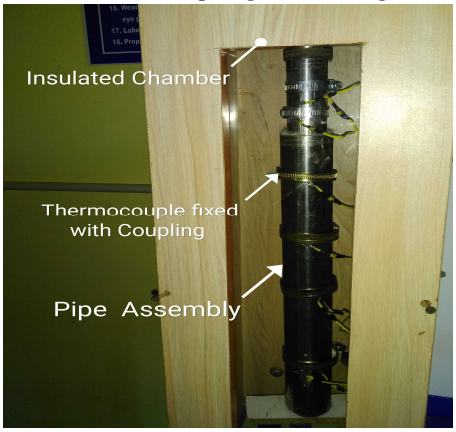


Fig. : Pipe assembly inside experimental chamber. Thermocouples on inner and outer surface

Table: Specifications

Material	Steel Pipe and Polyester fiber
Diameter of inner cylinder (pipe)	3.87×10^{-3} m
Diameter of outer cylinder (pipe)	5.15×10^{-3} m
No of thermocouple used	2 on inner cylinder surface 3 on outer cylinder surface

3) Theory: Consider the transfer of heat by mode of conduction through the wall of a hollow cylinder formed of insulating fiber. Consider the pipe is ppipe is insulated at end or it is of sufficient length by which heat loss from end are negligible. If T_i is greater than T_o then heat will flow from inner tube to outer tube. The process will be described by Fourier's law as follow [5]

$$Q = -kA\frac{dT}{dr}$$

Integrating radius from r_1 to r_2 and corresponding temperature limits of T_i to T_o we get

$$Q\int_{r1}^{r2}\frac{dr}{r} = -k.2\pi L.\int_{Ti}^{To} dT$$

$$Q.\ln\frac{r2}{r1} = -k.2\pi L.(To - Ti)$$

$$Q = \frac{k.2\pi L.(Ti - To)}{\ln\frac{r2}{r1}}$$

So it can be written for conductivity, *k* (in W/mK) as follows

$$k = \frac{Q.\ln\frac{r2}{r1}}{2\pi L.(Ti - To)}$$

Let,

r_1 = radius if inner cylinder
r_2 = radius of outer cylinder
T_i = average (mean) temperature of inner surface ºC
T_o = average (mean) temperature of outer surface ºC
L = length of the pipe
Q = heat input in watts
k = conductivity of insulator W/mK

4) Observation Table: attached in Appendix
Ambient Temperature
23 ºC for Day-1 (Observation 1, 2) and
21 ºC for Day-2 (Observation 3,4,5)

5) Calculation
V = Voltmeter reading in volts
I = Ammeter reading in amp
Q = V x I Heat input in watts
r_1 = radius if inner cylinder = 3.87×10^{-3} m
r_2 = radius of outer cylinder = 5.15×10^{-3} m
L =length of inner surface (effective) pipe = 40×10^{-2} m
T_i = Average (mean) temperature of inner surface ºC
T_o = Average (mean) temperature of outer surface ºC

Table ; Calculation table

Set No	Voltage V (volts)	Current I (amp)	Heat Q (watt)	Average inner surface (pipe) temperature ºC	Average outer surface (pipe) temperature ºC	Conductivity k (W/mK)
1	17.25	0.10	1.725	33.25	31.6	0.1188
2	32	0.21	6.72	43.4	36.46	0.11008
3	39.6	0.25	9.9	54.7	43.1	0.09702
4	49.8	0.34	16.932	63.7	47.76	0.1207
5	59.8	0.40	23.91	79.1	56.46	0.1201

From above equation for conductivity we can simplify with values of r1, r2 and L, we get

$$k = \frac{Q.\log_e \frac{r2}{r1}}{2.\pi.L.(Ti - To)}$$

$$k = \frac{Q.\log_e \frac{5.15}{3.87}}{2.\pi.(0.4).(Ti - To)}$$

$$k = \frac{Q.(0.2857422)}{(Ti - To).(2.513274)}$$

$$k = \frac{V.I.(0.113693)}{(Ti - To).}$$

We will put various values of V,I,Ti, and To to get value of *k* (conductivity) in above equation
Here, *k*= conductivity of plastic fiber in W/Mk

