

Automated Carbon Scrubbing and CO₂ Usage

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ABSTRACT: Automated Carbon scrubbing is the process of making carbon capture automatic, efficient and reliable. Carbon scrubbing deals with capturing Carbon dioxide from exhaust flue gases coming out from the industries or any gases producing equipment containing high amount of CO₂. Mostly it captures CO₂ from the flue gases preventing it from going outside in to the atmosphere thereby decreasing the global warming and green house effect. This carbon dioxide that goes into atmosphere which is the major cause of all is known as anthropogenic carbon dioxide. This paper describes the way of making carbon scrubbing efficient, effective and reliable. Different controlling parameters of carbon scrubbing, regeneration of its material and pure CO₂ has been described. This paper depicts that it uses two adsorption column section consisting of two different adsorption material (PEI-MS & PEI MC) that will increase its efficiency. Industrial level concept like re-flux and by pass system has been added in the process for increasing its safety precautions while making it applicable in large scale. Oil buffer pressure system has been added for measuring the adsorption column pressure. Temperature monitoring and measuring system has been added in each and every process for maintaining the parameters. The temperature, inlet pressure, outlet pressure, chamber pressure, pipeline monitoring system, valve system, purging time and material input and output are maintained in control system and was also maintained using android app. Versatile properties and usage of CO₂ in different industries and in different research field has been described.

KEYWORDS: Adsorption column, Scrubbing, Polyethyleneimine, Mesoporous Silica, Mesoporous Carbon, Regeneration, Automation, oil buffer system, Re-flux and Bypass system.

I. INTRODUCTION

Environmental pollution is a cause for concern not only for us but also for the mankind as a whole. The last century has seen the rise of this menace assume gigantic proportions, so much so that it has cast its gloomy shadow on nature itself. Pollution is a by-product of the unprecedented Industrial revolution that we have seen in the last few decades. The establishment of large scale factories benching out smoke, fumes and chemically hazardous waste, has now started having a telling effect on the environment.

The diminishing ozone ionosphere leading to global warming and the unpredictable seasonal variation, are some of the adverse effects of pollution that are threatening the environment in which we live. Coal fired power plants are the single largest stationary source of pollution in any country. The toxins these power plants produce severely damage both human health and the environment and contribute to a reduced quality of life. Among the harmful gases and pollutants released by power plants, carbon dioxide (CO₂) is the most significant green house gas that contribute to global warming. The dangers include disruption of global weather patterns and ecosystems, flooding, severe storms and droughts. Thus it no longer remains an individual or national concern but is now a global problem, to be addressed internationally.

The separation of CO₂ from different emission sources such as chemical industries, power stations, etc. To reduce green house effect has been a mutual interest of the world. Its decrease greatly reduces global warming. CO₂ is mainly found in the flue gases from combustion of fossil fuels in thermal power plants. The flue gas coming from power stations having temperature around 65°C first reaches a wet scrubber where it is cooled and freed from any residual traces of sulfur dioxide that might impair CO₂ scrubbing.

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Carbon capture and storage (CCS) (or carbon capture and sequestration or carbon control and sequestration[1]) is the process of capturing waste carbon dioxide (CO₂) from large point sources, such as fossil fuel power plants, transporting it to a storage site, and depositing it where it will not enter the atmosphere, normally an underground geological formation.

The work in this paper are divided in 3stages. 1) Carbon Scrubbing 2) Automation 3) Usage of CO₂.

The aim is to prevent the release of large quantities of CO₂ into the atmosphere (from fossil fuel use in power generation and other industries). It is a potential means of mitigating the contribution of fossil fuel emissions to global warming[2] and ocean acidification[3].

The scrubbing part is further divided into 4 stages CO₂ 1)Capture 2)CO₂ Storage 3) steam stripping with Re-flux and Bypass system

Automation consists of a control system and android base management system. A Usage shows versatile nature of CO₂ and its application in various research field.

