

Cooling Tower Performance Enhancement Using Bagasse Flyash Adsorbent based Dehumidification System



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CERTIFICATE

This is to certify that Mr. Sumit Kumar Mishra (2018061057), Mr. Vikash Pratap Singh (2018061060), Mr. Viraj Jaiswal (2018061061), and Mr. Vishal Singh (2018061062), the students of B. Tech in Chemical Engineering, have successfully completed the Project Phase II, on “**Cooling Tower Performance Enhancement Using Baggase Flyash Adsorbent based Dehumidification System**” for the complete fulfilment of the Degree of Bachelor of Technology in its Chemical Engineering branch by Madan Mohan Malaviya University of Technology in the academic year 2021-2022.

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ABSTRACT

Temperature control in industrial operations is a major function of cooling towers. They transfer heat from the heat source to the basin. That is why they have become a major part of power plants. As a final year project, a lab-scale cooling tower was designed and experiments were performed with different inlet flow rates. In addition to the variation of flow rates, the inlet temperature was also changed after one complete trial. Four sets of readings were recorded. By doing so variation of effectiveness was studied and based on this data, some design modifications were implemented. Relation of effectiveness with respect to time was studied by plotting graphs. To design the cooling tower Merkel's Theory was used. This theory is universally adopted for calculations of cooling tower performance. The cooling tower's design parameters include a 0.5 kg/s inlet flow rate and a 50°C inlet temperature. The design technique section goes into greater detail about these design parameters as well as other properties of manufactured cooling towers. Experiments revealed that the effectiveness ranged from 50% to 70%. An rise in the humidity of the surrounding air after one complete trial is one source of mistake. As a result, the air becomes saturated, resulting in decreased effectiveness. Drift losses can sometimes cause experimental results to be inaccurate.

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1.INTRODUCTION

(According to Statista Sugar Production World Wide Report in 2019/2020) India is one of the world's top ten sugar cane producers. Sugarcane production encompasses 420,146 hectares of sugar cane plantation land (Ha). Sugar cane production has the potential to reach 2,465,450 tons per year. Bagasse is what's left over after sugar cane is crushed to extract sugar juice for sugar manufacturing. Bagasse is made up of a little quantity of soluble substance, short fiber, and water. Around 3 tons of bagasse is produced for every 10 tons of sugarcane processed, a large amount that harms the ecosystem over time. As a result, it is believed that some initiatives to convert bagasse to a usable material will solve the problem. It is backed up by the bagasse's high cellulose content. The detailed composition is 50% cellulose, 25% lignin, and 25% hemicellulose^[1]. The high cellulose content of bagasse is an important factor to consider when selecting it as a raw material for carbon synthesis. Carbon-based materials can be used for a variety of applications, including gas adsorption, wastewater treatment, media storage electrodes, antibacterial agents, gas storage, and photocatalytic applications. The attempt to convert bagasse, which is a sugarcane industrial waste, into activated carbon is critical in order to boost bagasse's commercial worth as well as its environmental value as a waste management solution^[2].

Activated carbon is extensively employed as an adsorbent in separation systems, as well as in the purification of liquids and gases, because it is a porous-high surface area material. The adsorption capacity of activated carbon is determined by its porosity, surface area, pore volume, and pore size distribution. It can absorb humidity or water vapor as well. Some countries, particularly tropical countries, are noted for having day and night temperatures of roughly 30 °C and 20 °C, respectively, with high relative humidity in the range of 80 % - 90 %^{[1][2]}. High humidity encourages the growth of bacteria, ticks, and fungi, resulting in human

health issues such as allergic reactions to bacteria, ticks, and fungi, which can cause asthma and atopic illnesses. Moreover, humidity also can cause structural damage to the wall and some equipments.

Activated carbon's adsorption capacity is projected to become a problem solution for humidity management. Water vapor adsorption happens at polar locations, and it is then adsorbed onto previously adsorbed water molecules. The adsorption takes place due to hydrogen bonding.

Overheating of machine parts is fundamental issue in industry^[2]. It is caused in light of unsurprising operation of machine and normal conditions of the soil. Operation can't be ceased or by the day's conclusion the machine can't be advertised time to be chilled off and thusly there must be course of activity for cooling. Water is the finest cooling medium because it is trashy and accessible in riches^[2]. In any case it must be seen that predictable stream of new water to the machine isn't wise because it makes unfathomable squander. Cooling tower is utilize to attain the motivation driving freezing with smallest propensity of modern water. It circles modern water for solidifying to the device and utilizations littlest make up water that's lost in light of dispersal. Next to industry cooled water is required for, for case, ventilation systems, or control time. A cooling tower is the device utilize to lessening the hotness of a water stream through ousting tall temperature from water and transmitting it to the discuss. Cooling tower sort utilization of vanishing whereby a small of the water is scattered into a mixing discuss stream arrive thusly settled into the discuss. As needs be, anything remains of the debilitate is cooled essentially as appeared up within the figure. Chilling towers can bring off the water temperature supplementary than gadgets that utilization essentially air to scrap warm, just like the radiator in an auto, and stand along these lines all the more monetarily insightful and imperativeness beneficial.

1.2 Need and what happens in a cooling tower

- Evaporation of small piece of cooling tower cools anything is cleared out of water.
- Some degree of sensible warmth exchange moreover happens.^[2]
- Cooling water gets drenched with oxygen and distinctive gasses appear in environment.
- The current of dry discuss entering the cooling tower carries with its clean, soil, little scale natural spores, natural contaminants, and prepare discharges vented to discuss.^[2] The cooling water gets debased.
- Concentration of salts in cooling water increases. The salts display in makeup water get included to the salts surrendered by the scattered water.
- Process spills sully cooling water.
- These changes in cooling water and a parcel of the characteristic properties of water incite issues of disintegration, scaling, microbial advancement and fouling of the framework.

1.3. Cooling Tower Types

Cooling towers drop into two main types.

- Natural draft cooling tower.
- Mechanical draft cooling tower.

1.3.1 Natural Draft Cooling Tower

Normal draft towers utilize wide cement chimneys to current discuss over the media. For the reason that the broad measurement of these towers, they are for the foremost portion utilized for water stream extents over 45,000 m³/hr. These sorts of towers are utilized fair by utility control stations.^[2]

1.3.2 Mechanical Draft Cooling Tower

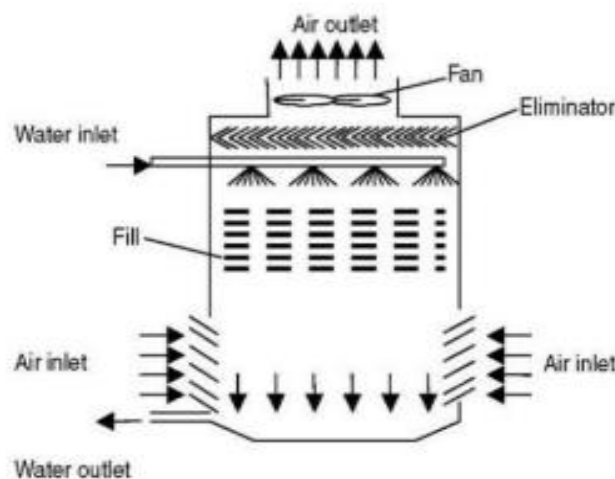
Mechanical draft towers utilize broad fans to drive or draw discuss through streamed water. The waterfalls slipping over seal planes, which bolster increase

the interaction period between the water and the discuss- this opens up warm trade between the two. Solidifying extent of Mechanical draft tower depend on their fan remove over and speed of prepare. Hence, the mechanical draft cooling tower are impressively advance for the most part utilized, the accentuation is organized them in this portion.^[2]

Mechanical draft towers are accessible in the accompanying wind stream courses of action:

- Counter flow induced draft.
- Counter flow forced draft.
- Cross flow induced draft.