6) Discussion: Here we will plot graph between steady state average inner surface pipe temperature "$T_{i\,avg}$" and conductivity "*k*". To get a clear vision that how conductivity behaviour of plastic fiber changes with varying temperature conditions
Thermal conductivity is thermodynamic property of material[6]. Thermal conductivity of solid and liquid is largely independent of pressure and depends on temperature only. It can be concluded that-

K= k (T)

Value of observation 3 differs from other values, it may be because on 2nd day pre heating time given to instrument was 30 minutes lesser than first day which was approx. 90 minutes because of setup arrangements. So the air particles were heated well on first day and less deviation is obtained in 1st and 2nd reading. Whereas 3rd reading which is first set of reading for second day is showing less conductivity because fiber and air particles were not heated properly also the atmospheric temperature of second day(21 ºC) was lesser than first day(23 ºC). so these initial parameters caused deviation in 3rd observation.

Table: Temperature v/s Conductivity value

Set no	Average inner surface (pipe) temperature Ti ºC	Conductivity k (W/mK)
1	33.25	0.1188
2	43.4	0.11008
3	54.7	0.09702
4	63.7	0.1207
5	79.1	0.1201

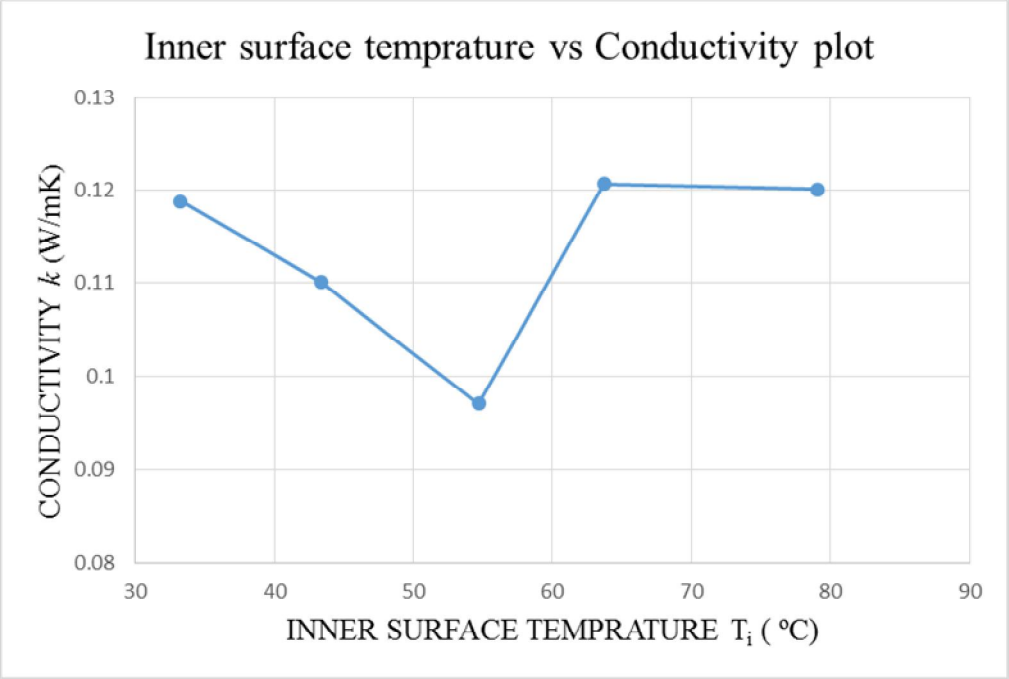


Fig : Plot between Average Inner surface temperature Ti (ºC) and Conductivity k (W/mK).

7) *Validation of Result:* Taking values from literature survey section point [7]. We can conclude that our Test value for conductivity *k* ranges from 0.097 to 0.1207 W/mK. Which falls in range (approximately) as author calculated in their experiment shown below.

Table : Various material and their Conductivity obtained by experiment[7].

