Integration of Natural Fiber Evaporative Media with Split AC Systems for Mitigating High Ambient Cooling Loads

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Abstract: The fast acceleration of global temperatures and urbanization have intensified the need for efficient cooling systems manifold. Conventional compressor-driven air conditioning systems, though efficient, are energy and emission-intensive because they are electric-powered and use synthetic refrigerants. This work suggests a novel method to reduce high ambient cooling loads by incorporating jute fiber-based evaporative cooling media into conventional split AC systems. Evaporative cooling is a low-energy, environmentally friendly technology based on water evaporation principle that provides an environmentally benign option especially efficient in hot and dry environments. Jute fiber, being a cheap, readily available, biodegradable natural fiber, has remarkable water-holding capacity, mechanical integrity, and thermal characteristics and thus qualifies to be an optimum medium for evaporative processes. In the combined system, ambient air is initially sucked through a wetted pad of jute fiber, where it is evaporative cooled prior to entering the condenser unit of the split AC. The pre-cooling effect reduces the condensing temperature of the refrigerant, with reduced compressor workload, increased cooling efficiency, and with considerable reduction in power consumption. The complementarity between the low-energy evaporative method and the high-performance split AC system creates significant energy savings and less environmental burden. The employment of jute fiber not only utilizes renewable, environment-friendly materials but also supports sustainable development principles in an attempt to reduce carbon emissions and encourage greener technologies. This work demonstrates the technical viability and environmental advantage of coupling natural fiber-based evaporative media with contemporary air conditioning systems. The hybrid system suggested here is an attractive solution for attaining sustainable indoor climate regulation amidst increasing urban heat challenges and energy needs.

Keywords: - Evaporative Cooling, Jute Fiber, Split Air Conditioning, Energy Efficiency, Sustainable Cooling, Pre-cooling Technology.

I. INTRODUCTION

Energy security is directly improved by low energy consumption gadgets, which also lower energy requirements and carbon footprints. It has been estimated that approximately 80% of primary energy comes from fossil fuels. Numerous forecasting studies pertaining to global energy have been conducted by various government bodies, including the WEC, OPEC, and others. The energy industry is essential to the nation's growth since it has a direct impact on manufacturing. However, the energy sector also directly and indirectly affects the sustainability and environment [1]. Usually, air conditioners and other compressor-based cooling systems use more energy than non-compressor-based cooling systems. This is because the compressor, which circulates refrigerant throughout the system to chill the air, is powered by electricity. The non-compressor based system such as ECS causes lower environmental degradation with satisfactory cooling performance [2].

A. Evaporative Cooling Technologies

Evaporative coolers offer an attractive alternative as a simple, cost-effective, environmentally friendly cooling solution particularly suitable in hot and dry areas. Compared to conventional mechanical vapour compression cooling systems, evaporative coolers have lower energy demands and require minimal initial and operating costs. They operate on the principle of cooling air through water evaporation, where the air temperature decreases significantly as the water absorbs heat during the phase change from liquid to vapour. This method uses far less energy than traditional vapour compression systems. In extremely dry climates such as arid and semiarid areas, evaporative cooling not only cools the air efficiently but also adds moisture, enhancing occupants' comfort with minimal energy consumption. Moreover, it represents a cost-effective option both initially and in terms of ongoing operational expenses compared to conventional cooling methods. Evaporative cooling systems with low energy consumption hold great promise for providing sustainable thermal comfort in buildings [3].

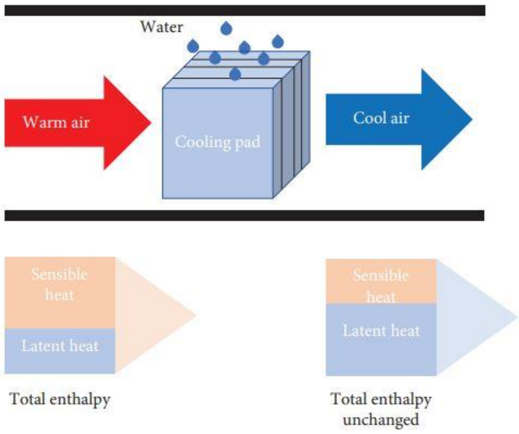

Figure: 1 working principle of evaporative cooling [3].