II. CARBON SCRUBBING

According to International Energy Agency, 'the world is not on track to meet the target agreed by governments to limit the long-term rise in the average global temperature to 2 degrees Celsius (°C). Global greenhouse-gas emissions are increasing rapidly and, in May 2013, carbon-dioxide (CO₂) levels in the atmosphere exceeded 400 parts per million for the first time in several hundred millennia[5]

II.I CO₂ Capture

The flue gas coming from power stations having temperature around 65°C first reaches a wet scrubber where it is cooled and freed from any residual traces of sulfur dioxide that might impair CO₂ scrubbing[4].The present idea deals with automated efficient industrial carbon scrubbing technique and its usage. The present idea uses two series of carbon scrubbing technique containing one re-flux system in one of them. The first way consists of scrubbing the CO₂ in polyethyleneimine impregnated with mesoporous Silica that has high adsorbing capacity and in 2nd stage is impregnated with mesoporous carbon. The performance of a mesoporous silica-supported polyethyleneimine (PEI)-silica adsorbent for CO₂ capture from ambient air has been evaluated in a laboratory-scale Bubbling Fluidized Bed (BFB) reactor[5].

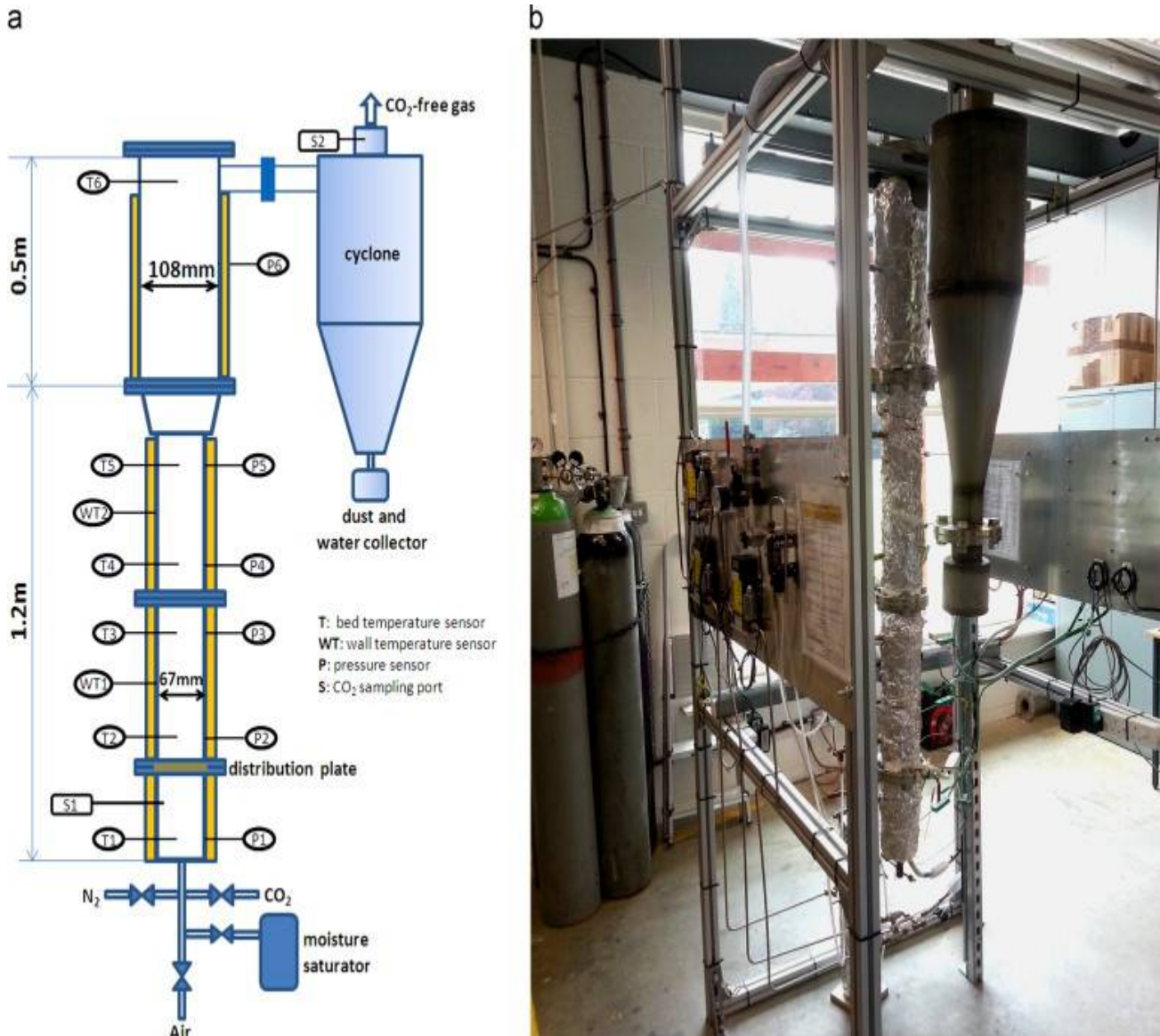


Fig 1:Laboratory-scale bubbling fluidized bed

shows the schematic and a photograph of the BFB reactor system designed and built for the evaluation of CO₂ capture and regeneration using solid adsorbents. The total height of the BFB reactor is 1.7 m, consisting of a fluidized bed section which is 1.2 m in height and 67 mm in internal diameter, and a freeboard section which is 0.5 m in height and 108 mm in internal diameter[6]. The composition of scrubbing material is 40% polyethyleneimine and 60% mesoporous silica. At this composition the capturing efficiency and strength of material is according to the requirement.

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II.II CO₂ STORAGE

CO₂ are stored within the scrubbing material in a column termed as adsorption column. This adsorption column is made up of a Aluminum T6-6061 grade due to its high tensile strength and light weight properties further it can withstand a huge amount of pressure thereby increasing the carbon storage efficiency and decreasing the leakage. The chamber pressure are monitored using oil buffer pressure system and its values are indicated in the control system as well as in the android app.