Material	Jacket Type	Conductivity k (W/mK)
NYLON RIPSTOP	NF-D-J	0.157
RECYCLED POLYESTER	PT-D-J	0.124
RECYCLED POLYESTER	PT-D-V	0.178
POLYESTER	MT-D-V	0.161
RECYCLED POLYESTER	PT-NP-JW	0.105
RECYCLED POLYESTER	PT-NP-JM	0.114
NYLON	PT-NA-J	0.107
THERMOBALL NYLON	NF-TB-J	0.120

V. CONCLUSIONS AND SCOPE OF FURTHER WORK

A. *Justification For Furniture Making From Waste Bottles*

"Our traditions emphasize on living in harmony with nature. We are committed to raising standards of living of people, in a sustainable and green manner" says PM Narendra Modi at function to mark World Environment Day.

1) *Current Scenario:* "BEAT PLASTIC POLLUTION" with this theme UN's World Environment Day was hosted by our INDIA. The theme tells everyone to consider how they make changes in their daily life to reduce plastic and dangerous pollution attached with them. While plastic is very useful in daily life still it is a bio non-degradable waste which can take 500-800 years to destroy completely.

Also chief minister of Tamil Nadu E PALANISWAMI announced in state assembly regarding the banning use of plastic items coincided with this international environment day. Also concet of Plastic free Tamilnadu. Famous sand artist Sudarshan Pattnaik made big sand turtle with message of Beat Plastic Pollution. Minister of Railways and Coal Piyush Goyalji tweeted about initiative taken by the railways to best plastic pollution, Shatabdi and Rajdhani express has started using fully bio degradable packages.

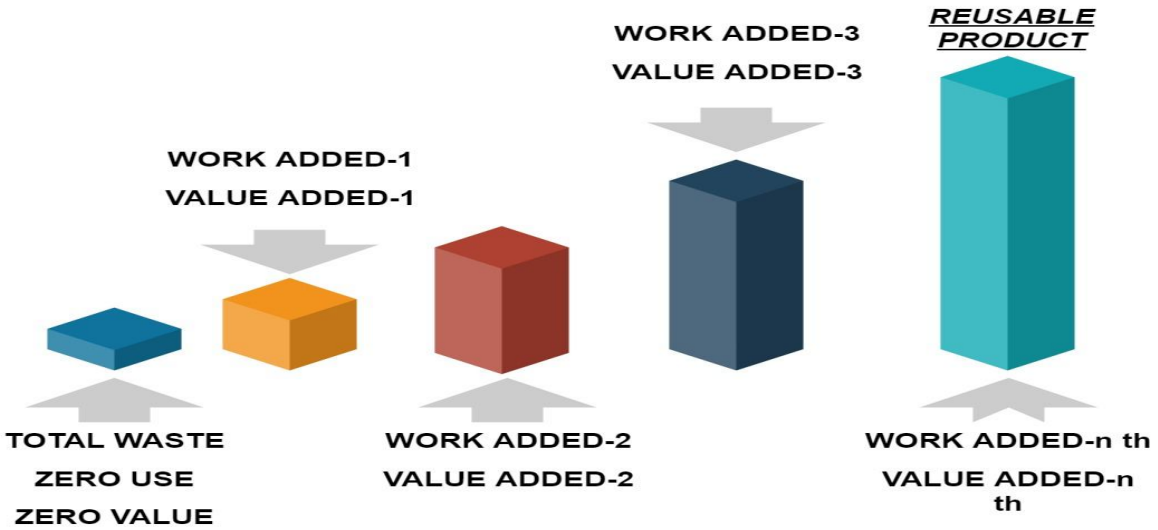
Our aim is to make The India and world plastic free to avoid enormous pollution to our environment and own health. This must stop and there's no one better to inspire to this than Mahatma Gandhi and Sadhguru, said UN Environment Executive Director, Erik Solheim.

