INDUSTRIAL POLLUTION CONTROL USING AI-CO2 AND METHANE

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ABSTRACT

The troposphere is the part of the atmosphere closest to the earth. Humans and animals live here, and it is also where the majority of biological activity occurs. Air pollution is caused by poisonous gases, smoke, fumes, smog, and other contaminants and these contaminants are mostly from the factories and industries that emit harmful gases. Though we could not stop these fumes coming out of the vent, we could purify the harmful gases coming out which would reduce its harmful effect on the environment. So we proposed a solution where the main objective would be monitoring the pollution and where the outlet would be connected to a chamber where the purification of the gases take place with the help of number of sensors, filters and purification unit. This purified gas could be thereby reused by the industries and for other purposes. The hardware being used would be chamber, sensors, filters, purification unit. We also make use of machine learning in order to predict if the gas is crossing the permitted threshold of harmfulness by the means of concentration of the substances. We make use of cloud to store the data of the respective gases to process it in further steps being carried out. This project is helpful to recycle and reuse the gas thereby contributing to lessen the air pollution. The suggested technology reduces pollution in the atmosphere while also maintaining a pollution-free environment. This proposed method involves a government-approved person automatically monitoring pollutants from industry. If industrial pollution falls below the permitted threshold, a notification call and message will be sent to the appropriate government official, who will then take the necessary action. This proposed method cleans industrial contaminants before repurposing them for domestic and industrial usage. Because industry pollutes the environment more, this system offers consumers with certain control methods.

Keyword: - *Industry pollution, sensors, Filters, IoT, Machine Learning.*

1. INTRODUCTION

Air pollution is caused by a variety of industrial processes. For instance, the production of sulphuric acid releases a significant amount of SO2SO2 into the atmosphere, whereas the production of iron and steel releases SO2,CO,CO2, metal oxides, and other pollutants. Nitrogen oxides and dust are produced by the fertilizer industry; metal oxides such as sodium, potassium, aluminum, and calcium are produced by the cement industry; and CO, NH3, formaldehyde, gasoline, nitrogen oxides, particulates, and other air pollutants are produced by the petrochemical sector. Air Pollution causes major effects to the environment like Global warming, Acid Rain, causes major air borne diseases. It also leads to ozone layer depletion. It has really a very harmful effect on animals and plants.
Hence it is not possible to always block the pollution emissions but a control equipment and purifying equipment has to be implemented instead. The main focus in our project is on methane and carbon-di-oxide. We make use of

the sensors, filters and purifying unit to process and purify methane and carbon dioxide mixed with the emissions in the outlet. The detailed process of the project would be discussed further in the paper.

Peiya Zhao [1] examined the effects and mechanisms of AI on the intensity of pollution emissions, using China as an example. They have demonstrated theoretically that the scale expansion effect and the technological innovation effect of AI can reduce the intensity of pollution emissions. Adil Masood and Kafeel Ahmad [2] presented a comprehensive overview of the most widely used AI-based techniques for air pollution forecasting namely Artificial Neural Networks (ANN), Deep Neural Network (DNN), Support vector machine (SVM).Shankar Subramanium [3] proposed a detailed discussion of the Artificial Intelligence methodologies and Machine learning (ML) algorithms used in environmental pollution forecasting and early-warning systems. Their work emphasizes more on Artificial Intelligence techniques (particularly Hybrid models) used for forecasting various major pollutants (e.g., PM2.5, PM10, O3, CO, SO2, NO2, CO2) in detail. Geetha Mani [4] presented the execution and plan of Internet-of-Things (IoT) based Air Pollution Monitoring and Forecasting utilizing Artificial Intelligent (AI) methods. Also, Online Dashboard was created for real-time monitoring of Air pollutants (both live and forecasted data) through 'firebase' from the Google cloud server. Time Series modelling techniques like the Naive Bayes Model, Auto Regression Model (AR), Auto Regression Moving Average Model (ARMA), and Auto-Regression Integrating Moving Average Model (ARIMA) used to forecast the individual air pollutants aforementioned.