Fig 2: Small scale in house designed carbon capture.

II.III Steam Stripping Technique with Re-flux and Bypass

In these methods the waste steam are passed through the scrubbing material containing CO₂, at 110 -120 °C. This releases pure CO₂ which are used in different ways, which has been depicted later on this paper. A large amount of waste CO₂ from different system are directed in the regenerative system for making the system cost effective and more preferred. This process include various parameters like the pH, Hardness, conductivity of water through which water is produced is always maintain and are tested in laboratory. The regenerated scrubbing material are again passed to the adsorption column . The purging time and scrubbing material are tested for knowing its longitivity and its effectiveness.

Again if the one of the material in the adsorption, loses it's properties of scrubbing then the gases can be by-passed towards other field or can be re-fluxed in another components. Heat ex-changers, controlling valve, temperature sensor, safety conditions are implemented are placed at each and every section.

III. AUTOMATION

Entire process are displayed, monitored and regulated in a control system and an android app has been developed to maintain and monitor the record from anywhere around the world. Microprocessor AT-Mega 328 P has been installed at each and every section. Temperature sensor, BMP 280 Pressure sensor and other monitoring modules are interfaced with the system to get the accurate value. The values are displayed in the android app. The app is a protected and a secure one. All the data are uploaded in the cloud server and records are maintained for future review. The system can work automatically. The system trips off if any of the safety indicator changes like:

- Temperature increases significantly greater than the threshold value.
- In case of oil buffer pressure system the values are monitored through the app, in case of any emergency the system automatically gets trips off.
- The android app interface is shown below:-

