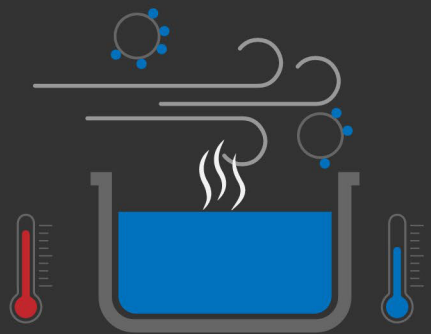

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Decentralized Desiccant Enhanced Evaporative cooling integrated facade

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Sustainable Design Graduation Studio - Master Thesis

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Reflection:

The Need:

The buildings account for almost 3rd of the global energy consumption and the greatest share of the building's energy is spent on space cooling using conventional HVAC systems especially in hot climates. India is becoming a power hungry nation and the power cuts are more common than before. It is essential to know the value of electricity supplied in this context and make sure it is used efficiently. The cooling requirement for India is expected to grow 8 times by 2037-38 compared to 2017-2018. Especially the space cooling is increasing rapidly almost 11 times than the current requirement (2017-18). India is one among the first country to develop a document, called India Cooling Action Plan. This research document addresses cooling requirements over several sectors and it has also listed the set of actions which needs to be taken called as "Intervention", both in terms of policies, research and implementation of sustainable cooling technologies.

The Solution:

The evaporative facade thesis is one of the interventions on exploring the possibilities of evaporative cooling to not only cut down the energy but also reduce the refrigerant's usage. This research project focuses only on open floor office buildings in the capital region (Delhi) due to its ever-growing demand. The research has collaborated between Climate Design and Facade design in building technology track. The major innovation revolves around what cooling system (Dew-point indirect evaporative cooling) has been used and how (Decentralized facade integrated ventilation) it has been integrated into the built environment. Both these aspects were researched, designed, evaluated and re-designed parallelly

Research + Climate Design :

The literature research and calculations took a lot of time in understanding the concepts behind the various psychometric process of the air. Especially coming from the architectural background it was quite challenging to understand the new concepts and to see how it can be designed. The feedback from mentors during the initial weeks was crucial and a bit harder to perceive but with the given time and motivation it was resolved. Th research began with the understanding the composite climate of Delhi and on the feasible alternative cooling technology that has been implemented in the country. Various evaporative cooling systems were analyzed in the context of Delhi throughout the year to understand it's performance. The Dew-point indirect evaporative cooler was chosen due to its high effectiveness.

During the initial stages of the design, with few numerical calculations, it was found that the performance of Dewpoint indirect evaporative cooler is very low during the months of monsoon and it is not a viable standalone solution. The limitations of the systems were understood in full depth and this drawback leads to the potential of coupling it with other sustainable technology. So, more research was conducted even after literature review period to identify the suitable technology for dehumidification to overcome the current issue. One of the alternative technology that can be coupled with the existing system is the desiccant systems to absorb excess moisture. This way the chosen evaporative cooler's effectiveness increases making it more suitable and sustainable for the given context.

The built structure needs to be integrated with passive design features to bring down the size of the cooling system so it has a very low impact over the facade. This passive design

of buildings has been studied a lot previously and well documented. This has been used for designing a passive structure and altered to the required situations after getting familiar with software DESIGN BUILDER which is used to assess the cooling load and energy consumption of the building.

Research + Facade Design :

In parallel research, the potential and limitation of the decentralized system over the centralized were understood. Various market products, features, functionality and different types of facade integration were also analyzed. Decentralized ventilation system avoids running ducts all over the structure thus eliminating the space required for it. So, the buildings can be designed a bit shorter by avoiding the ducts and save construction resources. The decentralized ventilation system reduces the complexity over the structure with one less process to co-ordination. This increases the role of the facade and leading to new development towards it.

But one of the major limitations over the facade design is that the proportion and form of the evaporative cooler and desiccant systems are so fixed that it didn't allow for a various form or design explorations. The particular proportion is the results of various research papers to achieve higher performance. It would have been great to experiment with various forms and sizes of the evaporative cooler to take a more informed decision towards the design. But this goes beyond the scope of the building technology track and needs assistance from multidisciplinary fields.

Based on various constraints three options were designed. The cooler can be placed next to the facade like a heater with just an air inlet over facade but the facade and cooler need to be installed separately or the system itself acts as a vertical design element and installed together as a single entity. The major reason why the designers don't prefer decentralized system is due to the presence of the compressor over the facade. Many regulations have been passed to avoid this usage. Well, over here the integration over the facade is so seamless making it a viable solution in the future. Especially the option where the cooler can be placed next to the facade needs only slight changes in the existing facade systems to integrate this design.

Research + Energy :

The main aim of the thesis during the initial period is to completely avoid the usage of high energy intensive chillers and refrigerants. But, in order to dehumidify the air continuously, the desiccants require hot and cold water. Even though using the solar collector to heat up the water seems like a sustainable solution, it requires a large area to address the quantity making it less feasible. The heat pumps have significantly higher COP and can address this situation. The heating demand required by the chiller to heat up the water is way less compared to the cooling demand required for the entire building. It is not possible for now to address the built structure in Delhi India only with evaporative cooling techniques unless any other less energy intensive technology is found to dehumidify the air. The project requires more detailed hourly analysis to understand it's the outcome. Further researching this system with physical prototyping should be carried out to understand it's a limitation and get more valid results.

But, still, from this thesis, it is found that it can reduce up to 40% of the building's energy, and with further research, it can even bring one step closer to the net-zero built structure.