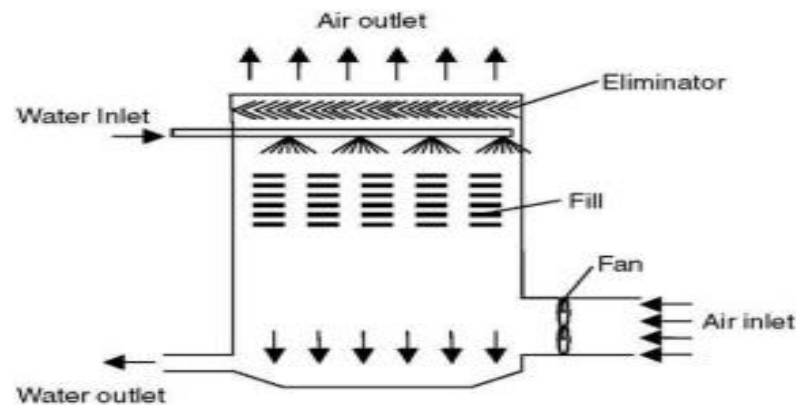
a. Counter Flow Induced Draft Cooling Tower Inside the counter stream incited draft format, warmed water arrives by the driving, while the talk about is shown on the base and takeoffs at the finest. Commonly obliged and prompted draft fans are utilized.



b. Counter Flow Forced Draft Cooling Tower

In a few compelled draft prisoner stream arrange, in any case, the water on the base of the seal is coordinated to a border rack that capacities as the cool water bowl. Propeller devotees stay connected underneath the best to pass the

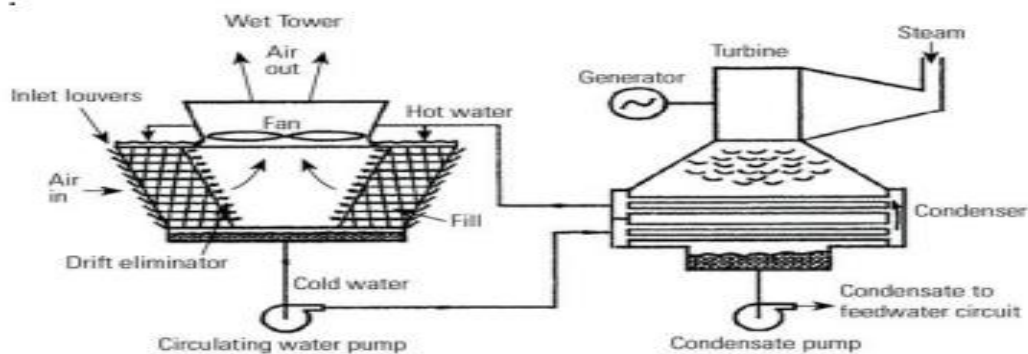
appearance over concluded the tower. Utilizing this layout, the tower is settled on supports, giving straight forward entrance close the supporters and their



motors.

c. Cross Flow Induced Draft Cooling Tower

In cross stream actuated draft towers, the water pass in at the leading and disregards the seal. The discuss, in any case, is shown along the edge either on one side(single-stream tower) or in reverse side (twofold stream tower). A incited draft fan attractions the discuss over the moistened seal and launches it through the foremost critical reason of the development.



Numerous towers are worked with the objective that they can be accumulated together to satisfy the pinned for control. Thusly, numerous cooling towers are gatherings of no less than two partitioned solidifying towers or "cells." The sum of chambers they take, e.g., an eight-cell tower, as as often as possible as conceivable proposes such towers. Different cell towers can be lineal, four-sided,

or bended subordinate upon the condition of the partitioned cells and whether the discuss deltas are organized on the borders or closes of the chambers.

1.4. Our Cooling Water System

In our actuated draft counter stream cooling tower are utilizing with one cell back to back setup.

Cooling tower			
Type	Counter Flow Forced Draft Cooling Tower		
No. of towers	One		
Wet bulb temperature	27 0C		
Dry bulb temperature			
Drift Loss	0.02 %		
Evaporation Loss	1.44 %		
Cost	2,000RS		
STRUCTURAL DETAILS			
Total Number of Fans	Two		
Fans per Cell	One		
Nominal Cell Dimensions	L X B X H	40*40*40	
Overall Tower Dimensions	L X B X H	40*40*167	
Motor data			
No. of Pumps			
Pump capacity	8415 m3/hr		
Pump speed	590 rpm		
Type of pump	Vertical mixed flow		

Motor Capacity	600 KW
MATERIAL OF CONSTRUCTION	
Frame work Members	Iron
Casing	Ply wood
Filling	PVC Film type
Support	Iron Beams
FAN	
Number	One per cell
Type	Axial Flow propeller type
No. of Blades	3 per fan
Diameter	40 cm
Fan speed	98 rpm

1.5. Components of Cooling Tower

The elementary apparatuses of an evaporative tower are

1. Frame and casing
2. Fill
3. Cold water basin
4. Drift eliminators

5. Air inlet

6. Louvers

7. Nozzles

8. Fans

1. Frame and casing: Most extreme towers have aide edges that help the exterior disconnect ranges (lodgings), motors, adherents, and different parts. With certain slighter plans, for occurrence, particular precious stone fiber parts, the bundling may on a very basic level be the edge.

2. Fill: Most extreme towers utilize seals to enable warm exchange through boosting water and discuss trade. Seal can either be sprinkle or film sort.

- With sprinkle seal, waterfalls over energetic coatings of indeed sprinkle chunks, productively negation into humbler globules, but too soaking the seal shallow. Adaptable sprinkle seal moves favored warmth exchange over the wood sprinkle fill.

- Film fill contains lean, immovably confined adaptable planes over which the water feasts, encompassing a tinny film in interaction with the discuss. These planes may be level, layered, honeycombed, or assorted cases. The film sort of seal is the supplementary competent and gives comparable warmth move in a more little capacity than the sprinkle seal.

3. Cold water basin: The solidifying water bowl, orchestrated adjacent the base of the tower, gets the chilled water that streams off over the tower and seal. The bowl frequently features a sump or moo point for the chilly water removal association. In a few tower projects, the frosty water bowl is underneath the entire seal.

4. Drift eliminators: These capture water globules entrapped recognizable all around stream that for the most part would be misplaced to the climate

5. Air inlet: Usually the reason for entrance for the discuss inflowing a tower. The inlet can take up a total sideways of tower-cross stream arrange or be found brief as a reexamination or the base of counter stream graphs.

6. Louvers: For the foremost portion, cross-stream towers have delta louvers. The inspiration behind louvers is to alter wind stream into the seal and hold the water interior the tower. A few counter stream tower plans do not require louvers.

