CH201
End Semester
Team Based Project
(Plastic Pyrolysis)

Team:
The Hustlers

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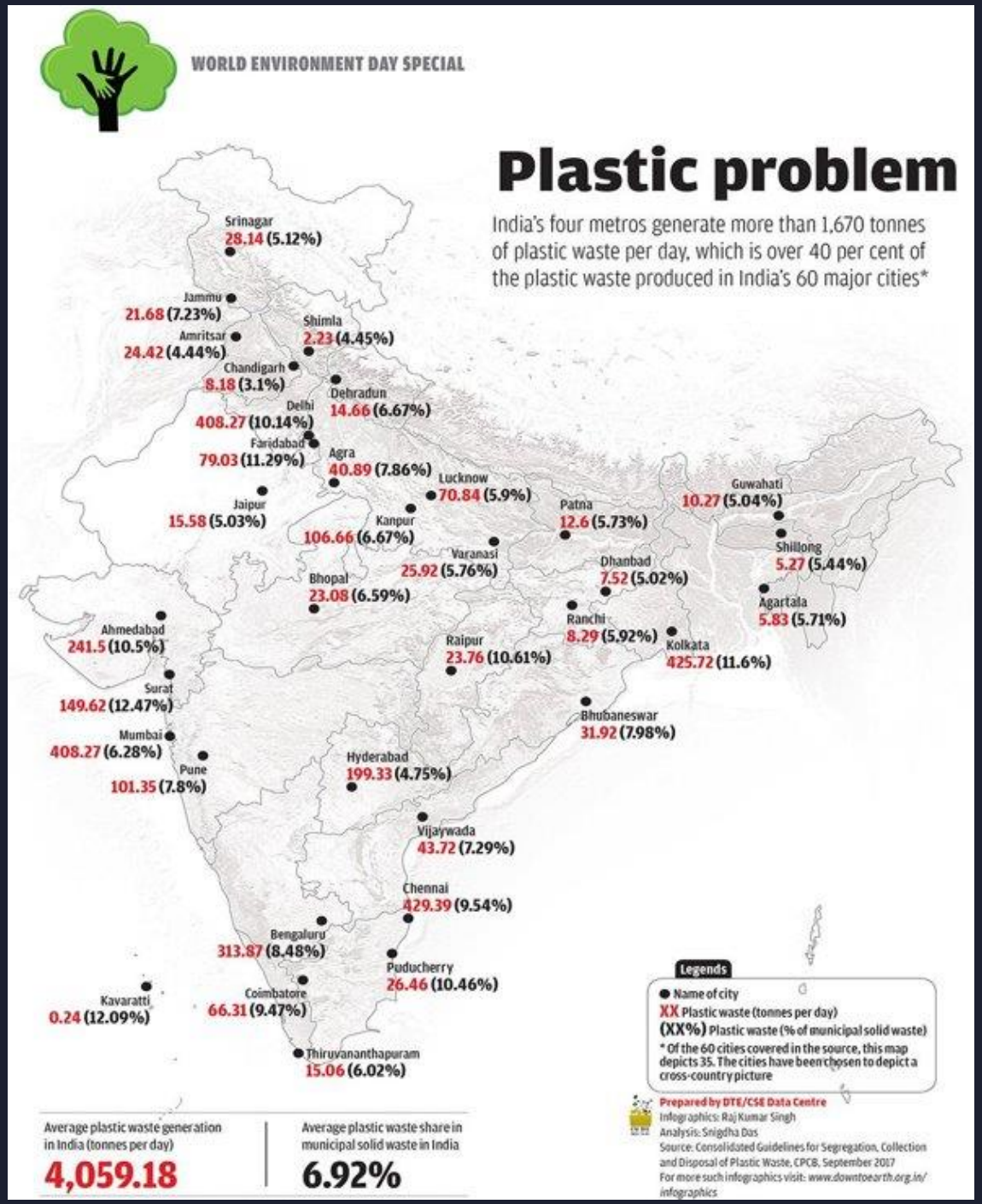
CONTRIBUTION OF TEAM MEMBERS

• Neeraj : (2020CHB1047)	Data Collection, Quantitative Cost Analysis and Study of various economic models of pyrolysis.
• Rishabh Garg : (2020CHB1051)	Study of Pyrolysis of Various Plastics, PPT Editing and designing, Data &Graph Collection.
• Sarbjot Singh : (2020CHB1054)	Quantitative Cost Analysis, Data Collection, Study of various economic models of recycling.
• Uttam Saroj : (2020CHB1057)	Qualitative Analysis, Data Collection, Calorific Value Calculation.



