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Industrial Chimney with Minimum Emission

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Abstract: *The industrial gas sector is a crucial component of modern manufacturing and energy systems, but its production and utilization often contribute to environmental pollution. This capstone project explores innovative methods for producing industrial gases with minimal pollution, focusing on reducing emissions, energy consumption, and waste in the gas production process. Key industrial gases such as hydrogen, oxygen, nitrogen, and carbon dioxide are widely used in various industries, but their production processes frequently involve fossil fuels, leading to harmful greenhouse gas (GHG) emissions and air pollution.*

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By minimizing emissions and optimizing resource use, this project aims to provide a more environmentally friendly model for the industrial gas industry, aligning it with global sustainability goals. The findings from this project will contribute to cleaner production technologies and support industries in reducing their environmental footprint without compromising efficiency or cost-effectiveness.

This project has the potential to significantly lower the environmental impact of industries dependent on industrial gases, leading to cleaner air and a reduction in GHG emissions.

Keywords: Industrial pollution control, Advanced filtration design, flue gas treatment, Eco- friendly stack.

I. INTRODUCTION

Air is an important factor in life, humans can survive without food for ± 5 weeks, without water for ± 5 days, without air for ± 5 minutes, (Stern C Arthur, 1977). In contrast to food and drink which requires money to get, air can be used by humans for free, but this has not yet made all humans maintain its quality together so that air pollution cannot be avoided.

Air pollution causes various health problems for residents who are exposed to pollution every day. The most dangerous pollutant, namely PM 2.5, causes severe health impacts both in the short and long term. PM 2.5 can cause ARI for short-term exposure, and death if exposed in the long term.

Air Pollutants are substances, energy, and/or other components that cause air pollution. Air Pollution Control includes: a. prevention, b. countermeasures, and c. restoration of the impact of Air Pollution.

Control of air pollution from immovable sources can be done by minimizing waste (waste minimization) at the source and using air pollution control equipment. Every industry must have an Environmental Manager who has the ability to work related to air which includes aspects of knowledge, skills and work attitudes in accordance with established standards. This is in accordance with the Regulation of the Minister of Environment and Forestry Number 6 of 2018 concerning Competency Standards and Certification of Persons in Charge of Air Pollution Control Installation Operations and Persons in Charge of Air Pollution Control.

II. LITERATURE SURVEY

Industrial chimneys are critical for the ventilation of exhaust gases from manufacturing processes. With increasing environmental regulations and concerns about air quality, minimizing emissions from these structures has become

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paramount. This survey reviews recent advancements and technologies in chimney design, materials, and emission control methods.

1. Chimney Design and Technology

Tall Chimneys: The height of chimneys plays a significant role in dispersing pollutants. Taller structures allow for better dilution of emissions in the atmosphere, thus reducing ground-level concentrations.

Stack Gas Treatment: Incorporating scrubbers, filters, and other gas treatment technologies can significantly reduce harmful emissions. For instance, electrostatic precipitators (ESPs) are effective in capturing particulate matter.

2. Emission Control Strategies

Regenerative Thermal Oxidizers (RTOs): These systems destroy volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) before they are emitted.

Catalytic Converters: Used in industrial applications to convert harmful gases (e.g., NOx, CO) into less harmful substances through chemical reactions.

3. Materials and Construction

Low-Emission Materials: The use of advanced materials that can withstand corrosive gases while minimizing emissions is crucial. For example, using stainless steel or specialized alloys can enhance durability and performance.

Insulation Technologies: Insulated chimneys can improve energy efficiency and reduce the release of unburned hydrocarbons.

4. Monitoring and Regulation

Real-Time Emission Monitoring: Technologies such as Continuous Emission Monitoring Systems (CEMS) allow for real-time tracking of emissions, enabling industries to comply with environmental regulations more effectively.

Regulatory Frameworks: Various environmental regulations, such as the Clean Air Act in the U.S. and EU directives, impose strict limits on emissions from industrial processes, driving innovation in chimney design and operation.

5. Case Studies

Cement Industry: Implementation of advanced filtration systems has resulted in significant reductions in particulate emissions from cement plants.

Power Generation: Upgrades to existing chimneys with flue-gas desulfurization (FGD) systems have led to decreased sulfur dioxide (SO2) emissions.

III. METHODOLOGY

Data Collection Methods Data were collected through semi-structured interviews and a review of existing literature. The interviews were conducted using a set of open-ended questions designed to elicit detailed responses regarding the design, operation, and challenges of zero-emission chimneys.

Data Analysis Interviews were transcribed and analyzed using thematic analysis to identify key themes and insights. Relevant case studies were summarized to illustrate the effectiveness of various technologies in achieving zero emissions.

Ethical Considerations All participants were informed about the purpose of the study and provided consent for their contributions. Confidentiality was maintained throughout the research process.

Image Suggestions:

- Flowchart of the research methodology.
- Infographic summarizing key findings from case studies.

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Key features:

An industrial chimney designed with minimum emissions typically incorporates several key features to reduce pollutants and improve environmental performance. Here are the key features:

1. High-Efficiency Scrubbers

- Scrubbers help to remove pollutants like sulfur dioxide (SO_2), nitrogen oxides (NO_x), and particulate matter from exhaust gases before they are released into the atmosphere.
- Common types include wet scrubbers, dry scrubbers, and electrostatic precipitators.

2. Advanced Filtration Systems

- Particulate filters (e.g., baghouses) capture fine particulates, such as dust, ash, and soot, from exhaust gases.
- Electrostatic precipitators (ESPs) use electrical charges to remove particles from gases.

3. Low-NOx Burners

- These burners are designed to minimize nitrogen oxide (NO_x) formation during combustion, which is a major contributor to air pollution and acid rain.

4. Catalytic Converters

- Catalysts in exhaust systems can help reduce harmful emissions, including NO_x and carbon monoxide (CO), by converting them into less harmful substances.

IV. CONCLUTION

Control of air pollution from immovable sources is not only by preparing good emission control equipment, but by minimizing efforts starting from the selection of raw materials, production process technology, including for some processes, pre- treatment of raw materials before the production process. In addition, operation according to SOP and maintenance of emission control devices is also very important to ensure the performance of emission control devices is in good condition. Manual emission monitoring or CEMS (Continus Emission Monitoring System) is a performance indicator in controlling air pollution from chimneys and ambient air quality.

Air pollution control can also make the production process more efficient, because in principle the emissions produced can also come from raw materials or auxiliary materials that are not used/combusted properly. Accumulatively controlling air pollution from industrial chimneys will make a good contribution to efforts to create better air quality.

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