The figure 1 illustrates an evaporative cooling process, where warm air passes through a water-saturated cooling pad, reducing its sensible heat and becoming cooler, while the total enthalpy remains unchanged due to an increase in latent heat.

II. RISING GLOBAL TEMPERATURES AND URBANIZATION

Urbanization and global warming are two of the most significant global developments of the twentieth and twenty-first centuries. The term "urbanization" describes the rise in a nation's urban population in comparison to its rural population. The observed warming of the Earth's land and ocean surfaces since the middle of the 20th century is referred to as global warming. Anthropogenic greenhouse gas emissions, including carbon dioxide, methane, and nitrous oxide, are mostly to blame for this process. In this article, we investigate the potential correlation between urbanization and global warming. We concentrate on global warming because it serves as the foundation for a wider range of equally persistent phenomena linked to global climate change, such as, e.g., rising sea levels, shrinking glaciers, the increased prevalence of extreme weather-events (e.g., heat waves, floods) and changing precipitation patterns [4]. Substantial increases in urbanization have happened in numerous parts of the world over the last few decades to century, which has generally increased the number of urban areas and heightened the urban heat island (UHI) effect in the urban areas or in its suburbs. The overwhelming majority of the land observational stations are located mostly in the urban areas or the immediate suburbs as a result of the expansion of the cities. [5]. These temperature increases are contributing to the intensification of extreme weather events, including more frequent and severe heat waves, prolonged droughts, and unpredictable rainfall patterns, all of which threaten ecosystems, agriculture, and human health. At the same time, rapid urbanization exaccerbates these climate conditions. As cities grow, the natural land cover is replaced by concrete, asphalt, and other impervious surfaces that absorb and re-emit heat, partially contributing to urban heat islands- or areas of land where air temperatures are greater than in surrounding rural areas. Urban heat islands increase cities' overall temperatures, increase energy demand and energy usage for air conditioning and cooling systems, and can strain power infrastructure while raising greenhouse gas releases. Additionally, the global temperatures are increasing and when they are coupled with urban heat this has complex health risks for vulnerable populations, particularly for the elderly, children and low income and marginalized communities that may not have access to cooling and health care services. The intersection of global warming and urbanization thus poses an urgent challenge to sustainable development and public health, necessitating integrated approaches within urban planning, energy efficiency and climate resilience, so that we can develop more liveable, equitable and environmentally sustainable cities. [6].

A. Energy Challenges in Conventional Cooling Systems

Traditional cooling systems, like air conditioners and refrigeration systems, present considerable challenges related to energy that are becoming more urgent as temperatures rise globally and urban populations expand. These systems utilize much electricity (especially examplify during peak summer cooling loads) which increases the strain on electrical grids (i.e., "peaking resources", and subsequently increases energy costs and bills). In many cases, the electricity used to operate cooling systems is largely provided by fossil fuel-based resources, particularly coal, natural gas, or oil in many areas, that are a limited resource and - when produced - resulting in significant amounts of green house gas emissions which aggravate the only problem they are trying to solve in the first place which is global warming. In addition, most traditional cooling systems utilize synthetic refrigerants (e.g., hydro fluorocarbons or HFCs) that also have high global warming potentials. [7]. Even minor leaks of these refrigerants can have disproportionate and larger impacts on climate change, amplifying the cost of cooling on the environment. Given continued urbanization and an expanding number of people having access to air conditioning, especially in developing nations, the global demand for cooling is expected to grow exponentially in coming decades. This behavior can create a feedback loop, where an increase in temperature, leads to increased cooling demand, which leads to increased energy use and greenhouse gas emissions, which magnifies temperature. If we are to mitigate these issues, a move toward more energy today from air conditioning and cooling technologies, let alone natural or low-impact refrigerants or renewable technologies, must happen soon or we will see a proliferation of conventional cooling systems that undermine climate action and energy sustainability. [8].