Also with hastag of #Beat Plastic Pollution bag the global twitter initiative was done and this challenge was accepted by many big celebrities of india

This will help regional growth by :

a) Small level employment generation
b) Cleanliness in daily life as well as outer technological help
c) Solution of non-biodegradable waste like plastic which is dangerous to our animals like "Cow".
d) Generation of money from zero cost waste
e) No harmful byproduct after use
f) After reuse we will provide other solutions also. Example after completion of life cycle of plastic bottles furniture, it can be converted to "Recycled Polyester Fiber". Which is used in making toys, pillows, and warm clothes jackets sweaters etc.

2) *Economical Opportunity Factor (Micro Scale Industry):* It also provides employment opportunities to people engaged in traditional arts in India's MSI accounts for employment of people in rural sector and unorganized sector. It provides employment to skilled and unskilled people in India. It provides employment opportunities to women in India. It promotes entrepreneurial skills among women as special incentives are given to women entrepreneurs. Also helps in improving the standard of living of people residing in suburban and rural areas in India. It helps to mobilize and utilize local resources like small savings, entrepreneurial talent, etc., of the entrepreneurs, which might otherwise remain idle and unutilized. Thus it in effective utilization of resources. Provide way for promoting traditional family skills and handicrafts. There is a great demand for handicraft goods in foreign countries. Our project can help Micro Level Enterprises for sure. As shown in flow chart below instead of going direct to dump yard the plastic waste generates money, uses manpower and work at each value added step. Which will help unemployed, unskilled people to earn money, betterment of their life. And will effect working of Municipal corporations too. Environmental impacts are not required to mention again.



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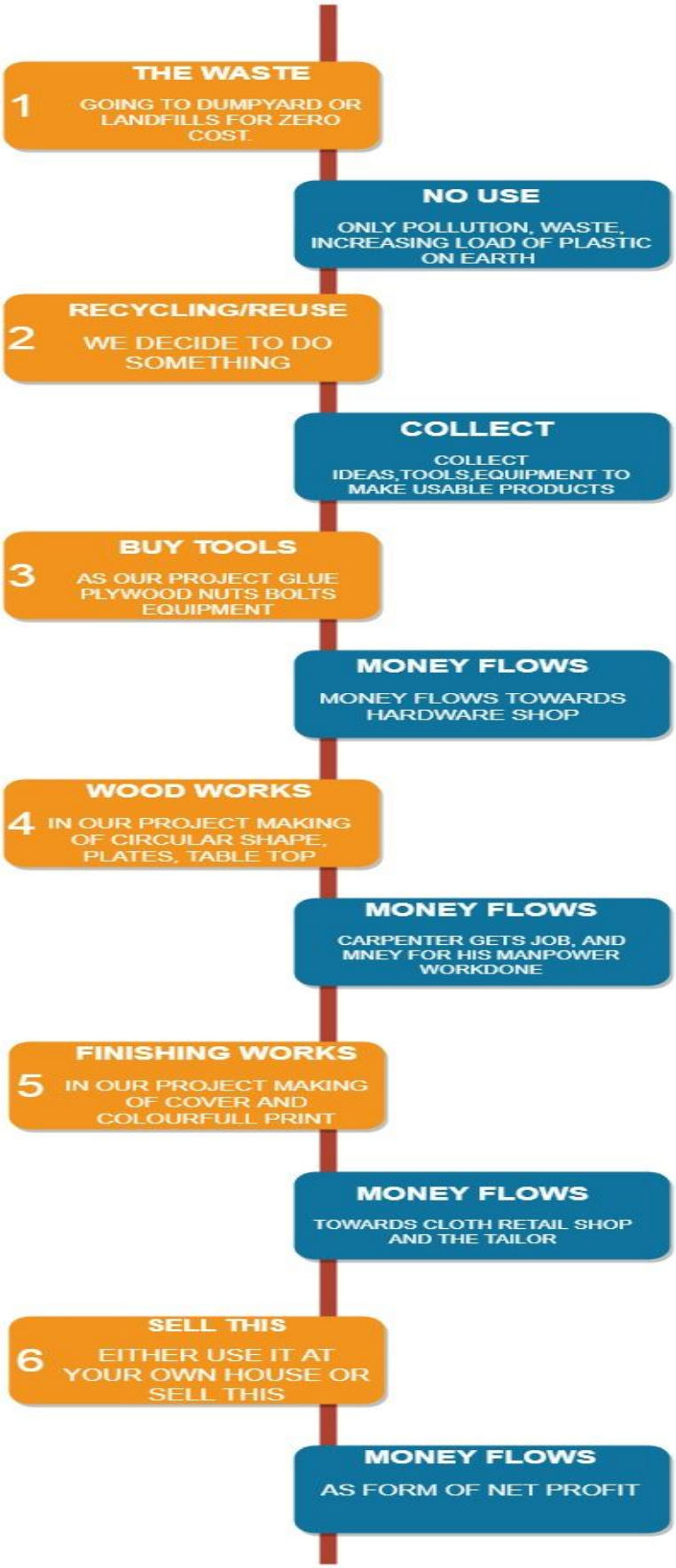