PROBLEM STATEMENTS

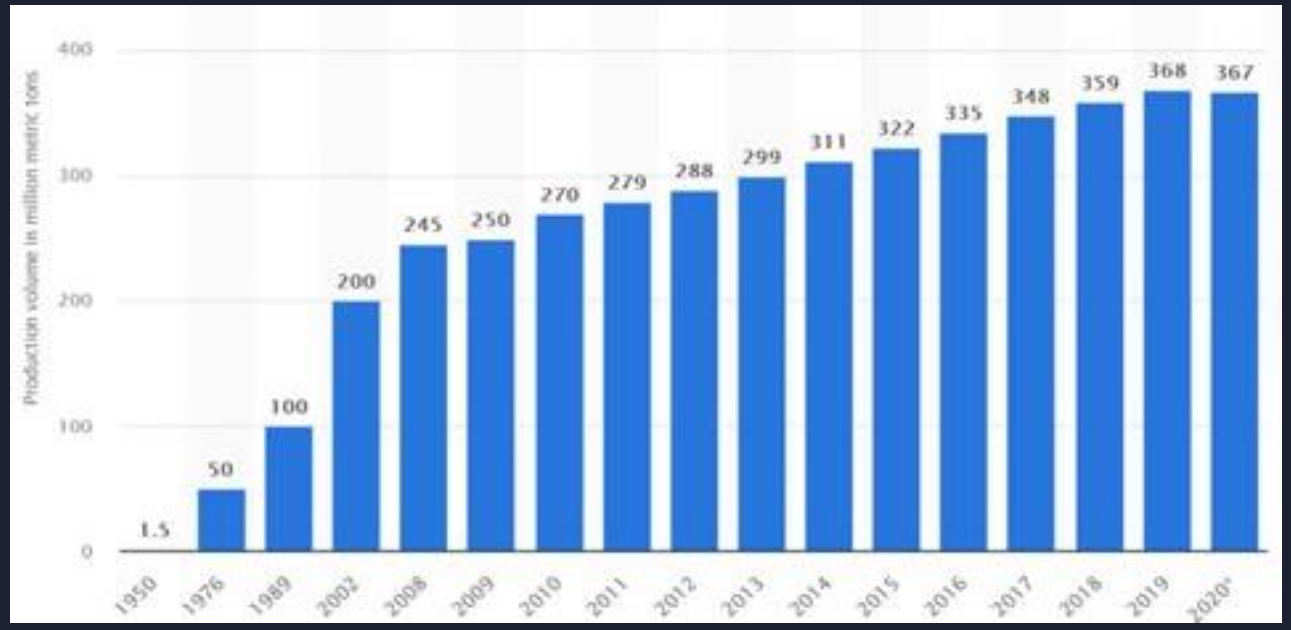
1. Plastic waste management without causing any overall adverse impact on the environment, which is also profitable and more sustainable.
2. Meeting the energy demand of the growing population without emptying all non-renewable sources of energy and with a more efficient method.