B. Need for Sustainable and Efficient Cooling Technologies

The existing cooling technologies have significant limitations with respect to resource consumption, even though they effectively remove heat. Therefore, it is clear that sustainable cooling solutions are necessary that minimize the impact on the environment without sacrificing performance of electronic systems. As pointed out, cooling solutions that are embedded directly in the chip are an opportunity to address sustainable cooling solutions while reducing heat via cooling solutions embedded at the source of heat. This enables better thermal management with lower energy loss from external cooling systems. Furthermore, a shift to more sustainable cooling technologies is illustrated with single-phase immersion cooling being used in the HEAT test bed system.. Explore the application of this technology in server environments, where the increasing thermal design power of processors challenges the viability of traditional air cooling methods. Single-phase immersion cooling, which involves the immersion of electronic components in a dielectric liquid, offers a significant reduction in energy consumption. This technology not only addresses the immediate thermal management needs but also aligns with the broader objective of sustainability in electronic cooling [9]. Throughout the 20th century, cooling has played a crucial role in forming civilization, and this will continue to be the case in the decades to come. It is essential for industrial production, food and medication preservation, and enabling thermal comfort for societies at high temperatures. There are strong links between cooling and the advancement of civilization since air conditioning is largely seen as a force of modernity and a factor in the shifting nature of living in the tropics. A remarkable shift is currently occurring in the cooling trajectory: as the economies and populations of the world's hottest regions expand, the need for cooling for human health could lead to one of the largest increases in energy and greenhouse gas (GHG) emissions in recent memory. Three-quarters of humanity will be at risk for fatal heat-related illnesses due to current climate and socioeconomic conditions, and between two and four billion people will need cooling in their homes to prevent these risks. This figure surpasses the energy poverty gap as defined by the Sustainable Development Goals7. According to projections, the energy required for space cooling alone will triple by 2050, which is the same as installing ten new air conditioners (ACs) every second for the following 30 years. [10].

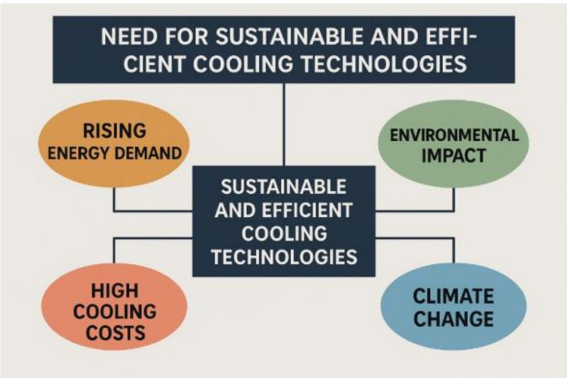

Figure: 2 sustainable and efficient cooling technologies [10].

The diagram highlights the need for sustainable and efficient cooling technologies due to rising energy demand, high cooling costs, environmental impact, and climate change. These factors drive the development and adoption of better cooling solutions.