7. Nozzles: These grant the water showers to damp the seal. Steady water scattering at the most noteworthy point of the seal is fundamental to achieve true blue soaking of the entirety seal shallow. Gushes holder either be settled set up and take either bended or four-sided shower designs or holder be a chunk of a rotating get together as start in certain circuitous cross-area towers.

8. Fans: Both middle point (propellers sort) and winding devotees are utilized as a chunk of towers. For the most part, propeller fans are utilized as a bit of induced Draft tower and commonly propeller and outward adherents are found in compelled draft towers. Subordinate upon their measurement, propeller fans can either be settled or flexible pitch.

- Fan going without non-programmed customizable pitch sharp edges permits a comparable fan to be utilized over an broad assortment of kW with the fan changed in understanding with pass on the pinned for wind current at the slightest control utilization.
- Automatic variable pitch cutting edges can vary wind current in light of changing burden conditions.

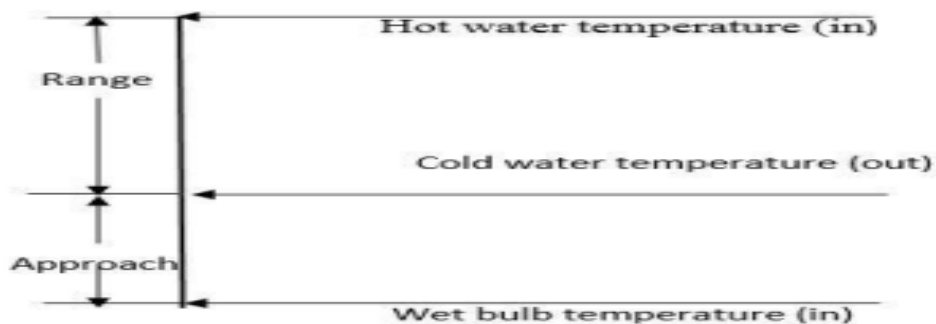
1.6 Tower Materials

Within the starting of refrigeration tower manufacture, towers stood built basically of timber. Wooden parts consolidated the edge, bundling, louvers, fill, and as often as possible the cool water bowl. On the off chance that the bowl remained not of wood, it plausible of cement. These days, tower creators make towers and tower fragments beginning an assortment of assets. Routinely many assets are utilized toward overhaul utilization encounter, reduce back, and development unflinching quality and long organization life. Mixed steel, diverse levels of stainless steel, glass fiber, and cement are by and large utilized as a portion of tower development and also aluminum and diverse sorts of plastics for some portions. Wood towers are as however available, be that as it may they have glass fiber as contradicted to wood sheets (bundling) over the timber framework. The channel discuss louvers could be precious stone string, the seal might remain adaptable, and the cool water bowl may be reinforce. Greater tower at times stay wrapped up of cement. Different towers—housings additionally bowls—are built of blended toughen or, wherever a damaging climate is an issue, stainless-steel. Once in a whereas an energized tower goes without a stainless steel bowl. Precious stone string in addition broadly utilized for refrigeration towers lodgings and bowls, giving expanded lifetime and protections after the dangerous impacts of various substances. Plastics are for the most part utilized for seal, tallying PVC, polypropylene, and diverse polymers. Protected timber sprinkle seal is as however decided for wood towers, in any case versatile sprinkle seal is moreover broadly utilized some time recently water circumstances command the utilization of sprinkle seal. Film seal, since it proposals more conspicuous warmth trade efficiency, remains the seal of choice for demands wherever the coursing water remains for the foremost portion permitted of rubbish that might protuberance the seal ways. Plastics furthermore capture broad utilization as gush instruments. Various gushes are presence wrapped up of PVC, ABS, polypropylene, and glass filled nylon. Aluminum, glass fiber, and hot-plunged electrifies solidify are ordinarily utilized fan assets. Dissimilar fans are regularly made after stirred steel.

Propeller fans are fabricated from stirred, aluminum, or molded gem fiber invigorated plastic

1.7. Cooling Tower Performance

The noteworthy components, starting the subject of characterizing the introduction of cooling towers, are



1. **“Range”** is the differentiate among the cooling-tower water inlet and vent temperature. A extraordinary CT Choice suggests that the cooling-tower has had the capacity to reduce the water-temperature effectively, and is hence introduction honorably.

$$\text{CT Range } (^{\circ}\text{C}) = [\text{CW inlet temp } (^{\circ}\text{C}) - \text{CW outlet temp } (^{\circ}\text{C})]$$

2. **“Approach”** is the differentiate among the coolingtower’s outlet frosty water temperature and encompassing damp handle temperature. Though, together assortment and strategy have to be checked, the Approach could be a prevalent pointer of cooling-tower’s execution.

$$\text{CT Approach } (^{\circ}\text{C}) = [\text{CW outlet temp } (^{\circ}\text{C}) - \text{Wet bulb temp } (^{\circ}\text{C})]$$

3. **“Cooling tower effectiveness”** (in rate) is the extent of assortment, to the culminate assortment, i.e., differentiate among cooling-water delta temperature and encompassing stormy handle temperature

$$\text{Effectiveness} = \frac{\text{Range}}{\text{Range} + \text{Approach}}$$

4. **“Cooling capacity”** is the warmth rejected in kCal/hr or TR, indicated as result of mass stream degree of water, specific warmth and temperature qualification.

5. **“Evaporation loss”** is the water sum scattered for cooling commitment and, theoretically, for each 10,00,000 kCal warm prohibited, vanishing sum workings out to 1.8 m³s. An correct association utilized frequently is

$$\text{Evaporation Loss (m}^3\text{/hr)} = 0.00085 \times 1.8 \times \text{circulation rate (m}^3\text{/hr)} \times (T_1 - T_2)$$

$T_1 - T_2$ = Temp. Difference between inlet and outlet water.

1.8. Fill Media Effects

In a refrigeration tower, warmed water is scattered over seal media which streams discouraged and is chilled since of vanishing by the blending discuss. Discuss draft is fulfilled with utilization of fans. In this way certain control is exhausted in drawing the water to a stature over the seal and besides in fans making the draft. A essentialness profitable or small control eating up cooling-tower is to devour successful diagrams of seal media through legitimate water scattering, coast eliminator, fan, gearbox and motor. Control save stores within the refrigeration tower, with utilization of compelling seal arrangement.

Function of Fill media in a Cooling Tower:

Warmth exchange among discuss and water is influenced through surface run of warmth exchange, period of warmth exchange (association) and commotion in water influencing cautious quality of blending. Seal average within the refrigeration tower is tried and true to achieve all of upstairs.

Splash Fill Media: As the depiction illustrates, sprinkle seal media makes the required warmth exchange zone through sprinkling action of water over seal media and from now on repudiation into more diminutive water globules. In like manner, shallow of warmth exchange is the shallow extend of the water globules, which is in interaction by discuss.