3) *Work Done During This Project:* This needs further research, testing, and better designing to improve stability strength and material used. When mass production will take place cost will decrease by 15-20% approximately. Still we made Stool-1 from 19 waste bottles, and one more Stool-2 from 14 waste oil bottles and Table from 32 waste bottles. Means we saved total of 65 bottles from going to sewerage or Land-Fills. If these products will give us 1.5 to 2 year of working life it simply means we are stopping huge amount of plastic going towards Landfills, or oceans, which will provide some time to our scientists and international research organizations to find better Recycle methodology as well as our Government to setup mechanism and awareness environment for this work. This is also going to create a opportunity to start a Micro level Industry with very minimal investment and skills to make these types of usable products from waste, which will generate revenue also from the waste having zero cost at dustbin standing at corner of the road. With lots of possibilities around and ahead we have submitted this project with a new sort of idea and creativity to sustainable development of our society. Normally cushioned and non-cushioned stools are available at price range of 400 to 2000 Rupee at various online platforms. Our one stool costs us below 300 Rupee. With respect to finishing, strength, better design, reliability and life span of industrial stool, our product justifies its cost and also possibilities can be further found to reduce final cost.

B. Justification To Convert Plastic Waste To Fiber

Pastic is an outstanding product and versatile in use. But still it is causing harmfull effect for both human and environment. That's why we are focusing on Reuse and Recycling of plastic waste. Which is thoroughly analyzed during this project work with best of my knowledge and availability of resources.(Report: SRI India)

1) Employment: No special skills are required for collection, sorting, packing the bulk. Both men and women can be employed. Number of employees may vary as per availability of waste at particular city and size of the recycling plant.
2) Salary: As per report mentioned above salary of employees ranges from 200-700 Rupee per day.
3) Profit: From report above and the research done on various internet sources it can be concluded that 50000 to 100000 Rupee per month profit can be generated.
4) Fiber and Fake characteristics: Recycled fiber shows better quality and versatile weather usability than natural cotton fiber. It can replace natural cotton from winter jackets because it is water resistance and light in weight. It can replace asbestos as insulator because of its flexibility and usability in any shape. Flakes are used as raw material to make new plastic products.

C. Future Scope Of This Project

Skilled and unskilled workers can use both suggestions given in our research work. Recycling plant of Flakes and Fiber will need some small amount of investment which can be funded by government by many available schemes. Chhattisgarh state government is going to set up Plastic Park in Rajnandgaon district near Khairjhiti village. It is clear that recycled flakes and fiber will generate a great start-up opportunity in upcoming future in our state.

Our research work can be further extended by finding more Reuse options to other Non-Biodegradable waste which we did not included in our research work. Articles made by us (Stool, Table) can be tested with furniture testing machine for better technical understanding of possible failures also possibilities can be investigated to reduce overall cost.

Also mechanical properties of fiber and flakes can be investigated more deeply and mixed with natural cotton fiber can be compared with fiber only. These can be used with cement mortar and its effects can be investigated for daily life usage. These fibers and flakes can also be used to make roads because of less abrasive property.