III. EVAPORATIVE COOLING AS A SUSTAINABLE SOLUTION

The ancient idea of evaporative cooling (EC) has been cleverly applied in contemporary, eco-friendly engineering. Fundamentally, it makes use of the straightforward idea that water absorbs heat from its environment during the change from a liquid to a gas. In order to develop a sustainable and energy-efficient cooling solution for the building industry's growing demands, this mechanism is presently the subject of extensive research. This kind of cooling started to replace conventional air conditioners. As these are mainly based on a compressor cycle with gaseous refrigerants, they are not perceived as a sustainable solution for the future, especially in terms of the aspect of global warming [11]. While buildings use a lot of energy, there is a growing need for energy-efficient HVAC (heating, ventilation, and air conditioning) systems. Evaporative cooling systems can be utilized as a cost-effective substitute for traditional systems or as a pre-cooler. Because of their easy maintenance, low electrical energy use, and zero emissions, these systems are frequently used. Direct evaporative cooling (As living standards rise, more energy is used by air conditioning systems to meet thermal comfort standards. People are said to spend about 90% of their time in air-conditioned spaces, which has resulted in a constant use of natural resources to create artificial built environments.. Over the past 20 years, as climate change and customer affordability have increased, China's energy demand for building cooling has increased. Since 2000, it has grown by 13% annually, reaching around 400 TWh in 2017. As a result, cooling-related CO_2 emissions from energy use have increased fivefold. Therefore, it is essential to create new strategies for lowering AC systems' energy usage while also ensuring thermal comfort and indoor air quality. Particularly in desert and semi-arid areas, indirect evaporative cooling which eliminates heat through evaporation—has been seen as one of the most promising alternatives to traditional air conditioning. The indirect evaporative cooler (IEC) has been the subject of numerous studies over the last few decades in an effort to assess its viability, enhance its thermal performance, and broaden its application areas. [13].

A. Principles of Evaporative Cooling

Evaporative cooling is a natural and energy-efficient way to cool air based on the science of thermodynamics and phase change, specifically the fact that water absorbs heat in its surroundings when it evaporates. An example of that is the human body's naturally occurring cooling system: sweat. As sweat evaporates from the skin, the body dissipates heat, thus creating a cooling sensation. Evaporative cooling employs this process by pulling warm, dry air from the environment into the system and pushing this air across water-saturated pads or some other type of wet medium. As the air passes over or through the wet face, the water evaporates and absorbs heat from the air mass, thus cooling the air mass lower than the initial temperature. The cooled air mass is then moved into the indoor space for comfort. Unlike traditional refrigeration based air conditioning systems that depend upon energy intensive compressors and harmful chemical refrigerants, evaporative cooling systems use significantly less electricity and have no harmful effects on the environment. These help to cool air by evaporating water into the air and are generally more efficient in hot and dry climates where the humidity is low. Evaporative cooling provides a greener alternative to cooling technologies which rely upon refrigeration and instead use the natural process of water evaporating to produce cooler, more comfortable spaces inside. [14].

B. Advantages of Evaporative Cooling in Hot Climates

Evaporative cooling has many benefits in hot climates, especially those with low humidity, where the dry air can effectively and efficiently remove water. This natural process significantly cools air temperature, thus making it a perfect cooling technique for dry and semi-dry climates. A major advantage of evaporative cooling is its reduced energy usage compared to air conditioning systems that rely on coolant fluids and compressors that consume energy. Given that evaporative coolers only use a fan and water pump, they use significantly less electricity, reducing energy costs, and lessening the demand on electrical grids during peak usage times in the evenings or during the summer. In addition, evaporative coolers do not utilize chemical refrigerants, which are specifically harmful to the atmosphere and are troublesome elements to global warming, ozone depletion or halogenated refrigerants. Without using chemical refrigerants, evaporative coolers also provide an environmentally friendly alternative that is consistent with sustainability principles. Evaporative coolers provide cooling as well as improved air quality by continuously bringing in a fresh supply of outdoor air, through water-saturated pads, which have trapped dust and particles. The continuous ventilation of cool, outdoor air not only cools the indoor environment, but it also brings a breath of fresh quality to the indoor environment, which helps the occupants become comfier while minimizing illness. In conclusion, evaporative cooling is a superior cost-effective, energy-saving, and environmentally responsible mechanism to manage indoor comfort when the climate is hot or dry. [15].