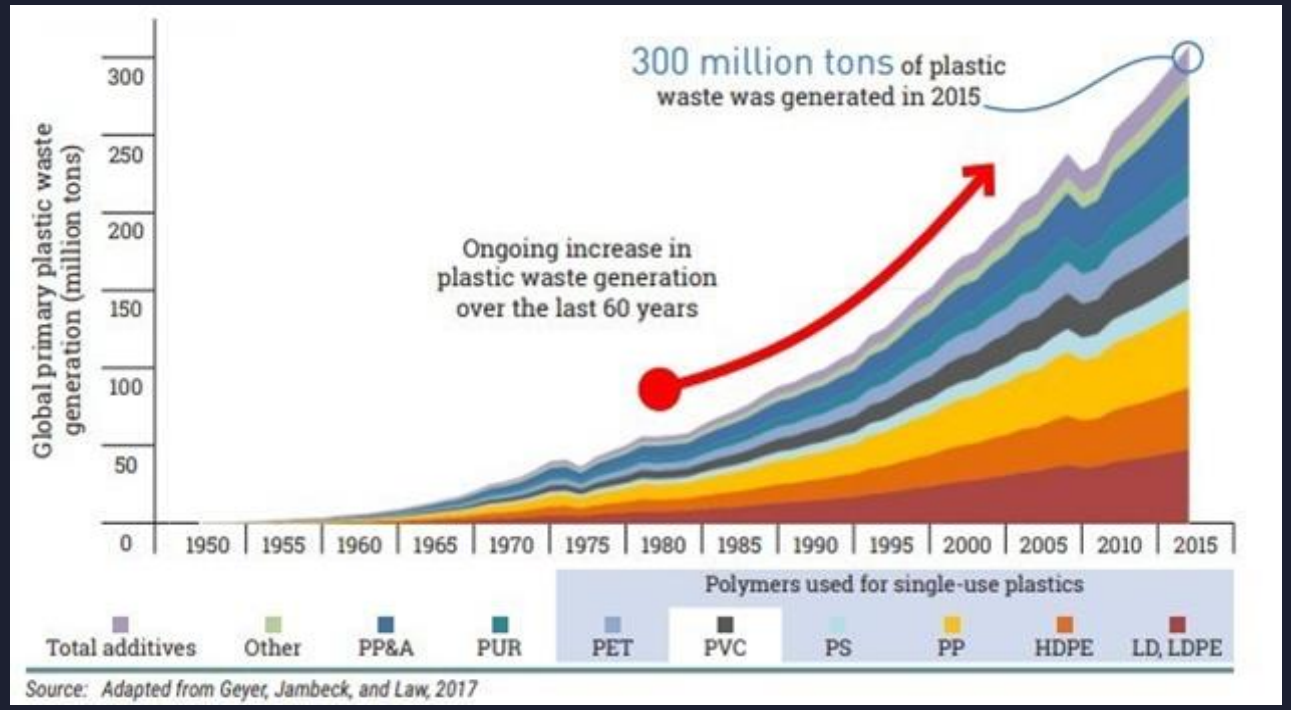
- Plastics are very beneficial in all terms of use, but it directly harms the living beings in many ways too.
- So instead of banning it, if we could find an eco-friendly way of generating energy from the plastic waste, it would be great step towards the sustainable development.

Data on:

