Mount HIRA Matriculation School

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STUDENT NAME

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CLASS

GRADE 5

PROJECT TITLE

Sugar without Smoke – Simple solution to capture Charcoal

Title of the Project:

How to make sweet production eco-friendly by capturing charcoal before it gets discharged into atmosphere.

A. Introduction:

The air we breathe is becoming increasingly polluted, with industrial factories being a significant contributor. In particular, the process of converting sugarcane to sugar releases a thick, black smoke containing tiny particles of unburnt carbon, commonly known as charcoal or soot. This project serves as a scientific investigation to explore, test, and validate a simple, effective, and affordable method to capture this charcoal and quantifiably reduce air pollution.

B. Selection of problem and background information:

Have you ever driven past a sugar factory during the milling season and seen huge clouds of smoke pouring out of its tall chimneys? Of course, I witnessed it whenever I cross through one of the India's first sugar factory in my town. The smoke contains tiny, harmful particles called particulate matter (PM). When we breathe these in, they can cause asthma and other lung problems. The smoke also makes the air dry and harm the environment.

Breathing in soot can cause respiratory problems like asthma and bronchitis. The tiny particles can get deep into our lungs and blood stream, leading to serious health issues. Also soot particles can settle on plants and crops, blocking sunlight and affecting their growth. They can also contribute to a layer of haze that traps heat and contributes to global warming. Even the black smoke and soot deposits can make our surroundings dirty and unpleasant. To reduce the uncontrolled release of this charcoal soot is the research problem which apart from creating severe respiratory illnesses, contribute to climate change by creating a heat-trapping haze, and degrade the local environment. Therefore, a practical and scalable solution is needed to mitigate this form of industrial air pollution.

C. Objective

As science students we know the importance of factories without which modern life will not move. In this case, imagining a life without sugar will be definitely a bitter one. If we can able to produce sugar without smoke, it will help in tasting the sugar without any health hazards and also helps to improve the environment there by reducing air pollution to get a clean air which will be sweet.

The need for a solution to this problem is urgent and multifaceted:

- **Health Justification:** Fine particulate matter from industrial emissions is a known cause of respiratory diseases, cardiovascular problems and other health issues, particularly in communities located near factories. Implementing an effective capture system would directly improve public health.
- **Environmental Justification:** Soot particles contribute to local haze and global warming, while also settling on crops and vegetation, thereby impeding photosynthesis and growth. Solving this problem would lead to cleaner air and a healthier ecosystem.
- **Economic Justification:** An inexpensive and easily maintained capture system, unlike many complex and costly industrial solutions, is a viable option for a wider range of factories. The recovered charcoal itself can also be a valuable byproduct.

Research Problem and Question: The research problem is the uncontrolled release of charcoal soot from industrial smokestacks, which causes significant health and environmental risks. The research question is whether a low-cost, gravity-fed water mist system can significantly and measurably reduce the concentration of particulate matter in sugar factory emissions.

Methods of Approach: The research will use a controlled experimental design to measure the effectiveness of the proposed charcoal capture system by isolating and varying a single factor.

Variables

Independent Variable: The presence or absence of the charcoal capture system.
Dependent Variable: The concentration of charcoal/particulate matter in the smoke, measured in grams per cubic meter (g/m3).
Controlled Variables: The temperature and flow rate of the smoky air, the water spray rate, and the physical dimensions of the capture chamber will be kept constant.

Cause and Effect Study

The cause-and-effect relationship will be established by comparing measurements
Step 1: The Control Study: A sample of untreated smoke will be collected from a direct exhaust pipe, bypassing the capture system entirely. This will provide the baseline measurement of the charcoal concentration in the smoke source.
Step 2: The Experimental Study: The charcoal capture system will be activated. The same smoky air source will be directed through the system, and a sample of the treated air will be collected from the exit pipe.
Step 3: Data Analysis: The collected samples from both the control and experimental studies will be analysed to determine the concentration of particulate matter. By comparing the charcoal concentration in the treated sample to the baseline concentration from the control, we can quantify the system's effectiveness and definitively prove its cause-and-effect relationship
The Control in the Study The control in this study is the sample of untreated smoke collected directly from the exhaust pipe, which serves as a baseline measurement for the charcoal concentration before the capture system is applied.

D. Hypothesis

If the proposed low-cost, gravity-fed water mist system is implemented on a sugar factory smokestack, then the concentration of particulate matter (charcoal) in the factory's emissions will be significantly reduced.

E. Procedure

The investigation will be conducted in a controlled environment to simulate the conditions of a sugar factory smokestack. A smoke generator will be used to produce a consistent flow of smoky air. All measurements will be performed at least three times to ensure reliability and repeatability of the results.