Film Fill: In a film seal, water outlines a tinny film on both adjoining of seal pieces. In this way region of warmth exchange is the shallow zone of the seal pieces, which is in interaction with discuss

2.Literature Review

Sugarcane bagasse could be a squander item from sugar refining businesses, gotten after the extraction of juice for generation of sugar. Approximately 54 million dry tons of bagasse are delivered yearly all through the world. Without appropriate treatment and transfer of these agrarian squanders, they may cause a genuine contamination issue within the environment. Sugarcane bagasse is composed generally of cellulose and lignin. Consequently, it could be a potential asset of cheaper crude fabric for enacted carbon (AC) generation in the event that pyrolyzed beneath controlled conditions or with a few chemical treatment. This might offer the combined benefits of diminishing the volume of agrarian squanders and at the same time creating a important adsorbent with lower taken a toll than commercial enacted carbons. Enacted carbon adsorption was over and over detailed to be an viable innovation for natural remediation, for mechanical handling, and to evacuate follow contaminants from both discuss and water. Mechanical exercises cause numerous natural issues and annihilation of a few environments due to aggregation of perilous poisons such as unstable natural compounds (VOCs), which are the foremost common toxins radiated by the distinctive businesses. VOCs are ordinarily display in gas or fluid streams and are exceptionally destructive for human wellbeing, crops, vegetation, and the environment, indeed at exceptionally moo concentrations. Hence, there's a squeezing ought to create unused environment-friendly advances and modern materials for VOCs expulsion.^[3]

In this think about, the enacted carbon was delivered through the chemical actuation prepare. Sugarcane bagasse squander, collected from the sugar refining businesses, was washed with refined water to evacuate substances within the fabric. At that point it was dried at 120°C in a hot-air stove for 24 hr, ground, and sieved. The sieved sugarcane bagasse was changed to carbon by start in a suppress heater at the temperature of 500°C without expansion of chemical specialist and

beneath air discuss for 2 hr. By carbonization, most of the noncarbon components, hydrogen and oxygen, are expelled in vaporous frame and the remaining carbon particles are gathered into organized crystallographic arrangement known as basic graphitic crystallites. The carbonization step more often than not comes about in an inert fabric with a particular surface zone and moo adsorption capacity. Created carbon was at that point treated with 30% fluid arrangement of phosphoric corrosive (H_3PO_4) in a weight proportion 1:1 for 24 hr and after that washed with double-distilled water a few times and dried.^[3]

This inquire about work reports on the potential of bagasse, a strong squander from sugar production lines, to create activated-carbon (AC) as an adsorbent. The actuation was conducted beneath 500, 600, and 700 °C utilizing steam as the enactment operator to create AC500, AC600, and AC700, individually. The prepared-materials were characterized to get it their essential substance, surface morphology, warm properties, utilitarian bunches recognizable proof, surface range, and pore measure. AC700 given the most elevated surface region of 592.36 m²/g and demonstrated the commitment of mesopores disperses along 1.5–8.0 nm of pore estimate. Hence, an adsorption test was conducted with AC700 as adsorbent.^[4]

Adsorption frameworks are predominant in numerous areas, and different endeavors have been made, such as for discuss conditioning frameworks and warm pumps, to make strides productivity. Activated-carbon (AC) could be a profoundly permeable fabric that has produced ubiquity of adsorption refrigeration frameworks due to its solid adsorption of a few refrigerants as adsorption sets. ACs are generally arranged from carbon assets, such as coal, peat, wood, shells, and different rural wastes.

Amid the generation organize. Bagasse contains brief strands and a little sum of solvent solids. Bagasse contains a tall substance of cellulose (up to 50%), hemicellulose (25%), and lignin (25%). The tall substance of cellulose may be a

solid reason for choosing bagasse for activated-carbon generation. Much inquire about on carbon and its allotrope generation has been conducted due to the multi-functional properties of the carbonaceous materials, counting for adsorption, photocatalysis, electronic materials, etc. Inquire about on the generation of activated-carbon from bagasse for Cr adsorbent was conducted in which the carbon was chemically enacted by ZnCl_2 at $600\text{ }^\circ\text{C}$ beneath N_2 environment. The surface region for the created activated-carbon was $916.134\text{ m}^2/\text{g}$. The carbon enacted by NaOH and H_2SO_4 was detailed advance, and the adsorption proficiency for methylene orange color from fluid arrangement was examined. Another analysis was also carried-out the chemical activation of carbon from bagasse by applying KOH solution with a KOH to biomass ratio of 1:3 under heat treatment of $800\text{ }^\circ\text{C}$ for 30 min. The activated-carbon showed an adsorption capacity (51.3 mg/g) to Pb^{2+} . The activated-carbon from bagasse, which is activated by a mixture of H_3PO_4 and ZnCl_2 , also shows good adsorption performance to remove chromophore from raw cane juice in sugar production. Moreover, microwave assisted heat treatment to sugarcane carbon produces activated-carbon powder with a maximum monolayer adsorption capacity for ammoniacal nitrogen ($\text{NH}_3\text{-N}$) adsorption of 138.46 mg/g and 12.81 mg/g for orthophosphate adsorption capacity. The kinetics of adsorption follows a second-order-kinetics model, indicating the potential of activated carbon prepared from sugarcane bagasse for the adsorptive treatment of semi-aerobic landfill leachate.^[4]

Numerous inquire about works performed chemical enactment by applying soluble base hydroxide or corrosive arrangement in conjunction with a warm treatment. The comes about appeared great adsorption capacity of the activated-carbon. Be that as it may, the chemicals chosen for actuation are not environmentally-friendly. Fluid squander after activation increases natural impacts and it requires dealing with for treatment. Within the system of the

compelling utilization of bagasse waste from the sugar manufacturing plant, the exertion has been made through steam enactment to make actuated carbon. The carbonized bagasse, actuated by steam, come to an ideal condition of 800 °C for 1 h. The steam at 110 °C, fundamental for enactment, was conducted for the carbonized remaining biomass sources. At an enactment temperature of 900 °C for 45 min beneath steam climate, enacted carbon extricated from olive bagasse was arranged, and the surface region expanded up to 1106 m²/g compared with N₂ actuation and the actuation beneath other chemical climates. At 700 °C for 1 h steam actuation, the ideal surface zone gotten by bagasse fly cinder was as it were 656 m²/g, but the enactment utilizing KOH as the chemical operator at 700 °C expanded the surface range up to 2571 m²/g. By expanding the steam actuation time, an increment in surface zone taken after by an increment in fragrant surface bunches and a diminish in polar/nonpolar surface bunches was as of late detailed; be that as it may, the interaction component was not created.^[4]

In this investigate work, carbonized bagasse was actuated by streaming water vapor as an enactment operator beneath different temperatures. The point of this investigate work was to investigate the plausibility, through steam actuation, of planning actuated carbon from bagasse a strong squander of sugar manufacturing plants. The coming about activated-carbons were characterized by a few strategies. Besides, the activated-carbon with the most noteworthy surface zone (916.13 m²/g) was tried for cooling tower execution upgrade utilizing bagasse adsorbent to get it its adsorption capability.

Enacted carbons with exceedingly created surface region are as a rule utilized around the world for water treatment, wastewater recovery, gas refinement conjointly as catalyst back. Enacted carbon delivered from a assortment of carbonaceous source materials. The choice of antecedent is generally subordinate on its accessibility, taken a toll, and immaculateness, but the fabricating handle and aiming application of the item are also important contemplations. Within the

later a long time, numerous other rural by items have been utilized as sources for actuated carbons. Agrarian biomass squanders have demonstrated to be promising crude materials for the generation of actuated carbons since of their accessibility at a moo cost, liberally accessible, and renewable assets. They were utilized for the generation of enacted carbon due to tall carbon substance, a tall adsorption capacity, tall thickness and significant great mechanical quality. They too have moo fiery debris substance which is perfect for making exceedingly permeable structures inside the enacted carbon framework. Numerous rural by-products such as coconut shell, grain sorghum , coffee bean husks, elastic wood sawdust, chestnut wood, and natural product stones, have been found to be appropriate antecedents for enacted carbon due to their tall carbon and moo fiery debris substance.