Qiangqiang Guo [5] has given an insight about Artificial intelligence, including disease prediction, environmental monitoring, and pollutant prediction. In recent years, there has also been an increase in the volume of research into the application of AI to air pollution. This study aims to explore the latest trends in the application of AI in the field of air pollution. SriramKrishna Yarragunta [6] proposed to learn and forecast the air quality index with the opportunity to adapt to the machine learning algorithms. Air Quality Index is a device used for determining the air quality and the causes of air pollution. He also mentioned that the highest possible values that are considered fit for public medical services are relatively higher than the daily air quality quantified attributes. S. Suganya [7] proposed a deep learning model that is consisting of Deep Recurrent Neural Network (DRNN) and Arithmetic Optimization Algorithm (AOA). Initially, the databases are collected from the open source system. After that, the data's send to the proposed deep learning model for prediction of air pollution. Piyush Devidas Potbhare [8] proposed a solution which is a low cost multimodality sensor-based system, such as MQ 2 used for sensing the occurrence of Propane, Hydrogen and LPG (Liquefied Petroleum Gas), MQ 5 and MQ 9 it can be used in gas leakage appliance to check leakage, MQ 6 used for checking of contamination of additional gases present in the air, MQ 135 used for air quality parameter sensor and DHT 11 use for measuring the temperature and humidity of the atmosphere for better quality of the air. Usha Mahalingam [9] addressed the challenge of predicting the Air Quality Index (AQI), with the aim to minimize the pollution before it gets adverse, using two Machine Learning Algorithms: Neural Networks and Support Vector Machines. P Nirmala[10] discussed the logic of Internet of Things that is being applied to the industrial automation needs and attains the benefits from that in correct manner. This is done with the abilities of Artificial Intelligence as well and the proposed logic is named as Artificial Intelligence Assisted Network Paradigm (AIANP).

2. METHODOLOGY PROPOSED

The methodology proposed here is that, a chamber is being connected to the outlet of the industry where the toxic fumes/gases are vented out. The chamber consists of many number od sensors in order to detect the concentration and what are all the gases present in the outlet produced gas.

The readings from the sensor is being fed to the cloud with the help of IOT.The focus of our project is methane and carbondioxide.The concentration of these two gases is being measured and saved in the cloud. This data from the cloud is being used further and processed using machine learning algorithm to monitor if it is crossing its threshold concentration or not.If it crosses the threshold,it immediately notifies the persons in the industry so that necessary action is being taken further to reduce it. Then the gas is being sent into the filter component where it filters the different gases present in the fumes.For this process to be carried out the data being stored in the cloud is being used. The gas is then further sent to the purification unit for the purification process. The gas after purification is sent into a storage block where it is tested for its threshold value with the help of two sensors for measuring the quality and quantity of gas.If it satisfies the threshold value it is being sent for storage but if it does not then it is sent back to the purification unit again for purification to take place.This process happens on loop until the threshold value is reached.The gas completely purified being stored in storage unit is being used for other purposes in household or industries reuse them