C. Integration with Conventional Air Conditioning Systems

Most of the time, electrically powered compressor systems provide the cooling energy required throughout the summer. Thus, there is a continuous search for alternate ways to generate cooling energy that will minimize air conditioning system operating costs while maintaining thermal comfort. Evaporative cooling is a tried-and-true method that can supply inexpensive cooling energy due to its efficient evaporation process in wet channels of the air-cooling dew point indirect evaporative coolers (DPIEC). In recent years, numerous experts have conducted in-depth studies on dew point evaporative coolers. Selected research in the area of dew point evaporative cooling was included in srudy [16]. Many studies have looked into the feasibility of integrating the DAC with other energy systems and technologies in order to enhance system performance as a whole. Numerous studies have been conducted on the integration of free heating and/or free cooling technologies with the DAC system. Free cooling might be utilized for desiccant/air cooling, and free heating could be used for desiccant regeneration. Because desiccant air-conditioning (DAC) systems can independently control temperature and humidity, they have been seen as a possible substitute for traditional vapour-compression cooling (VCC) systems [17]. Conventional air conditioners have limits that can be overcome by integrated systems. To improve the energy efficiency of air conditioning systems, three types of integrated systems are frequently taken into consideration and assessed. Evaporative cooling units and direct expansion systems make up the first kind of integrated system. Desiccant technology and direct expansion systems are combined in the second kind, and evaporative cooling and desiccant are combined in the final form. PCMs and energy recovery technologies can be integrated into these systems. By storing and releasing thermal energy during phase transitions, PCMs can improve the energy efficiency of HVAC systems while lowering peak loads and energy consumption. Additionally, PCMs can increase energy efficiency, decrease compressor runtime, and stabilize indoor temperatures. [18].

IV. NATURAL FIBER MEDIA: JUTE FIBER

Concrete is the most widely used material worldwide in the construction business. However, its limited fracture strain capacity, poor resistance to crack opening, and sensitivity to mild tension make it unsuitable for application. In order to compensate for the brittleness of ordinary concrete, fiber reinforced concrete is frequently considered as an alternative (increased tensile strength). Weak matrixes have been reinforced using fiber. According to a number of studies, adding fibers to concrete significantly improves its qualities. The American Concrete Institute (ACI) asserts that thin fibers are more effective than thick fibers at minimizing the width of plastic shrinkage fractures. Concrete components are reinforced with a variety of fibers, including inorganic and organic fibers. Numerous elements, such as the fibers' length, modulus of elasticity, surface, and material of formation, influence the type of fibers utilized in concrete to increase tensile capacity. Metallic and non-metallic fibers are the two common categories into which fibers fall. The ability of metallic fibers to conduct electricity sets them apart from non-metallic fibers. Natural fiber reinforced cement composites have been found to be an intriguing choice for low-cost building construction in poor nations. In terms of sustainability and biodegradability, natural fibers have emerged as one of the most widely used reinforcing materials. non-toxic and environmentally friendly, qualities that are especially advantageous for the production of bio composites Conversely, natural fibers also contribute to lowering CO2 emissions into the atmosphere. Because of their availability and affordability, jute fibers (JTF), which are derived from annual plants and are plentiful, may be considered as a possible material for concrete composites. They are a great option for outdoor use because of their soundproofing, UV protection, and antibacterial properties. They have a pentagonal or hexagonal cross form. Because of their superior mechanical properties, jute textiles can be used as reinforcements in laminated and bionic composites. [19].