REFERENCES

[1] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4940549/
[2] http://www.dcmsme.gov.in/ssiindia/defination_msme.htm
[3] https://www.ukessays.com/dissertation/examples/construction/thermal-insulation-in-buildings-in-malaysia.php
[4] https://www.engineeringtoolbox.com/thermal-conductivity-d_429.html
[5] https://nptel.ac.in/courses/112108149/pdf/M2/Student_Slides_M2.pdf electrical analogy for 1-D cylinder heat flow.
[6] https://nptel.ac.in/courses/112108149/pdf/M1/Student_Slides_M1.pdf 1.4 thermal conductivity and its properties, relation with temperature
[7] Emma Steinhardt.2015.Determing an easily measured factor of merit for the thermal performance of jackets. MIT. USA Measurement and Instrumentation. [2.671]-2015

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APPENDIX

After first set of reading it is clear that steady state reaches after 90 minutes (approx) so we decided to take next set readings for 90 minutes with an interval of 30 minutes to check temperature variation. Inner surface average temperature $T_{i\,avg}$ and outer surface average temperature $T_{o\,avg}$ are calculated for last reading which is very close to steady state condition.

A. Thermocouple T_8 and T_9 were attached to inner surface pipe.
B. Thermocouple T_1 , T_3 and T_5 were attached to outer surface pipe.
C. Ambient Temperature
23 ºC for Day-1 (Observation 1, 2) and
21 ºC for Day-2 (Observation 3,4,5)

Set 1: V=17.25 volt, I=0.10 amp

Time interval min	Inner surface (pipe) thermocouple temperature Ti			Outer surface (pipe) thermocouple temperature To			
	T_8	T_9	$T_{i\,avg}$	T_1	T_3	T_5	$T_{o\,avg}$
0	27.6	27		27	27.5	27	
10	29.2	28.4		28.5	28	28.2	
20	30.3	29.1		29.3	28.4	28.9	
30	31	29.8		29.9	28.7	29.6	
40	31.6	30.2		30.4	28.8	30.1	
50	32.1	30.6		30.7	30.6	30.5	
60	32.7	31.2		31.2	28.9	31.1	
70	33.6	31.7		32.0	29.2	31.9	
80	33.8	32.3		32.4	29.5	32.3	
90	34	32.5	33.25	32.6	29.7	32.5	31.6

Set 2: V=32 volt, I=0.21 amp

Time interval min	Inner surface (pipe) thermocouple temperature Ti			Outer surface (pipe) thermocouple temperature To			
	T_8	T_9	$T_{i\,avg}$	T_1	T_3	T_5	$T_{o\,avg}$
0	34	32.2		31.9	29	32.1	
30	40	39.2		34	29.4	35	
60	41.1	40.9		34.9	35	35.8	
90	44	42.8	43.4	35.6	37	36.8	36.46