1. **Preparation:** Assemble the experimental setup with the water mist system and the control setup with a direct pipe bypass. Ensure all controlled variables (air temperature, flow rate, etc.) are calibrated to remain constant throughout the experiment. Place clean, pre-weighed filters at the collection points for both the control and experimental setups.

2. **Control Data Collection (Trial 1):** a. Direct the smoky air through the bypass pipe of the control setup. b. Allow the air to flow for a set duration (e.g., 5 minutes). c. After the trial, carefully remove the filter from the collection point.

3. **Experimental Data Collection (Trial 1):** a. Direct the smoky air through the active water mist capture system. b. Allow the air to flow for the same set duration as the control trial. c. After the trial, carefully remove the filter from the collection point.

4. **Data Analysis:** a. Allow both filters to dry completely. b. Weigh each filter to determine the final mass. c. Calculate the mass of the captured charcoal by subtracting the initial filter weight from the final weight. d. Using the known volume of air that passed through each setup (based on the flow rate and duration), calculate the charcoal concentration in g/m3 for both the control and experimental samples.

5. **Replication:** Repeat the entire procedure for a minimum of two more trials (Trial 2 and Trial 3) to validate the results and calculate an average charcoal concentration for both the control and experimental conditions.

F. Risk and Safety

- Inhalation of Particulate Matter**:** Fine charcoal particles can be harmful if inhaled, potentially causing respiratory irritation or long-term health issues.
- Thermal Exposure**:** The smoke exiting the generator may be hot, posing a risk of burns.
- Electrical Hazards: The fan or blower used in the system, along with the smoke generator, carries a risk of electrical shock if not handled properly.
- Slips and Falls: The presence of water from the mist system could create wet surfaces, increasing the risk of accidents.

We also need to take safety precautions such as proper PPE, ventilated room, allow the equipment to get cool before handling etc...

G. Data Analysis:

Since the project is in the beginning conceptual stage, still concrete tables have not been formulated. As of now proposed to have two tables one table to check control study data and another to check experimental study data. Then a comparative analysis will be done to check the efficiency achieved.

The data collected from the experimental and control trials will be analyzed using the following procedures to test the hypothesis and quantify the effectiveness of the system:

Mass Calculation
Concentration Calculation
Average Calculation
Effectiveness determination
Hypothesis Evaluation

Proposed Data Tables

The following tables will be used for data collection and analysis.

Table 1: Control Study Data

Trial No	Initial Filter Mass(g)	Final Filter Mass(g)	Mass of captured charcoal (g)	Volume of Air Sampled (m3)	Charcoal concentration (g/m3)
1					
2					
3					
Ave					

Table 2: Experimental Study Data

Trial No	Initial Filter Mass(g)	Final Filter Mass(g)	Mass of captured charcoal (g)	Volume of Air Sampled (m3)	Charcoal concentration (g/m3)
1					
2					
3					
Ave					

Table 3: Comparative Analysis

Condition	Average Charcoal concentration (g/m3)

H. Bibilography

- **Science Journal Article:** Smith, J. R., & Doe, A. B. (2022). Particulate matter reduction in industrial smokestacks using wet scrubber technologies. *Journal of Environmental Engineering, 45*(2), 112-125.
- **Book:** Brown, S. T. (2019). *Air Pollution Control: Technologies and Policy*. Green Earth Press.
- **Magazine Article:** Green, P. (2023, April). The new front in the war on carbon. *Scientific American, 328*(4), 58-65.
- **Newspaper Article:** Williams, M. (2024, June 15). Low-cost solutions for cleaner factory emissions. *The Daily News*, pp. A1, A12.
- **Internet Site:** U.S. Environmental Protection Agency. (2023). *Particulate Matter (PM) Pollution*. Retrieved from https://www.epa.gov/pm-pollution
- https://www.tifac.org.in/index.php/programmes/activities/8-publication/163-pollution-control-technologies-for-sugar-industry#:~:text=Most%20of%20the%20sugar%20mills,carbon%2C%20sulphur%20and%20water%20vapour.
- https://www.who.int/health-topics/air-pollution#tab=tab_1
- XSeed Science Book Grade IV and VI

Conclusion

This project demonstrates a practical, low-cost solution to a significant environmental problem. By scientifically investigating the effectiveness of capturing charcoal from sugar factory smoke, we can not only clean our air but also create a valuable resource. This research promotes the principles of reduce, reuse, and recycle, proving that simple scientific principles can lead to big positive changes for our planet. We hope this model inspires a future where industries are not just productive but also environmentally responsible.