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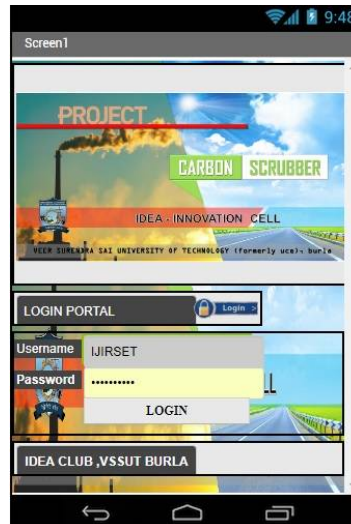


Fig 3:Front page of Android app management system interface

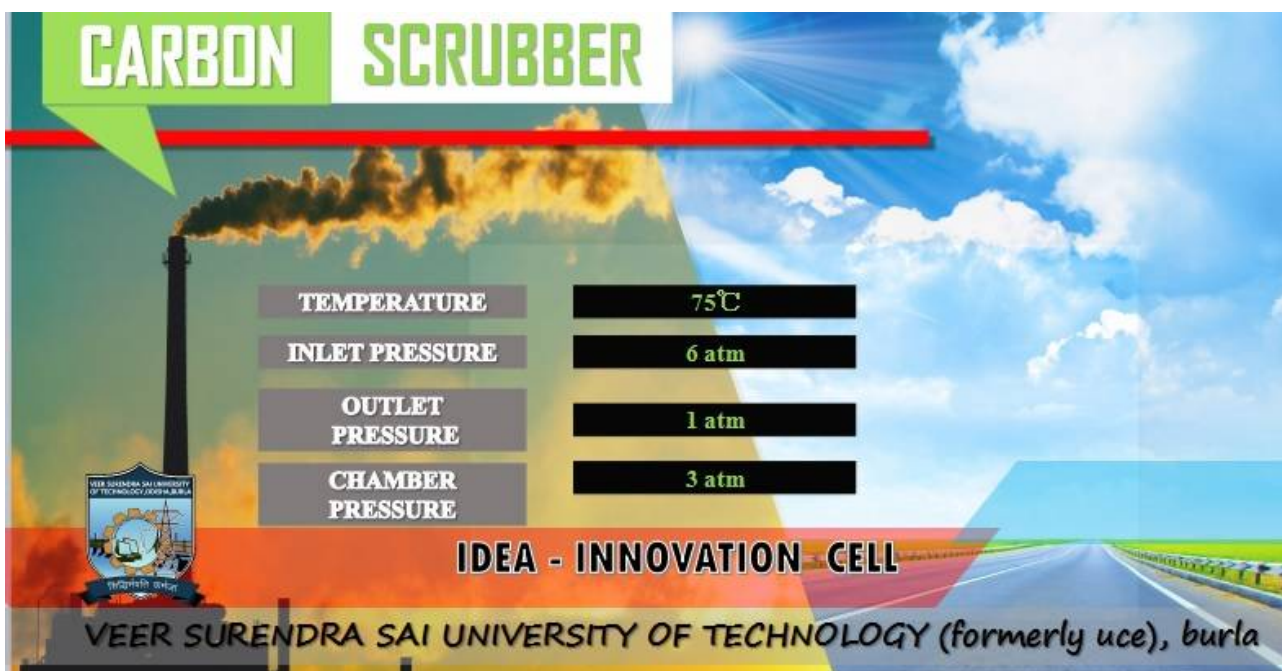


Fig-4:Required parameters and its values

IV. USAGE OF CO₂

Various uses of CO₂ are:-

- CO₂ is a super-critical liquid which can be used in detergent due to its tunable property.[7]
- CO₂ can be used in type B fire extinguisher
- CO₂ can be used as dry ice for storage of food and beverages.
- CO₂ also removes the ionic toxics from bio-fuels.[8]
- CO₂ cartridges are manufactured for different purposes like parachute ejection in rocket.