In common, there are two primary steps for the planning of actuated carbon: (1) the carbonization of crude materials underneath 800oC, within the nonappearance of oxygen, and (2) the enactment of carbonized item (char), either utilizing physical or chemical actuation methods. Generally physical enactment could be a two-step prepare which includes carbonization of crude materials followed by actuation of the coming about char at lifted temperature within the presence of appropriate oxidizing gasses such as carbon dioxide, steam, discuss or their blends. Within the chemical enactment prepare, both steps are carried out at the same time, with the antecedent being blended with chemical actuating operators. In chemical enactment, getting dried out reagents such as phosphoric corrosive, sulfuric corrosive, zinc chloride, potassium hydroxide are utilized to impregnate the crude materials. Chemical enactment offers a few points of interest which incorporate single step actuation, moo enactment temperatures, moo actuation time, higher yields and way better permeable structure. Be that as it may, the method includes a complex recuperation and reuse of the actuating operator, which produces fluid release that requests gushing treatment.

Sugarcane bagasse (SCB) is appropriate for planning actuated carbons due to their great normal structure and moor cinder substance. SCB could be a by item of sugarcane businesses gotten after the extraction of juice for generation of sugar. Change of sugarcane bagasse into enacted carbons which can be utilized as adsorbents, particle trade, carbon atomic strainer, catalyst would include esteem to these agrarian commodities, offer assistance decrease the fetched of squander transfer, and give a possibly cheap elective to existing commercial carbons. Considers on CO₂ enactment of sugarcane bagasse have not been detailed in writing and subsequently the show think about endeavors to plan enacted carbon with well created porosity. The points of this work were to utilize SCB, biomass squander, for the arrangement of actuated carbon by physical enactment utilizing CO₂ gas as an actuating operator. There are a few basic parameters within the planning of actuated carbon that would influence its structure, one of which is carbonization temperature. The impacts of carbonization temperature on the physico-chemical characteristics of the actuated carbon were examined in arrange to get tall adsorption capacity and surface range of the item. The one-step physical enactment handle utilizing CO₂ gas is alluring due to lower vitality utilization, capital use, preparing time that can altogether move forward the method financial matters.^[5]

Preparation activated carbon

Orange peel (OP), external skin with white inward skin, a by-product collected from the neighborhood eatery and natural product juice businesses, was the forerunner utilized within the show consider. The crude forerunner was washed comprehensively with deionized water to evacuate following soil particles from the surface. Dried (at 110 °C) OP was cut, measured to a molecule measure of 4 mm. The comes about of proximate and extreme examination of orange peel are given.

Within the to begin with step of actuation, the beginning fabric was blended with

ZnCl₂ at the ZnCl₂/starting fabric weight proportion of 1:1 and the blend was work with including refined water. The blend was at that point dried at 110 °C to prepare the impregnated test. Within the moment step, the impregnated test was set on a quartz dish, which was at that point embedded in a quartz tube (channel diameter 60 mm). The same strategy and proportion moreover is connected for K₂CO₃.

Carbonization of the impregnated tests was carried out in a 316 stainless steel tubular reactor with a length of 90 mm and an inner distance across of 105 mm beneath nitrogen stream. The impregnated test was warmed up to actuation temperature beneath N₂ stream (100 ml min⁻¹) at warming rate of 10 °C min⁻¹ and held for 1 h at this actuation temperature. The enactment temperature shifted from 400 to 1000 °C.

Yield of AC (wt%) = (Weight of activated carbon/Weight of orange peel) × 100

Experimental Analysis

Pretreatment of bagasse

The bagasse was collected from sugar cane plant in Kudus, Central Java, Indonesia. Bagasse was washed and drenched in refined water for 24 hours. Damp bagasse was dried in stove at 120 °C for 24 hours to kill any remaining dampness and dodge condensation amid try.

Synthesis of Activated Carbon

Sum of bagasse was carbonized in a heater beneath N₂ stream inside 200 cm³/min rate stream, at 600 °C for 30 min with warming rate of 18 °C/min. The carbonized item was at that point cooled to room temperature in N₂ climate. After weighing to know carbonization abdicate with condition (1), the following step was actuation prepare beneath 600 °C and 700 °C for 1 h with warming rate of 18 °C/min beneath steam stream. The enactment was conducted inside an

installed-tube heater as depicted in Fig. 1. Steam was delivered by bubbled water at 120 ° C and stream the steam into the heater with N2 carrier stream. The actuation comes about were weighted to calculate mass debasement and % surrender with condition (2) and (3). Carbon that were actuated at 600 °C and 700 °C signified as C600 and C700, separately.

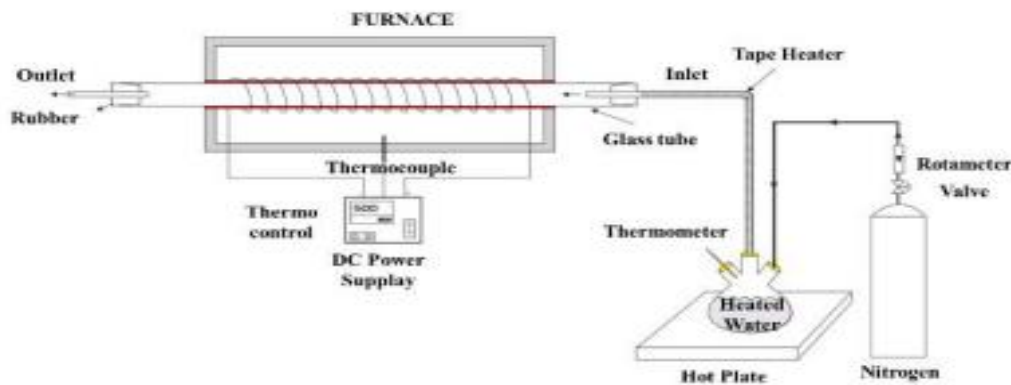
$$y_1 = \frac{m_2}{m_1} \times 100\%$$

$$y_2 = \frac{m_4}{m_2} \times 100\%$$

$$y_3 = \frac{m_4}{m_1} \times 100\%$$

Materials characterization

The prepared-material was analyzed by X-Ray Diffraction (Rigaku Miniflex600) with Cu/K α radiation extending from 0° to 80° to get it its particular diffraction design. Fourier Change Infrared, FTIR investigation was conducted inside 4000-400 cm⁻¹ wavenumber to analyze its useful bunches vibration at some time recently and after actuation. Essential investigation was carried out by Yanaco CHN Corder MT-5. The isotherms of N₂ were measured at 77K at a relative weight.



Water vapor adsorption

The water vapor adsorption capacity and isotherm of adsorption-desorption of actuated carbon were carried out at 20 °C and 30 °C at a relative weight employing a attractive suspension adsorption estimation unit (MSBVG-S2) given by Bel Japan. The weight of adsorbed water vapor was measured up to a comparing immersion weight. Adsorption isotherm was gotten by plotting the sum of adsorbed water vapor to the expanding of the relative weight. In the interim, desorption isotherm was decided from the sum of water vapor discharged by the activated-carbon when the weight diminished.