Set 3: V=39.6 volt, I=0.25 amp

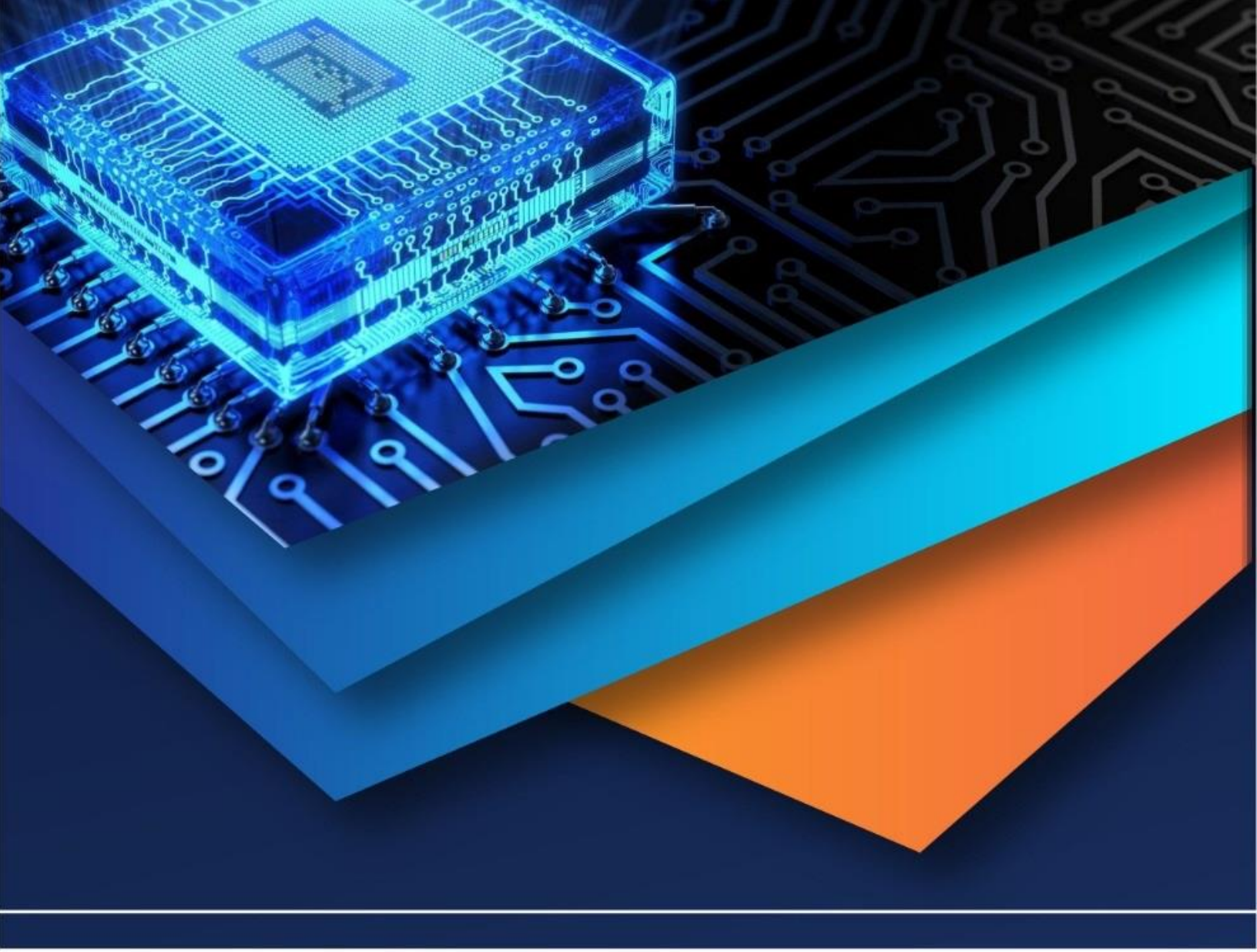
Time interval min	Inner surface (pipe) thermocouple temperature Ti			Outer surface (pipe) thermocouple temperature To			
	T_8	T_9	$T_{i\,avg}$	T_1	T_3	T_5	$T_{o\,avg}$
0	40.9	39.7		33.3	34.2	33.8	
30	48.5	46.9		37.6	39.5	39.2	
60	53.1	51.3		40	42.3	42.6	
90	55.7	53.7		41.1	44	44.2	43.1

Set 4: V=49.8 volt, I=0.34 amp

Time interval min	Inner surface (pipe) thermocouple temperature Ti			Outer surface (pipe) thermocouple temperature To			
	T_8	T_9	$T_{i\,avg}$	T_1	T_3	T_5	$T_{o\,avg}$
0	55	53		41	44	44	
30	63.1	60.6		44.4	48.5	48.5	
60	65	62.1		44.9	49.0	49.3	
90	65.2	62.2	63.7	44.8	49.1	49.4	47.76

Set 5: V= 59.8 volt, I=0.40 amp

Time interval min	Inner surface (pipe) thermocouple temperature Ti			Outer surface (pipe) thermocouple temperature To			
	T_8	T_9	$T_{i\,avg}$	T_1	T_3	T_5	$T_{o\,avg}$
0	65.2	62.3		44.7	49.1	49.4	
30	73.6	70.3		48.6	53.6	54.2	
60	77.8	74		50.6	56	57	
90	81	77.2	79.1	52	58.6	59	56.46



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