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To Study the Performance Evaluation of Hybrid Air Conditioning system using Indirect Evaporative Cooling Approach

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Abstract:- In hot and humid climate where simple vapor compression system does not perform well, desiccant based air conditioning system can do better since it is capable to overcome the bulk of moisture i.e. latent load. However, removing the moisture from the air at the cost of sensible load, it increases due to heating of the air. This paper represents the Performance Evaluation of Hybrid Air Conditioning system using Indirect Evaporative Cooling Approach. The experimentation has been done with various cycle of operation viz. ventilation, mixed, with different dessicant materials and dessicant wheel speed. In desiccant wheel, if the regeneration temperature increases, the loads gets completely separated, thereby performance of cooling coil improves a lot i.e. 70% to 80%. However, system performance decreases due to increased power at higher regeneration temperature and the latent load does not get reduced in the same proportionate. Performance of cooling coil is significantly governed by latent load. Dehumidification is more at low humidity and it decreases with increasing regeneration temperature. Hybrid air-conditioning can be a good option when the humidity level is high.

I***ndex Terms –*** *Evaporative cooling, humidifier, air conditioning*

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I. INTRODUCTION

The indirect evaporative cooling works on the principle that when water evaporates it carries out the heat. The heat is exchange on the set of polymer plates called as cross flow heat exchanger. An indirect evaporative cooler includes a number of heat transfer plates. Each plate has a wet side and a dry side, and the dry sides of adjacent plates face each other. The plate dry sides have low permeability to an evaporative liquid. Input air flows over the dry sides from an input end to an output end. Part of the input air becomes product air and exits at the output end. The rest of the input air passes through perforations in the plates to the other side of the plates to become working air. The other side of each plate is a wet side, which is wet by an evaporative liquid. Working gas flows over the wet side, evaporating the evaporative liquid and cooling the evaporative liquid, the plate, and finally the product gas by heat transfer. The perforations are formed both toward the input end of the plate and toward the output end of the plate. Part of the wet side of the plate, toward the output end of the plate, has a plurality of barriers placed to cause the working gas at that end of the plate to flow in a direction generally counter to the input air. The major challenge in the indirect evaporative cooling system is to achieve high heat and mass transfer rates and low pressure drops, so that the system can be more efficient and more compact. Fig.1 shows schematically an example of indirect evaporative cooling. It is composed of several chambers separated by a heat conductor plate. In one chamber, water is sprayed in the secondary air stream which is thus cooled down by a direct evaporative cooling. The primary air is circulated inside the chamber contiguous to the one inside which the cooled secondary air is circulated. Thus, it transmits its heat to the secondary air through the separating plate, realizing thus the indirect evaporative cooling. The primary air is used to cool the space and the secondary air is dumped into the environment.

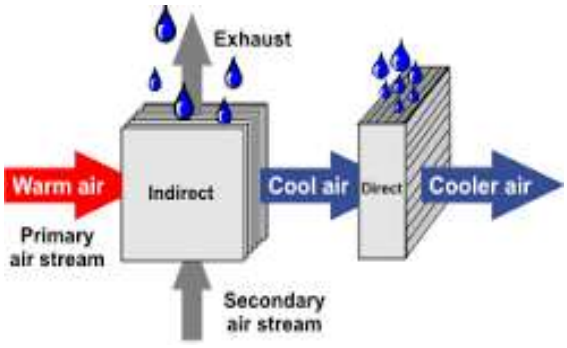

Fig.1. Indirect Evaporative Cooling

Classes of desiccants:-

Within the general class of solid desiccants there are several subclasses of materials:

1. Silica's
2. Alumna's
3. Zeolites
4. Hydratable salts

5. Mixtures

Activated carbons have purposely been left off this list of typical materials. Although activated carbons will adsorb water at vapor pressures less than saturation pressure, the surface is actually hydrophobic (repels water). Because of the very high surface-to-volume ratio, the pores of activated carbon will fill with water because of capillary forces. However, carbon is excluded from this list because it will preferentially adsorb practically every other chemical species before it absorbs water. This is why activated carbons make such excellent water filters. Isotherms depicted for activated carbon and water were measured with "pure" material. After any significant atmospheric exposure, carbon's capacity for water will be seriously degraded, eventually loosing any significant capacity

II. PROBLEM DEFINITION

In hot and damp climatic conditions the straightforward vapor pressure frameworks does not perform well, crossover aerating and cooling framework can improve since it is able to beat the heft of dampness i.e. inert burden. Expelling the dampness from the air at the expense of sensible burden, it increments because of warming of the air. To handle the extra sensible burden, desiccant framework can be clubbed with traditional vapor pressure framework, shaped a cross breed aerating and cooling framework.

III. OBJECTIVE

To study the performance evaluation of hybrid air-conditioning system employing an in-direct evaporative cooling approach for comfort air-conditioning applications.