Plastic Waste Generation &

Plastic Production

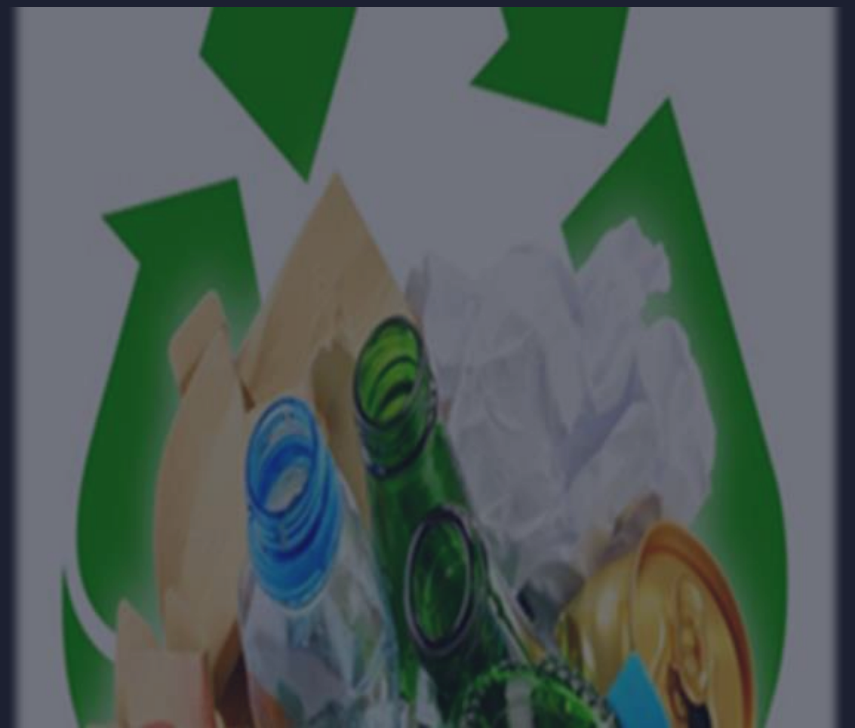


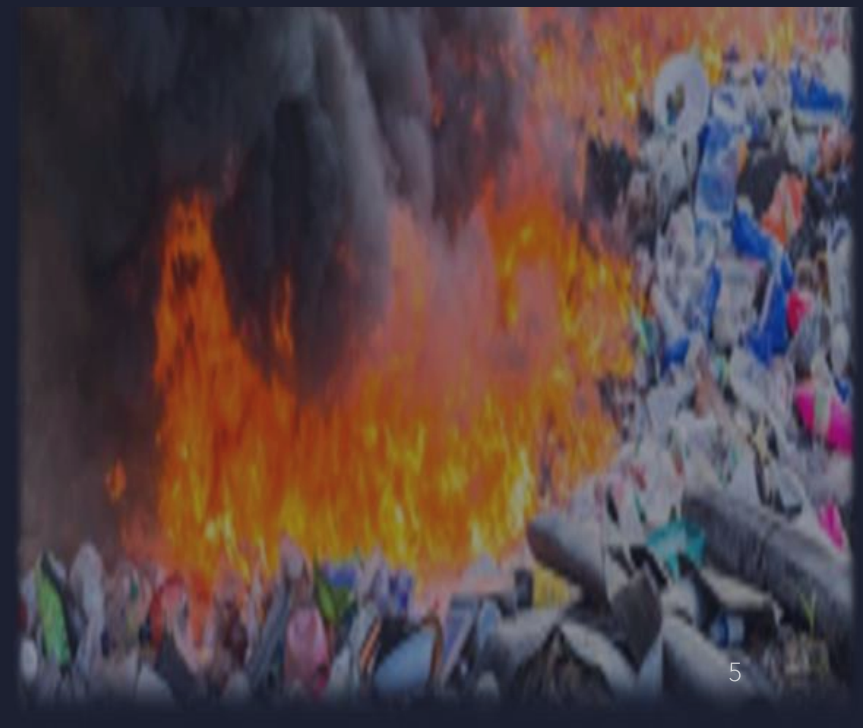


PRESENT MAJOR SOLUTIONS:

***PLASTIC WASTE MANAGEMENT PROCESSES*:**

- RECYCLING: Labour intensive, Water contamination
- LANDFILLING: Consume large space, Not economical and Causes land pollution
- INCINERATION: Expensive, Causes air pollution
- OCEAN DUMPING: Threat to aquatic life, Microplastics





PRESENT MAJOR SOLUTIONS:

***FUEL/ELECTRICITY GENERATING PROCESSES*:**

- SOLAR/WIND/HYDRO: Regional, Not completely reliable.
- MINING FOR OIL: Erosion, Respiratory complications, loss of biodiversity, etc.
- ELECTRICITY GENERATION: Pollution from burning non-biodegradable fossil fuels.