3. Materials and Methods

3.1 Materials Required

1. **Fly Ash of Bagasse:** It could be a squander collected from the particulate collection gear connected upstream to the stacks of bagasse-fired boilers. Bagasse fly fiery debris contains a tall sum of unburned carbon and can have a few potential impacts on people, plants and creatures through the discuss, water and soil. Since BFA has exceptionally little molecule sizes extending from 0.5 to 300 microns and being lightweight, it can be effortlessly airborne and tends to cause discuss contamination and respiratory problems. It contains follows of overwhelming metals, which contaminate the discuss, soil and groundwater. It can be utilized as fertilizer but it solidifies underground. As it were land-filling (dumping) methods are utilized to arrange of it, which needs expansive areas. This fly fiery remains isn't arranged of in open areas or sea-going bodies such as oceans, waterways or ponds. In this survey, we center on the valorisation of bagasse fly fiery debris (the solid squander of the sugar industry) in several zones to decrease the strong squander era and natural contamination stack, in this manner killing the natural stack we utilize it as water vapor adsorbent.



2-(0.1) M HCl: We have 35% purity of HCl in lab. concentration (M) =
purity * density * molality

$$\text{concentration} = \frac{"35\text{g}"}{"(100\text{g solution})"} * \frac{"1180\text{g}"}{"(1\text{L solution})"} * \frac{"(1\text{mol HCL})"}{"36.46\text{g}"} \approx 12 \text{ moles per liter}$$

Concentrated HCl is 12 M, which suggests 12 moles/L or 0.012 moles/mL.

0.1 M solution has arrangement of HCl has 0.1 moles/L

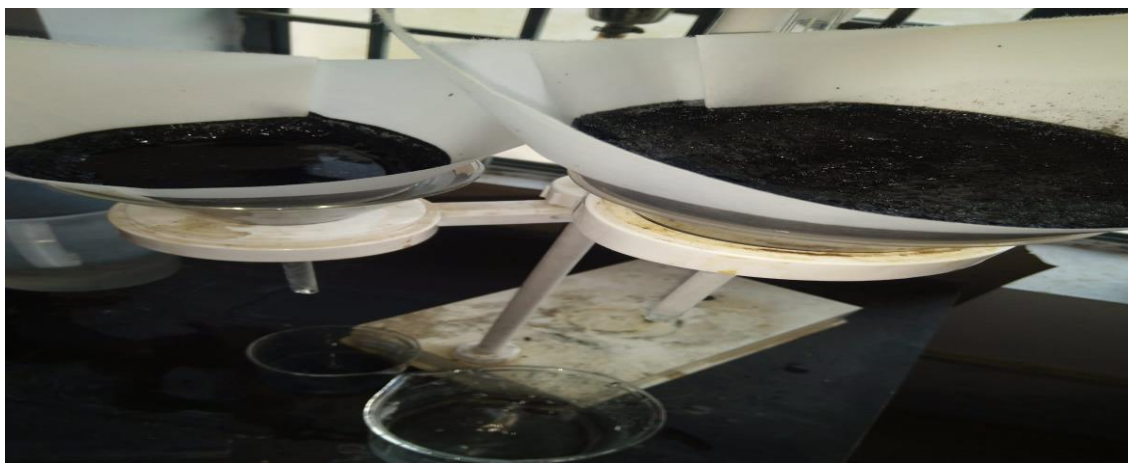
$$(0.012 \text{ moles/mL})(x \text{ mL}) = 0.1 \text{ moles}$$

$$x = \frac{0.1}{0.012} = 8.33$$

Total volume of 1 liter (means add the 8.33 mL con HCl to 991.67 mL water).



3-Filter Paper: It could be a semi-permeable paper boundary put opposite to a fluid or discuss stream. It is utilized to partitioned fine strong particles from fluids or gases. We utilized to channel flyash after treating it with 0.1 M HCl and washing it with water amid neutralization prepare.



3-Calcium Chloride (CaCl₂): Calcium chloride is an ionic compound of calcium and chlorine. It is exceedingly solvent in water and it is deliquescent. It may be a salt that's strong at room temperature, and it carries on as a commonplace ionic halide. Calcium chloride is exceedingly permeable, exceedingly deliquescent and can effectively be broken up in

water. When broken down into water, it makes a expansive sum of arrangement warm and enormously brings down the solidifying point of water, with solid antifreezing and de-icing impacts. It's primary employments are antifreezing, de-icing, dehumidifying, dust-control, squander fluid treatment, etc.



3.2-Instruments Required

1-Oven: It could be a device which is utilized to uncover materials to a hot environment. Stoves contain a empty chamber and give a implies of warming the chamber in a controlled way. We required it for drying of our item which is delivered amid the method of making enacted carbon.

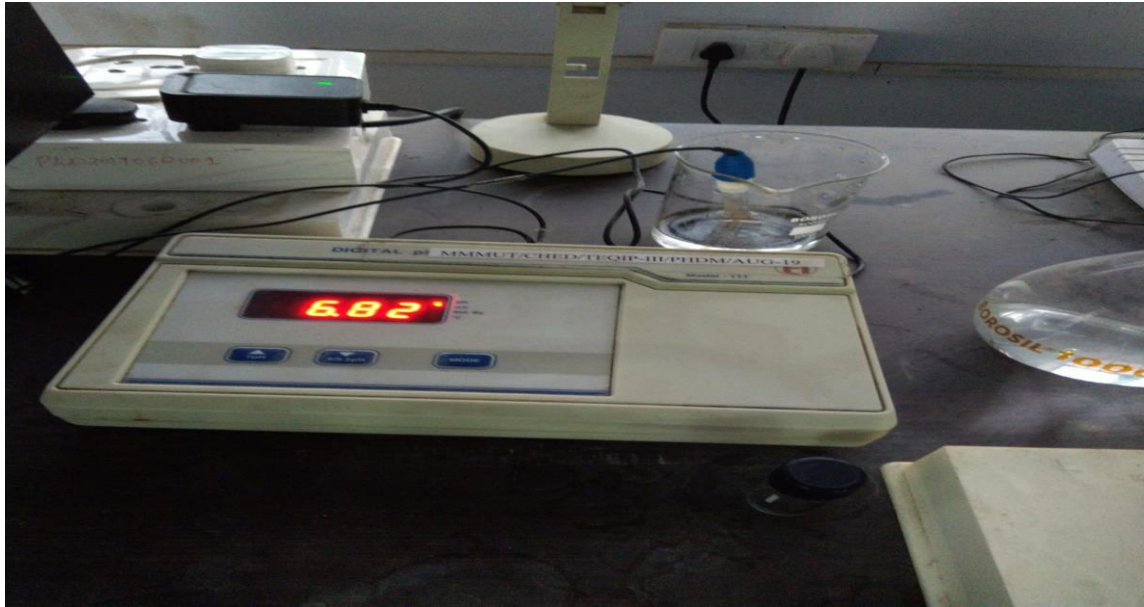


2-Weight measuring device: Advanced weighing scales offer assistance show the precise weight of the protest being weighed. We utilized it to degree required amount of flyash and time to time we degree weight of our item which is ready amid the method of making actuated carbon and adsorbent sheets from enacted carbon.