A. Selection Criteria for Evaporative Media

Selecting suitable evaporative media is a critical part in designing a reliable and effective evaporative cooling system, as it is the foot of the main system, and primary components of a system which affects cooling capacity, efficiency, stability, and long-term performance. A potentially important criteria of an evaporative media is the saturation efficiency of the media, which represents the efficiency with which the evaporative media materials can absorb moisture and transfer it to the passing air reducing the air temperature (lower temperature if we allow enough moisture transfer). High rates of saturation lead to more effective cooling, especially in hotter, drier climates. While efficiency is important, there is also both the structural integrity and durability of the media that must also be factored in, especially in situations where dust, mineral depositions, and microbial growth [20]. As such, the media must withstand physical and chemical degradation to achieve a long lifespan of service. Air permeability is another important characteristic, since media with reduced airflow resistance seeks to reduce the energy it takes to move air through the system, which can improve overall energy efficiency. The material should also have a good ability to retain water but dry easily while the system is off, as unfavourable conditions of constant moisture retention would allow efficient breeding for mold and bacteria, presenting health risks, and possibly reducing indoor air quality. Maintenance commitments, replacement ease, and total cost including both as-purchased price and life-cycle cost should also be assessed. The environmental impact of the material is also relevant, including recyclability and manufacturing footprint and is becoming important in sustainable designs. Lastly, compatibility with the intended evaporative cooling system and operational conditions should be ensured for optimal performance. In summary, the perfect evaporative media should provide the right amount of cooling efficiency, mechanical strength, low maintenance, energy savings, and sustainable environmental practices that allow for a long-term solution for effective cooling [21]. When considering evaporative media, selection criteria include: cooling efficiency, durability, water retention ability, airflow resistance, and maintenance status. An evaporative media should be able to deliver high evaporation rates for cooling and allow for high airflow with a low pressure drop. It should resist degradation, algae growth, and nuisance mineral buildup to allow for long service life with minimal maintenance. Performance and cost-effectiveness are also affected by the media's thickness, integrity (cellulose versus synthetic), and the operational and design compatible nature of the system. [22].

B. Properties of Jute Fiber for Cooling Applications

Bast fiber reinforced composites (BFRCs) have been used across global industries such as electronic communications, home appliances, and transportation. This is attributed to some of the environmental concerns echoed around the globe. 1, 2 BFRCs are less expensive, lower density, and have a higher specific strength. 3, 4 BFRCs have been used primarily to make load-bearing constructions in structural applications largely due to their low mechanical properties compared to chemical synthetic fiber reinforced composites. 5. Widespread use of BFRCs is dependent on their ability to create high mechanical performances. In this light, one successful way to improve mechanical performances is to optimize the process parameters of BFRCs.. Prior research has shown that the general mechanical behaviors of the molded parts during the compression molding process are closely dependent on the molding conditions such as molding temperature, molding pressure, and molding time. Many researchers have investigated the relationship between BFRC mechanical properties and molding conditions. Singh et al. investigated how different curing temperatures affected the mechanical properties of compression molded jute reinforced composites and arrived at the best curing temperature for mechanical strength.

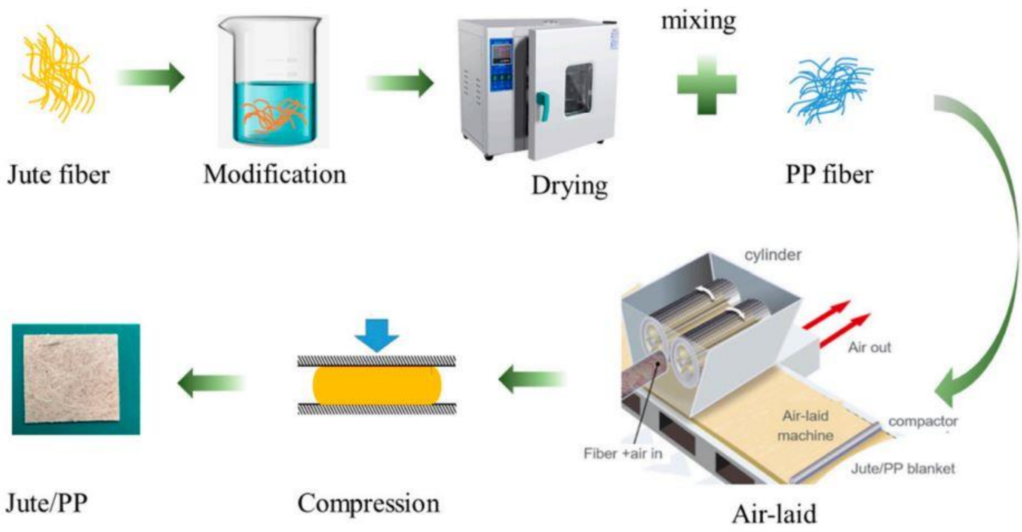

Figure: 3 Fabrication flow of jute/PP [23]