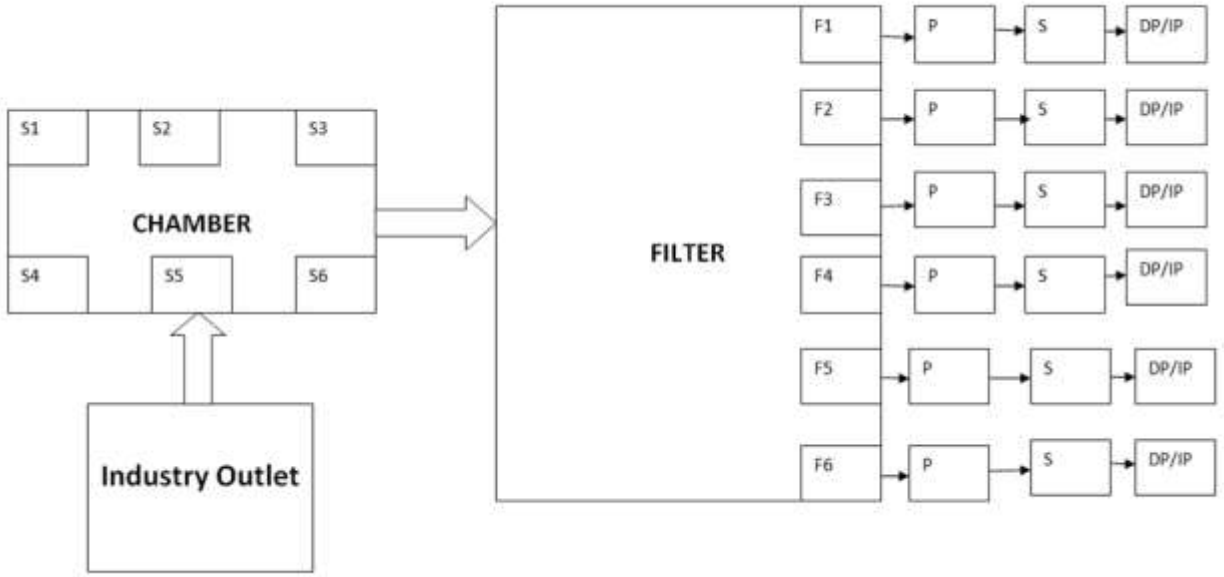

Fig -1: Overall Industry setup of the project

2.1 Chambers with sensors

This chamber consists of sensors used for measuring the concentration of methane and carbondioxide in the fumes from the outlet.The sensors are gas sensors.This readings from the sensor is being sent to the cloud for further processing. To manage the sensors and regulate the chamber's conditions, a sophisticated data acquisition and control system is employed. This system can be computer-based and allow researchers or operators to set and adjust parameters, record data, and analyze results. Chambers with sensors often have safety features to protect both the samples or specimens under study and the operators. These may include safety interlocks, emergency shutdown systems, and alarms for abnormal conditions.

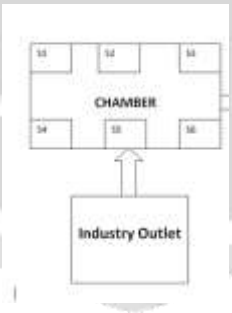

Fig -2: Chamber with sensors

2.2 Machine Learning Algorithm

The data from the cloud is being passed into the algorithm to check if the proper threshold is maintained in the concentration of the gases. It uses classification algorithm to classify if it is safe or unsafe.And if it is unsafe the authorized person would be notified about the situation which would lead to further steps to avoid it taking place.

For classifying gas concentrations as safe and unsafe, you can use a machine learning algorithm like a supervised binary classification model. Binary classification algorithms are designed to separate data into two

distinct classes based on features. In your case, the two classes are "safe gas concentration" and "unsafe gas concentration."

Hence the processes that needs to be carried out for classification of gas into safe and unsafe concentration include

Data collection –

Gather a labeled dataset containing gas concentration samples along with their corresponding labels (safe or unsafe). Ensure that the dataset is balanced to avoid bias towards one class.

Data preprocessing –

Clean and preprocess the data to handle missing values, outliers, and normalize the features. This step ensures that the data is in a suitable format for the machine learning algorithm.

Feature Selection/Extraction-

Identify relevant features that are useful for gas concentration classification. These features should have a significant impact on determining whether a concentration is safe or unsafe.

Splitting of data into training set and test set-

Divide the dataset into two parts: a training set and a testing set. The training set is used to train the machine learning model, while the testing set is used to evaluate its performance

Choose a classification Algorithm-

Several algorithms can be used for binary classification tasks. Commonly used algorithms include Logistic Regression, Support Vector Machines (SVM), Decision Trees, Random Forests, Gradient Boosting, and Neural Networks.

Training the model-

Feed the training data into the chosen machine learning algorithm and train the model. The model will learn the patterns in the data and adjust its parameters to make accurate predictions

Evaluating the model-

Use the testing set to evaluate the model's performance. Common evaluation metrics for binary classification include accuracy, precision

Process of Hyperparameter Tuning-

Fine-tune the model by adjusting hyperparameters to optimize its performance. This can be done using techniques like cross-validation.

Deployment-

Once you are satisfied with the model's performance, deploy it in your gas concentration monitoring system. The model will then predict whether a given gas concentration is safe or unsafe based on the features provided.

It's essential to periodically retrain and update the model with new data to ensure its accuracy and effectiveness over time. Additionally, make sure the model is validated against real-world scenarios to confirm its reliability in practical applications.

2.3 The Filter Unit

This filter unit consists of filters where the actual filtration of the gases from the fumes take place.Thus makes use of the sensor data from the cloud. It consists of about 6 filters in the unit for this process to take place.

The purpose of this unit is to remove or separate specific gases from a gas mixture based on their concentrations.Here's a general outline of how such a filter unit could work:

- Gas Inlet: The gas mixture containing methane and carbon dioxide enters the filter unit through an inlet. The gas may also contain other gases, but the filter unit is specifically designed to target methane and carbon dioxide.

- Separation Mechanism: The filter unit employs a specific separation mechanism to isolate methane and carbon dioxide from the gas mixture. The separation can be achieved through various methods, such as adsorption, absorption, or selective permeation.

- Filtering Media: The filter unit contains a filtering media that has an affinity for either methane or carbon dioxide or both. This media can be in the form of granules, membranes, or other specialized materials designed to capture the target gases.

- Adjustable Parameters: In some cases, the filter unit may have adjustable parameters to fine-tune its performance. For example, you might be able to adjust the flow rate, pressure, or temperature to optimize the filtering process.