3-pH Meter: It is an instrument utilized to degree corrosiveness or alkalinity of a arrangement. It is measured on a scale of to 14. We utilized it to degree pH esteem of our item so that ready to make our item impartial

(implies pH esteem is close to 7) by once more and once more washing it with water and filtered water pH is measured till it's esteem comes close to 7.



3.3 Methods of Preparation Adsorbent sheet from baggase

- Firstly, Bagasse was dried under sunlight to reduce the moisture content in bagasse at New India Sugar Mills, Hata ,Uttar Pradesh, India.
- The dry bagasse was ground with a pounding machine and set interior electric heater. After firing at 1200°C for 3h bagasse ash was obtained at New India Sugar Mills, Hata, Uttar Pradesh, India.
- Flash ash is dipped in water so that lightest ash of bagasse float on upper surface of container and unwanted impurities can be removed such as sand ,solid particles e.t.c and proper stirring is done.
- Formation of two layer can easily be seen in water, Upper floating layer of container is collected in beaker
- Drying in Oven for 2-Days.
- After drying 2 days, dried powdered ash obtained.
- 100 gm of dried ash is taken.

- Making solution of 0.1 M HCl, in which Distilled water of 991.67 ml and 8.33 ml of conc. HCl is taken.
- Proper stirring is done in solution of 0.1 M HCl
- Prepared product after stirring then it is left for drying for 6 hours in oven at 107°C
- Washing to neutralize the product and filter with the help of filter paper.
- pH determination of filtered water.
- Again and again washing is done till its pH comes near to 7 on pH scale 0 to 14.
- Drying the product for 1 day.
- Now, We are going to make two types of adsorbent sheets.
 - ❖ Adsorbent sheet without CaCl₂ (Dried product is put on rectangular steel frame so that we can get rectangular sheet which is easy to put in Cooling Tower)
 - ❖ Adsorbent Sheet with CaCl₂ (Dried product is mixed in 1:8 with CaCl₂ and formed product is put on rectangular steel frame same as adsorbent sheet without CaCl₂)
- (All Experiment were performed in the laboratory of Department of Chemical Engineering, Gorakhpur, Uttar Pradesh, India.)

3.4 Image of prepared adsorbent sheet



3.5 Preparation of Cooling Tower

- Firstly, Iron frame structure is formed in which one cuboid shaped tower with height 167 cm, breadth and length of 40cm and one cube shaped cell is attached with height ,breadth and length of 40cm.
- One sprinkle is attached with iron water tube which is put in the middle of cuboid shaped tower at the height of 117 cm from the bottom.
- All iron frame structure is covered with wooden ply .so that unwanted dust particles and other things are do not enter into cooling tower.
- Two exhaust fans are attached one in tower and other in cell.



- Polyvinyl Chloride (PVC) fills are used which is attached in cooling tower below sprinkle.
- Water cooler Grass is put above PVC so that breaking of large water droplets into small droplets is achieved and increasing of it's surface area is done. Large surface area helps in better loss of heat energy.
- A water suction pump is attached with iron tube with the help of plastic pipe with the help of it hot water is sucked and dropped by the sprinkle system.
- Our prepared adsorbent sheet is put above cell exhaust and we perform three experiments
 - Without Adsorbent
 - With Adsorbent Sheet which is made without CaCl_2
 - With Adsorbent Sheet which is made with CaCl_2

3.6 Schematic explanation and working of our Cooling Tower Setup

Most cooling towers work based on the principle of "evaporative cooling":

Evaporative cooling is the process where warm water from an industrial process is pumped up to the top of the cooling tower where the water distribution system is. The water then gets distributed by cooling tower nozzles to the wet deck. At the same time, air is being drawn through the air-inlet louvers forcing water to evaporate. Evaporation causes the heat to be removed from the make up water. The hot air naturally rises out of the tire.



4.Result and Discussions

4.1 Cooling Tower without Adsorbent Sheet without CaCl₂

Intial Temperature (Hot Water) °C	Final Temperature (Cold Water) °C	Range °C
78°C	51	27
70	47	23
60	44	16
55	41	14
65.75	45.75	20

CT Mean Range=20°C

CT Wet Bulb Temperature=26°C(Inlet)

CT Wet Bulb Temperature=37°C(Outlet)

CT Approach=CWT-WBT=45-26=19°C

CT Effectiveness (η)= $\frac{Range}{Range+Approach} * 100$

$$\eta = \frac{20}{20+19} * 100 = 51.28\%$$

Temperature Range=65.75-45.75=20°C

Dry Bulb Temperature= 30°C(Inlet)

Dry Bulb Temperature= 38°C(Outlet)

Cooling Capacity=16276*4.2*20*0.000278*0.239=90.8384kcal/sec

$$\text{Evaporation Loss} = 0.0085 * 1.8 * 16276 * 20 = 498.456 \text{ m}^3/\text{hr}$$

$$\% \text{ Evaporation} = \frac{498.0456}{16276} = 3.06\%$$

4.2 Using Adsorbent Sheet without CaCl₂

Initial Temperature (Hot Water) °C	Final Temperature (Cold Water) °C	Range °C
55°C	40	15
60	42	18
70	46	24
65	45	20
62.05	43.25	19.25

$$\text{CT Mean Range} = 19.25^\circ\text{C}$$

$$\text{CT Wet Bulb Temperature} = 26^\circ\text{C (Inlet)}$$

$$\text{CT Wet Bulb Temperature} = 37^\circ\text{C (Outlet)}$$

$$\text{CT Approach} = \text{CWT} - \text{WBT} = 43.25 - 26 = 19.25^\circ\text{C}$$

$$\text{CT Effectiveness } (\eta) = \frac{\text{Range}}{\text{Range} + \text{Approach}} * 100$$

$$\eta = \frac{19.25}{19.25 + 17.25} * 100 = 52.7\%$$

4.3 Using Adsorbent Sheet with CaCl₂

Initial Temperature (Hot Water) °C	Final Temperature (Cold Water) °C	Range °C
70°C	44.5	25.5
65	42	23
60	40.5	19.5
55	39	16
62.5	41.5	21

CT Mean Range=21°C

CT Wet Bulb Temperature=26°C(Inlet)