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- CO₂ is used in carbonated soft drinks and soda water.
- CO₂ is used in oil fields for oil enhance recovery.[9]
- CO₂ can be used in chemical laboratory for different testing purposes.[10]
- Used in pipeline transmission of heavy crude oil transmission pipeline.[11]

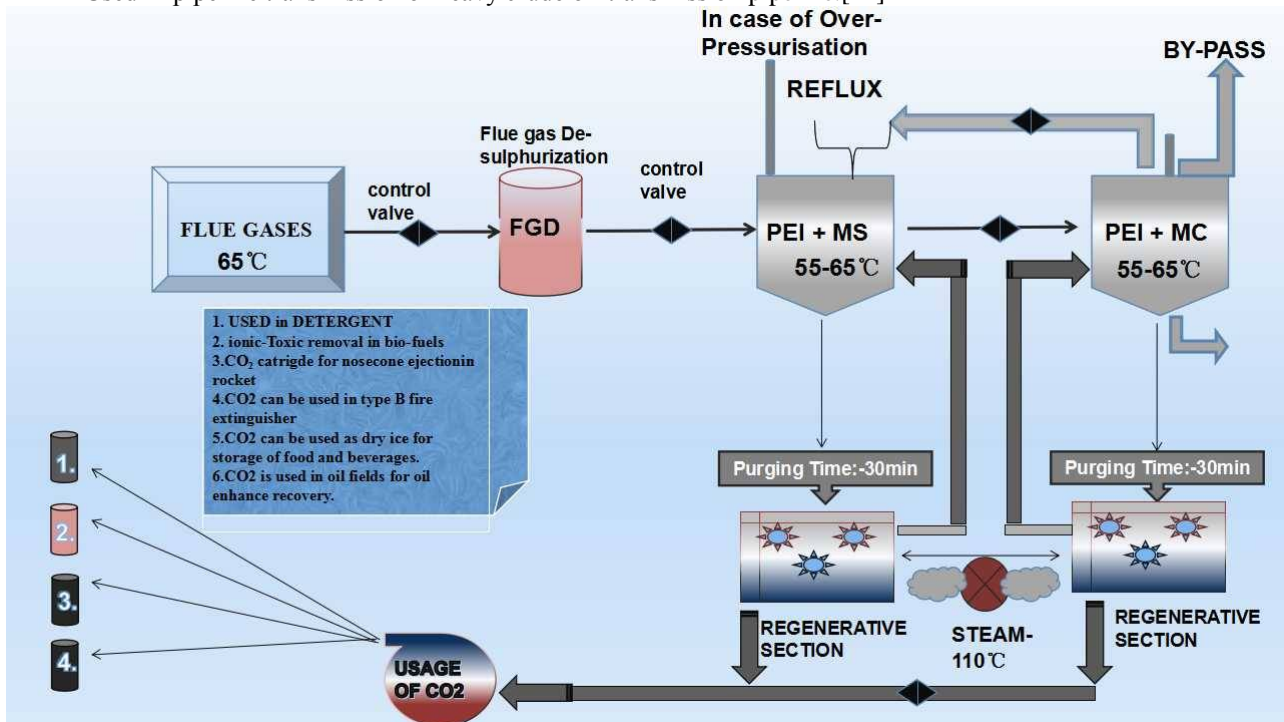


Fig-5: Complete flowsheet of the process with required PARAE

The entire process is depicted in a single flow-sheet. In regenerative section each time a sample of scrubbing material is taken and its characteristics were tested for different results. According to which its lifetime are decided.

Thus to meet increasing demand of power with minimal environmental impact for sustainable development, adoption of clean coal technologies with enhanced power plant efficiency, efficient pollution control systems and proper by-product and waste handling and utilization, is necessary. This idea was proposed based on present need as well as future need which include the concept of absorption, scrubbing, automation, cloud monitoring, commercial product from by product, utilization of CO₂ in an efficient and productive way.

V.CONCLUSION

We have implemented the concept of carbon capture, automation industrial safety guidelines, android app management system in an efficient and in an effective way . This methodology has been found to have versatile usage in all filed of industries. This concept can be implemented in field of Clean And Coal Technology. This will reduce anthropogenic CO₂ thereby reducing global warming and green house effect.

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