- Gas Outlet: After passing through the filtering media, the gas mixture is separated into two streams: one enriched in methane and the other enriched in carbon dioxide. These streams exit the filter unit through separate outlets.

- Gas Analysis or Utilization: Depending on the application, the separated gas streams may be further analyzed, processed, or utilized. For instance, the methane-enriched stream could be used as a fuel source, while the carbon dioxide stream might be sequestered or used for specific industrial processes.

2.4 The Purification Unit

The filtered gas is being sent to the purifying unit where the purification takes place.Here the purification takes place differently for different gases. A purification unit designed to purify methane (CH4) and carbon dioxide (CO2) until a threshold level of safe concentration is achieved is a critical component in scenarios where these gases need to be removed or reduced to acceptable levels. Here's a general outline of how such a purification unit might work

The gas mixture containing methane and carbon dioxide, along with other gases, enters the purification unit through an inlet. The initial concentration of methane and carbon dioxide in the incoming gas mixture may exceed the safe threshold levels. In some cases, the gas mixture might require pre-processing before entering the purification unit. Pre-processing can involve removing particulates, moisture, or other impurities that could interfere with the purification process.

The purification unit employs a specific separation mechanism to isolate methane and carbon dioxide from the gas mixture. Various techniques can be used, such as adsorption, absorption, or membrane separation. The purification unit contains a purification media that has a high affinity for methane and carbon dioxide. This media selectively captures these gases while allowing other gases to pass through or be vented safely.

The gas mixture is passed through the purification media, where methane and carbon dioxide are captured and retained. The media can be regenerated or replaced periodically to ensure consistent performance. Throughout the purification process, gas concentration levels are monitored to determine if the safe threshold has been achieved. The purification unit's control system adjusts the purification process to optimize efficiency and ensure that the desired level of purification is attained.

After passing through the purification process, the gas mixture exits the unit through an outlet. The purified gas now contains reduced concentrations of methane and carbon dioxide, meeting the safe threshold levels. Depending on the application, the purified gas may undergo further analysis to verify that it meets the safety standards or specific requirements.

2.5 The Storage Block

The purified gas is being sent to this block.This block consists of two sensors measuring the quality and quantity of the gas. Based on the gas quality satisying the threshold,it would be decided if it has to be sent to the purification unit or the storage.This happens on loop until the threshold value is satisfied.

The storage block consists of large storage tanks or cylinders specifically designed to hold different types of gases. The choice of storage containers depends on factors like gas type, pressure requirements, and storage capacity. Safety is a top priority when dealing with gases, especially flammable or pressurized ones. The storage block is equipped with safety features such as pressure relief valves, temperature monitoring, and leak detection systems to ensure safe storage and handling of gases.

Gases are typically stored at high pressures to ensure an adequate supply. Before distribution, the pressure of the stored gas may be regulated to match the pressure requirements of the household or industrial applications. The storage block is equipped with monitoring and control systems to track gas levels, pressure, and other relevant parameters. This data helps ensure that the storage block always has an adequate supply and can manage gas distribution effectively.

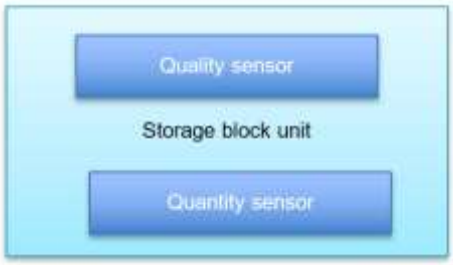

Fig -3: Storage Block unit

3. RESULTS AND DISCUSSION

The proposed system reduces the pollution in the environment. The gases causing pollution are properly treated and can be reused for various purposes like agriculture, fuel etc. This system can. This proposed method automatically monitors industrial pollution by a government-approved individual. If industry pollution falls below an acceptable level, a notification call and message will be issued to the appropriate government official, who will then take the necessary action. This proposed approach cleans industrial contaminants and repurposes them for residential and industrial use. Because industry generates more pollution, this system offers users particular control options. Apart from this, the storage block stores the gases for further use. The available methods are used to sense only one gas. But this methodology can be used to sense, purify and filter 6 various gases. Another value added features includes storing the purified gases, reusing the gases, alerting the corresponding industry person when the value of gas is more than the threshold value.

4. CONCLUSIONS

This proposed method involves a government-approved person automatically monitoring pollutants from industry. If industrial pollution falls below the permitted threshold, a notification call and message will be sent to the appropriate government official, who will then take the necessary action. This proposed method cleans industrial contaminants before repurposing them for domestic and industrial usage. Because industry pollutes the environment more, this system offers consumers with certain control methods.

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