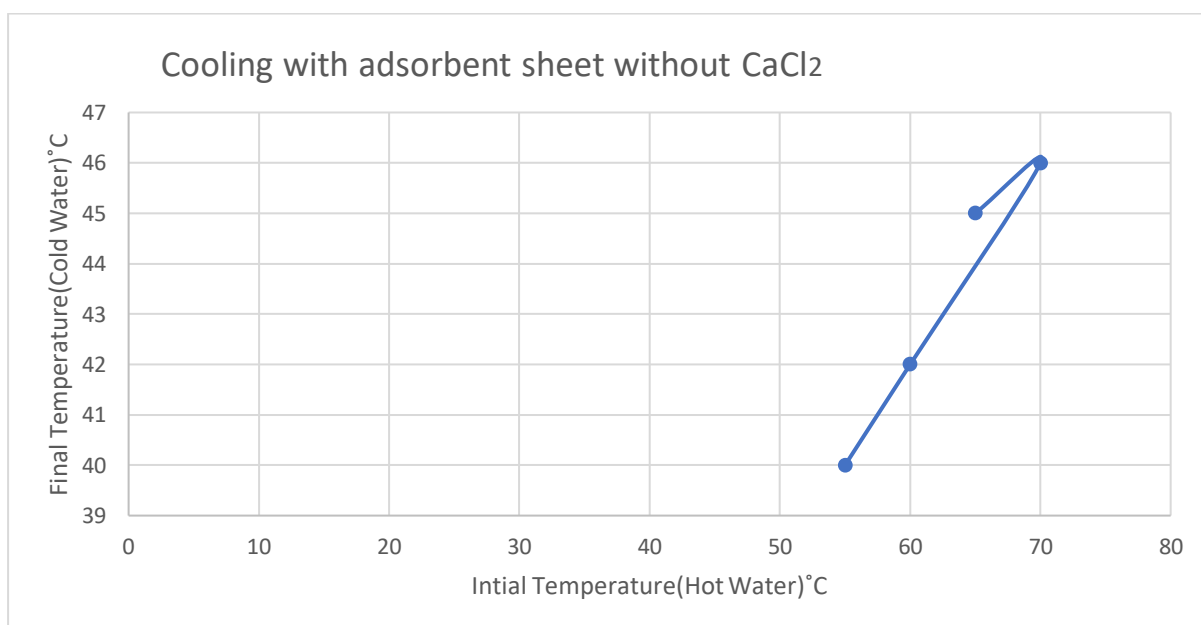
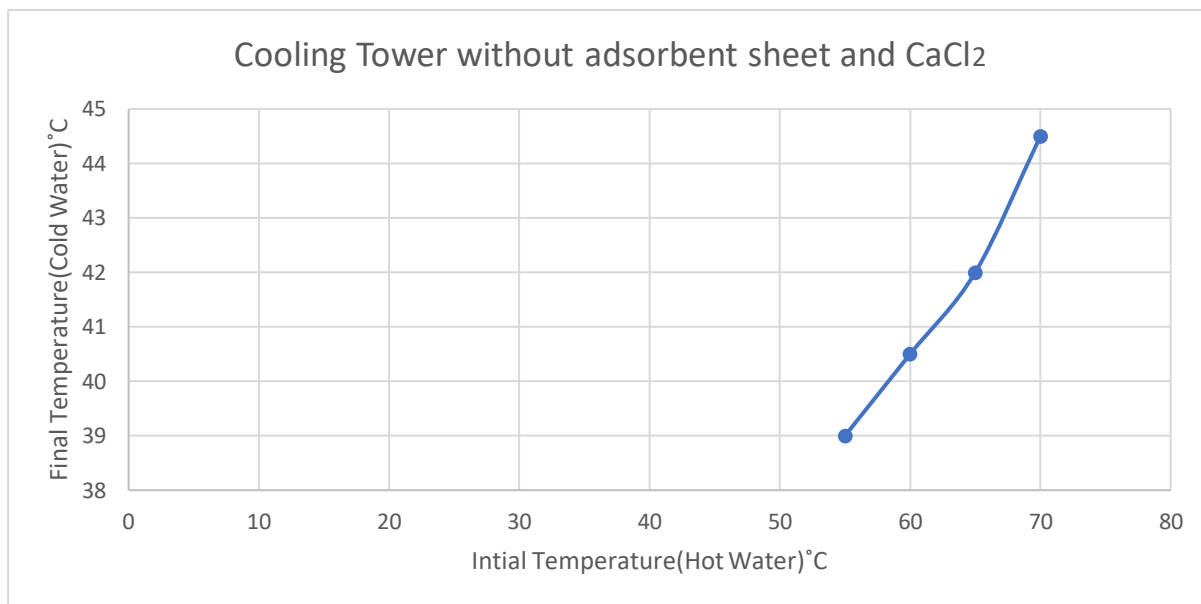
CT Wet Bulb Temperature=37°C(Outlet)

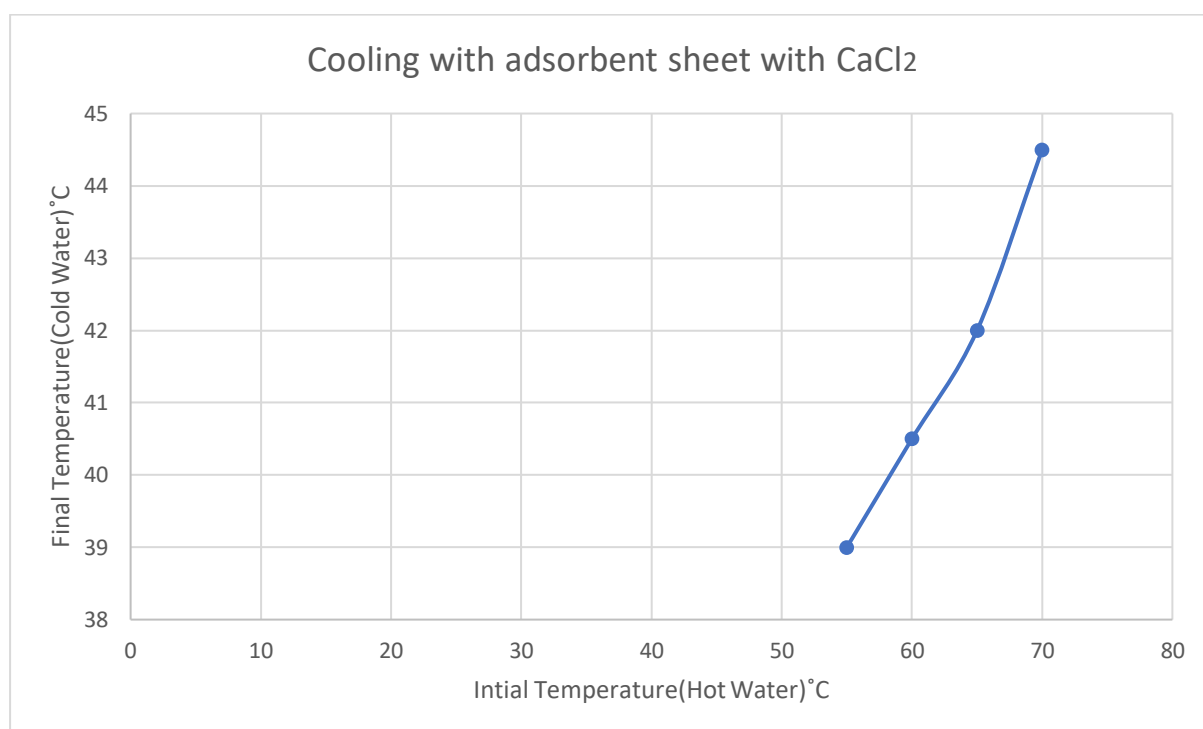
CT Approach=CWT-WBT=41.5-26=15.5°C

CT Effectiveness (η)= $\frac{Range}{Range+Approach} * 100$

$$\eta = \frac{21}{21+15.5} * 100 = 57.53\%$$

4.4 Graph





5.CONCLUSION

It is found that effectiveness of cooling tower increases with adsorbent sheet but it is much more increases when we are using adsorbent sheet with CaCl_2 . Normal Cooling Tower gives only effectiveness of 51.28% but after using adsorbent sheet with CaCl_2 it's effectiveness increases by 57.53%. This happens due to CaCl_2 it creates more activated pores on adsorbent sheet.

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