IV. LITERATURE REVIEW

The greater part of existing R&D chips away at cross breed desiccant frameworks are of this kind. Blazes et al. [1] have concentrated on the execution of three conceivable cross breed framework designs in market applications and have contrasted their execution and conventional VAC framework on the premise of the idea of weighted vitality utilization, with one unit of electrical vitality weighted twice that of warm vitality. As reported, an aggregate cooling sparing going from 56.5% to 66% could be accomplished for determined configuration conditions (encompassing conditions: 30 0C, 16 g/kg da; indoor conditions: 24 0C, 10.4 g/kg; room sensible warmth proportion: 0.35). Likewise, Dhar and Singh [2] have assessed the execution of four cross breed cycles, which incorporated another proposed cycle and the cycles proposed by Burns et al. [1], for run of the mill hot-dry and hot-sticky climate conditions, utilizing the similarity strategy for Maclaine-Cross and Banks [3]. The impacts of room sensible warmth element, ventilation blending proportion, and recovery temperature have been considered. It was found that strong desiccant-based half and half ventilating frameworks gave considerable vitality reserve funds in examination

with routine vapor pressure refrigeration-based aerating and cooling frameworks in most ordinarily experienced circumstances. Furthermore, Sheridan and Mitchell [4] have broken down the execution of a mixture desiccant cooling framework for hot-muggy and hot-dry atmospheres. results demonstrated that the vitality funds extended from 20% to 40% in high sensible warmth load applications and the half breed framework spared more vitality in a hot-dry atmosphere than that in a hot moist atmosphere where it may even utilize more vitality than a traditional framework. Maclaine-Cross [5] has researched the plausibility of gas-let go half and half desiccant cooling frameworks for medium to extensive general aerating and cooling ventures. The desiccant unit, which comprises of a regenerative humidifier, heat exchanger, evaporative cooler, warming curl and fans, handles the natural air, idle and part of the sensible warmth load. The staying sensible warmth burden is expelled by a gas motor driven VAC plant. Examination results proposed that half of the vitality expenses could be put something aside for Australian conditions, if the waste warmth was recuperated to flame the desiccant unit. Worek and Moon [6] The aberrant evaporative cooling comprises in utilizing another air stream cooled straightforwardly and evaporative (called optional air) as the warmth sink to cool the procedure air (called essential air) inside a warmth exchanger, by and large a plate heat exchanger (PHE). The DEC is an adiabatic procedure in which the temperature of procedure air is brought down just to the detriment of higher dampness content noticeable all around. This cycle of evaporative cooling can work proficiently in dry atmospheres. In moderately more damp atmospheres, in any case, the IEC [7-10] would rather be the best decision since it empowers a genuine cooling (diminishment of enthalpy) without including dampness into the procedure air. It additionally permits the utilization of lessened air volume in examination with that would be required in direct desiccant cooling. Where Tdb is the dry knob temperature, Tout is the outlet temperature, and Twb is the wet globule temperature. Since the direct evaporative cooled auxiliary air is utilized to cool by implication the essential air, the backhanded evaporative cooling proficiency would be sub-par compared to that of direct evaporative cooling. The viability of warmth exchange from the auxiliary air to the essential air which, in no way, shape or form can square with 100%-assumes a reductive part in the general procedure. When all is said in done, evaporative cooling frameworks are best connected where the

encompassing wet globule temperature does not as often as possible surpass 25 0C [9]. As per Munters [11], they highlight an adequacy of 90% for the DEC and 70–80% for the IEC. They are exceptionally successful cooling advances and have been shown to work with a COP coming to up to 5 in dry atmosphere [10]. Be that as it may, in muggy atmospheres their viability decreases due to as of now almost immersion of encompassing air. In this way, with a specific end goal to make their use conceivable in sticky atmospheres along these lines developing their climatic materialness' degree, resort made to the adjunction of a desiccant dehumidifier, which evacuates some portion of dampness of handled air and in this way makes the states of powerful working. The plan along these lines shaped is a desiccant cooling framework.

EXPERIMENTAL SETUP:-

Schematic diagram of the Hybrid air-conditioning test facility is shown in Fig. 2. Test rig consists a dehumidifier rotor, indirect evaporative cooling system

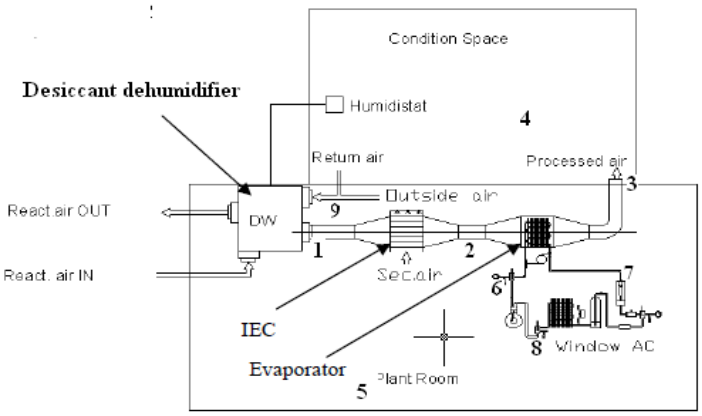

Fig. 2. Experimental test set up layout

The experiments will be carried out for various operating conditions to study the effect of amount of dehumidification, mixing of re-circulated air, variation of ambient conditions etc. The experiment was conducted for following conditions.

- Varying the speed of the Dessicant Wheel
- Cycle of operation of the system i.e. ventilation, mixed and recirculation
- Experimenting with different Dessicant material

RESULTS & DISCUSSION

From writing survey, In desiccant wheel, if the recovery temperature expands, the heaps gets totally isolated, in this manner execution of cooling loop makes strides. In any case, framework execution diminishes because of expanded force at higher recovery temperature and the inert burden does not get lessened in the same proportionate. Execution of cooling curl is essentially represented by idle burden. Thus by Varying the rate of the Dessicant Wheel and utilizing distinctive Dessicant material the execution may increments.

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