PYROLYSIS PROCESS

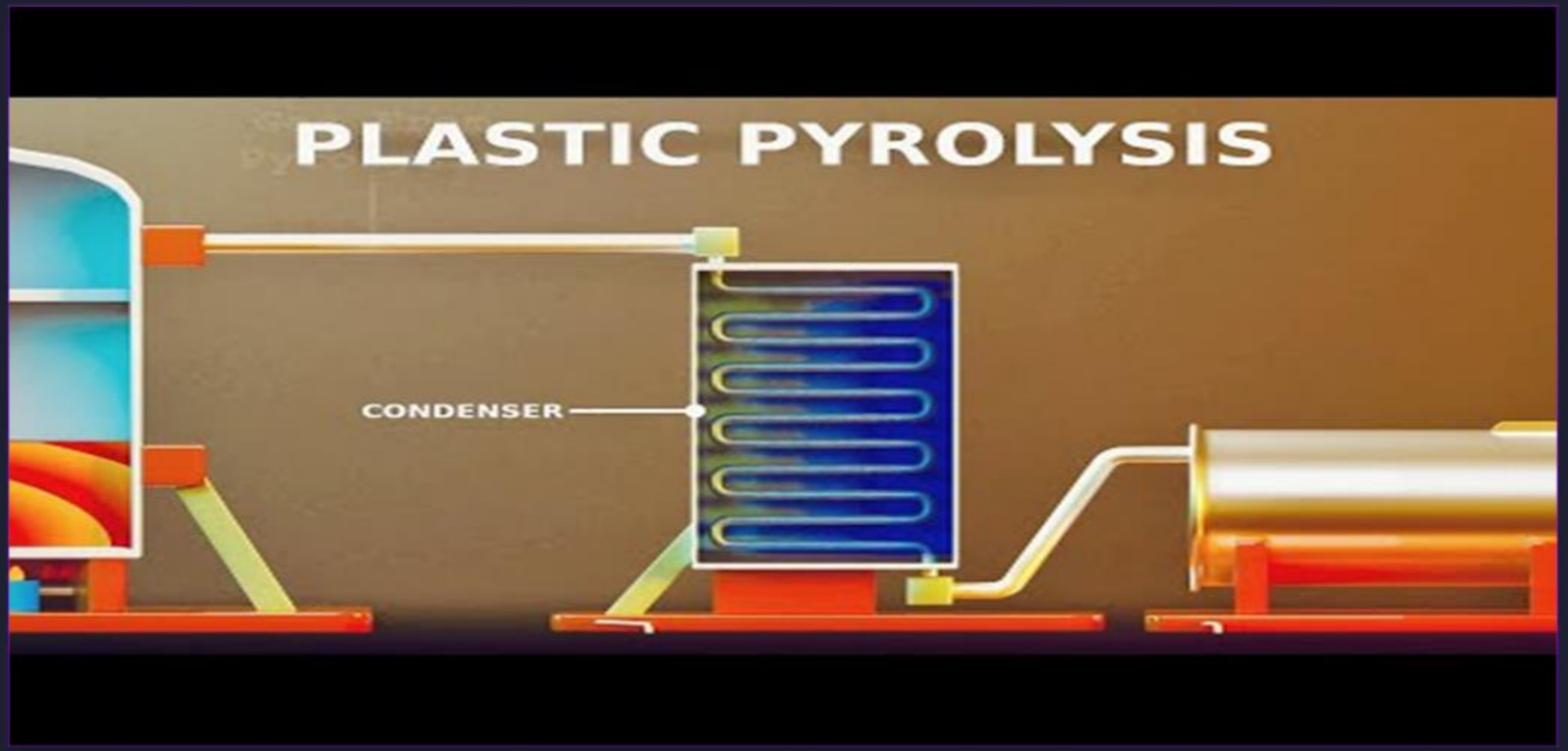
- ✓ Pyrolysis is the process of thermally degrading long chain hydrocarbons molecules into smaller, less complex molecules through heat and pressure. It is performed in an inert atmosphere (in absence of oxygen).
- ✓ The three major products that are produced during pyrolysis are:

  1.) Oil (80%): fueling in engines and turbines, transportation fuel.

  2.) Gas (15%): increases efficiency of process, used in gas turbines.

  3.) Char (5%): water treatment, burning with coal, increasing sequestration property of soil.
- ✓ The pyrolysis output depends on several reaction parameters such as temperature, pressure, type of reactor, reaction rate, residence time, etc.

INDUSTRIAL SETUP



RECYCLING COST ANALYSIS:-

According to Central Pollution Control Board (CPCB) , 34 lakh tons of plastic waste was generated in 2019-20.

Out of total waste generated, around 60% is recycled.

Total Cost: Rs 16,360.11/t

Total Revenue: Rs 11,668.08/t

Net Loss: Rs 4,692.03/t

Pyrolysis Cost Analysis:-

Pre- Treatment :- It includes acquisition and pre-treatment of Pyrolysis feedstock.