The diagram illustrates the process of creating a Jute/PP composite: jute fibers are modified, dried, and mixed with PP fibers, then processed through an air-laid machine and compressed to form a Jute/PP mat.

This work used RSM to investigate the co-effects of moulding process parameters on the mechanical properties of jute/PP and Box-Behnken design (BBD) to design mechanical trials. Regression models were developed to describe the nonlinear relationship between the mechanical properties of jute/PP and the parameters of the molding process. In order to maximize the tensile, flexural, and impact strengths of jute/PP, compression molding settings were tuned. [23].

C. Environmental and Economic Benefits of Natural Fibers

natural fibers' capacity to provide the highest-quality, most biodegradable, and sustainable natural fiber goods. Human civilization has benefited greatly from the use of natural fibers, which are sustainable and environmentally acceptable sources of raw materials for making eco-friendly products. With their many advantages over synthetic fibers such as lower density, lighter weight, reduced cost, biodegradability, fewer health risks during processing, easy availability and abundance, low production costs, lower energy requirements, and lower CO2 emissions—natural fibers have a lot of potential as a replacement for carbon, glass, and other synthetic fibers. Because of their availability and technical feasibility, natural fibers are preferred bio-sourced materials as an alternative to carbon fiber reinforced composites and non-sustainable glass. From the perspective of mechanical and physical attributes, natural fiber has a high electrical resistance, strong thermal and acoustic insulation qualities, and a reasonably high tensile strength and Young's modulus. Additionally, tensile characteristics, density, and crystallinity are strongly correlated with the chemical characteristics of natural fibers, such as their high cellulose content [24]. Numerous industries, including the furniture, automotive, electronic, and building construction sectors, have effectively used natural fibers. Ahmed et al. claim that Areva javanica fiber brake pads have a 16% greater wear resistance than acrylic fiber brake pads; as a result, the A. javanica fiber may be utilized as a potential replacement for disc brake pads made of synthetic acrylic fiber. [25]. The continuous advancements in science and technology have resulted in the increase in demand for natural resources all over the world [26].