Processing :- It includes the cost of Pyrolysis feedstock processing.

Transport :- It includes the transportation cost and sales cost of pyrolysis liquid to the market.

Total Cost: Rs. 28,027.50/t

Total Revenue: Rs. 33,708.45/t

Net Profit: Rs. 5,681.25/t

Net Loss from Recycling :-

34,00,000 * 0.6 * 4692.03 = Rs 957,17,41,200 Per Annum

Net Profit from Pyrolysis :-

34,00,000 * 0.6 * 5681.25 = Rs 1158,97,50,000 Per Annum

Total (Saving + Profit) after switching to Pyrolysis:-

Rs 1158,97,50,000 + Rs 957,17,41,200 = Rs 2116,14,91,200 Per Annum

CALORIFIC VALUES OF PLASTICS

Plastics	Wt. %C	Wt. %H	Wt. %O	Wt. %S	Wt. %N	Higher/Gross Calorific Value, HCV (MJ/Kg)	Lower/Net Calorific Value, LCV (MJ/kg)
Polyethylene terephthalate (PET)	62.48	4.8	0.089	0	0.32	28.03508394	26.97408849
High-density polyethylene (HDPE)	86.1	13	0.9	0	0	47.71043442	44.83690506
Polyvinyl chloride (PVC)	38.7	4.8	0	0	0	20.01190464	18.95090918
Low-density polyethylene (LDPE)	85.7	14.2	0.05	0	0	49.46075329	46.32197507
Polypropylene (PP)	86.1	13.7	0.14	0	0	48.85800102	45.82974316
Polystyrene (PS)	92.7	7.9	0	0	0	42.74232144	40.99609975

Dulong's Formula :-

HCV = (8080*C+34500*(H - O/8) +2240*S)*1/100 kcal/kg

LCV = (HCV – 9/100 * H*587) kcal/kg

Where H,C,O and S are % by mass

COMPARISON B/W CALCULATED AND EXPERIMENTAL CALORIFIC VALUES

Plastics	Experimental Calorific Values (MJ/kg)	Calculated Calorific Values (MJ/kg)	Commercial Fuels	Calorific Values (MJ/kg)
PET	28.2	28.03	Gasoline	42.5
HDPE	40.5	47.71	Petrol	45
PVC	21.1	20.01	Diesel	43
LDPE	39.5	49.46	LPG	55
PP	40.8	48.85	Kerosene	45
PS	43	42.74	Coal	33

OBSERVATIONS:

- ✓ Calculated and experimental CV values are very close, thus verifies the calculation.
- ✓ The above comparison shows how the CV values of fuel from pyrolysis of different plastics is very close to the standard values of CV of various commercial fuels.
- ✓ This shows the potential of the pyrolysis process of providing a better energy source as compared to others, for the upcoming generations.

CONCLUSION

- ✓ The pyrolysis process offers several advantages such as in: 1.) enhancing the waste management system, 2.) reducing the reliability on fossil fuels, 3.) increasing energy sources, 4.) prevents contamination to the environment and 5.) cost effective.
- ✓ This technique offers great versatility and better economic feasibility in terms of the process handling and the variability of the product obtained.
- ✓ The overall use of the products from pyrolysis process makes it an eco-friendly method.
- ✓ Lot of research is yet to be made.

REFERENCES

- A-review-on-pyrolysis-of-plastic-wastes_2016_Energy-Conversion-and-Managemen.pdf
- https://www.downtoearth.org.in/news/waste/an-indian-consumes-11-kg-plastic-every-year-and-an-average-american-109-kg-60745
- https://www.livemint.com/news/india/indias-plastic-waste-generation-has-more-than-doubled-in-five-years-environment-ministry-11638803478992.html
- https://www.statista.com/statistics/282732/global-production-of-plastics-since-1950/
- https://byjus.com/biology/calorific-value/
- https://www.bcg.com/publications/2019/plastic-waste-circular-solution
- https://www.financialexpress.com/lifestyle/science/world-environment-day-2021-plastic-pollution-plastic-waste-segregation-bottles-for-change-initiative-bisleri/2265215/

THANK YOU