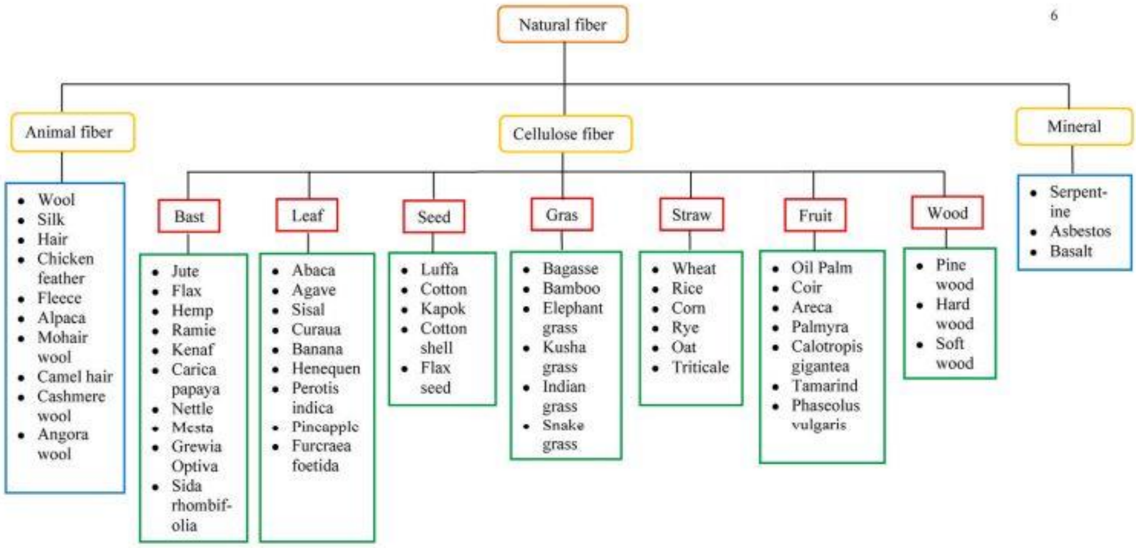

Figure: 4 Classification of natural fibers [26].

The figure presents a classification of natural fibers into three main types animal, cellulose (plant-based), and mineral fibers with further subdivisions based on their source, such as bast, leaf, seed, grass, straw, fruit, wood, and specific examples listed under each category.

V. MECHANISM OF AIR PRE-COOLING USING JUTE FIBER

The process begins with ambient air being drawn through a wetted cooling pad, which is continuously supplied with water to maintain saturation. As the hot air passes through the pad, a portion of the water evaporates, absorbing heat and lowering the air temperature. This pre-cooled air then flows over the condenser coils, facilitating more effective heat dissipation and reducing the refrigerant’s condensing temperature. A lower condensing temperature results in a reduced compressor pressure ratio, which increases the refrigerant’s mass flow rate in evaporator [27].

VI. DESCRIPTION OF THE SPLIT AC SYSTEM

A Split Air Conditioning (AC) system is a modern and efficient type of cooling system that is widely used in both residential and commercial spaces. It is composed of two primary units: the indoor unit and the outdoor unit. The indoor unit is mounted inside the room or space that requires cooling and typically includes the evaporator coil and an air handler or blower. This unit is responsible for drawing in warm air from the room, passing it over the evaporator coil filled with refrigerant to absorb the heat, and then circulating the cooled air back into the room. On the other hand, the outdoor unit is installed outside the building and contains key components such as the compressor, condenser coil, and expansion valve. Its main function is to release the heat absorbed from the indoor air into the external environment. The indoor and outdoor units are connected by insulated copper tubing that carries the refrigerant between them, enabling the heat exchange process. The compressor in the outdoor unit pressurizes the refrigerant and circulates it through the system, ensuring efficient cooling. This type of air conditioning system is preferred for its ability to cool spaces quietly and effectively, its aesthetic appeal due to the absence of bulky components inside the room, and its relatively simple installation compared to traditional central AC systems. Split AC systems also offer the flexibility of zoning, where different indoor units can be installed in multiple rooms, each controlled independently, allowing for personalized comfort and energy savings [28].

VII. CONCLUSION

The combination of jute fiber-based evaporative cooling media with traditional split air conditioning systems offers a viable solution to reduce high ambient cooling loads, particularly in hot and dry weather conditions. This combined system takes advantage of the sustainability and low energy use of evaporative cooling combined with the high performance of compressor-based systems and achieves substantial energy savings, improved cooling efficiency, and low environmental footprint. Through the pre cooling of the ambient air before it is introduced into the condenser unit, the system reduces the refrigerant's condensing temperature, hence reducing the compressor work and enhancing system performance overall. Biodegradable, inexpensive natural fiber jute has superior water holding, mechanical strength, and thermal characteristics, and thus it makes a good evaporative media. It not only brings increased indoor comfort with lower electricity consumption but also environmentally friendly design through reduced carbon emissions and sustainable use of renewable resources. Overall, this combined system is a sustainable and pragmatic innovation in air conditioning technology addressing both energy efficiency and climate resilience under increasing global warming and urbanization.

Conflict of Interest: The corresponding author, on behalf of second author, confirms that there are no conflicts of interest to disclose.

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