STUDY OF COMPRESS AIR FIT (CAF) IN A CONTROL ENVIRONMENT COOLING APPLICATION

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ABSTRACT

The study focused on energy consumption as well as the efficiency and effectiveness of the compressed air fit system for air cooling in a controlled environment structure. Based on the compressed air that rotates in the tube to separate the air into cold and hot air streams, it seems to be capable of supplying cold air up to -40 degrees where cooling is immediate. This device can function without any moving parts and can cool the surrounding environment without the need for a cooler. The findings indicate that the compressed air fit system can cool a small room to a set temperature but is less effective at cooling large areas. In order cooling larger rooms, more compressed air is needed. Results showed that low cooling can be achieved when there is high pressure entering the compressed air fitting system tube. Agriculture can benefit from more research on the compressed air fit system in that it focuses on smaller cooling spaces such root cooling or air circulation in the shelf room.

Keywords: vortex tube, cooling device, control environment, compress Air Fit.

INTRODUCTION

Compress Air Fit (CAF) functions by producing a powerful vortex and a stream of both hot and cold air when a supply of pressurized gas enters tangentially through one or more nozzle inlets at a high speed. These powerful whirlpools will split into hot and cold streams. When the hot flow from the annular region of the wall near the vortex tube moves towards the hot end and exits the hot tube, the cold flow from the central region exits the cold tube through the central orifice near the input nozzle. There is a minimum of -40°C cold flow and a maximum of 52°C heat flow that can be created. Due to its long lifespan and exceptional separation characteristics, the vortex tube has been widely used in a variety of energy and mass separation industries, including gas separation, spot cooling, oil and gas, refrigeration, and aeronautics. A lot of research has been done on the vortex tube, one of the cooling methods. (Avdhoot et al. 2015)

Vortex tubes are considered an option for air conditioners in the agricultural sector, as using air conditioners for plant cultivation can be expensive. Similar to a refrigerator without moving components, a vortex tube is a visually appealing, straightforward device with no moving parts that can produce cold and flow heat from a compressed fluid at ambient temperature. (Younghyeon et al.2020) The objective is to minimize the extra expense of energy use while increasing plant growth and well-being. Energy efficiency and environmental preservation have become of significant importance and widespread attention as science and technology have advanced. It is essential to improve the cooling system's advanced and efficient capabilities. A study into the possibility of cooling impact of CAF has been carried out. Due to a lack of specific references for using the CAF system in agriculture, the study focuses on proof of concepts in a specific area. The approach may be used to plant growth systems based on several data parameters that were gathered.

MATERIALS AND METHODS

APPARATUS

The study was conducted at Workshop C-13 MARDI Serdang in July 2023. The equipment consists primarily of a vortex A/C enclosure, temperature and pressure sensors, solenoid valve an air compressor, an air tank and an air filter. As shown in Fig. 1, a PLC system monitor and controls every input sensor was installed on the tube to measure temperature and humidity. Temperature studies are obtained at the experimental box chamber and the vortex outlet. As the solenoid valve to control the pressure from the air compressor to keep a constant value of temperature. The Vortex A/C Enclosure, with a cooling capacity of 5000 Btu composed of an inlet, three outlets (include two cold air outlet and a hot air outlet) was utilized for the cooling investigation in a 600 x 250 x 800 cm box to demonstrate the compressed air fit system (CAF) proof of concept. To prevent temperature loss, insulation is placed around the outside of the box as illustrated in Fig 2. The Vortex inlet is fed using two compressor units, 3hp 237 L and 3hp 110 L, each with a variable capacity and power. It was not possible to test the compressor simultaneously due to the limited quantity of Vortex A/C Enclosures available. Consequently, it was necessary to divide the experiment into two. In the first experiment, a compressor 3hp 110 L was tested and followed with compressor 3hp 237L. All the parameter data pressure, temperature and humidity were recorded. The objective of the research is to verify that the Vortex A/C Enclosure can operate in a temperature range of 24 °C or less throughout operation. The ideal temperature range for plants to grow well is generally 21–24 degrees Celsius. An increase in temperature over 29 degrees might cause issues very fast in the growing area. (Bierhuizen et al.1973)

Figure 1: Automation and monitoring system integration

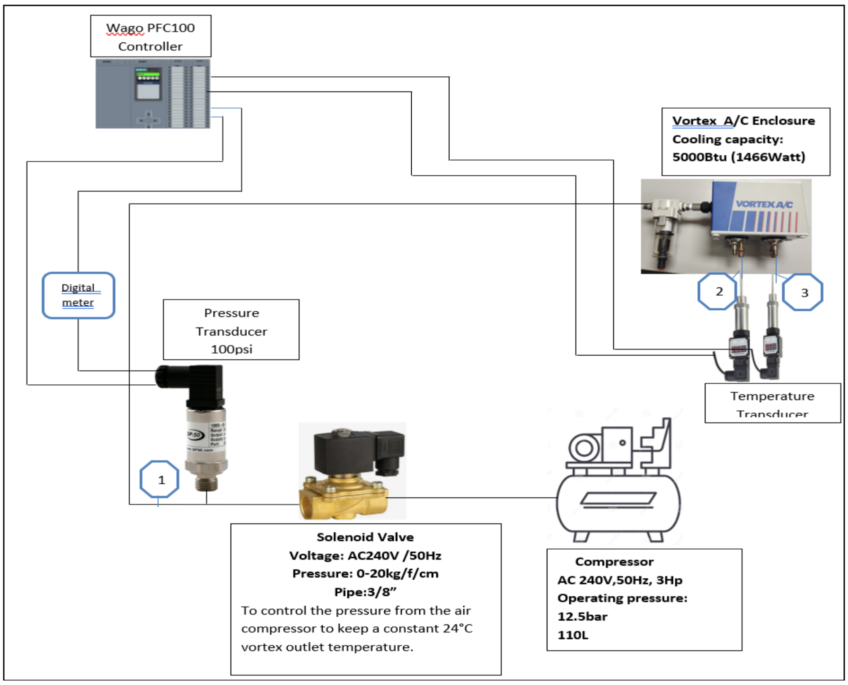


Figure 2: The condition of the enclosure and the location of the sensors T1(outlet vortex) & T2(Enclosure)

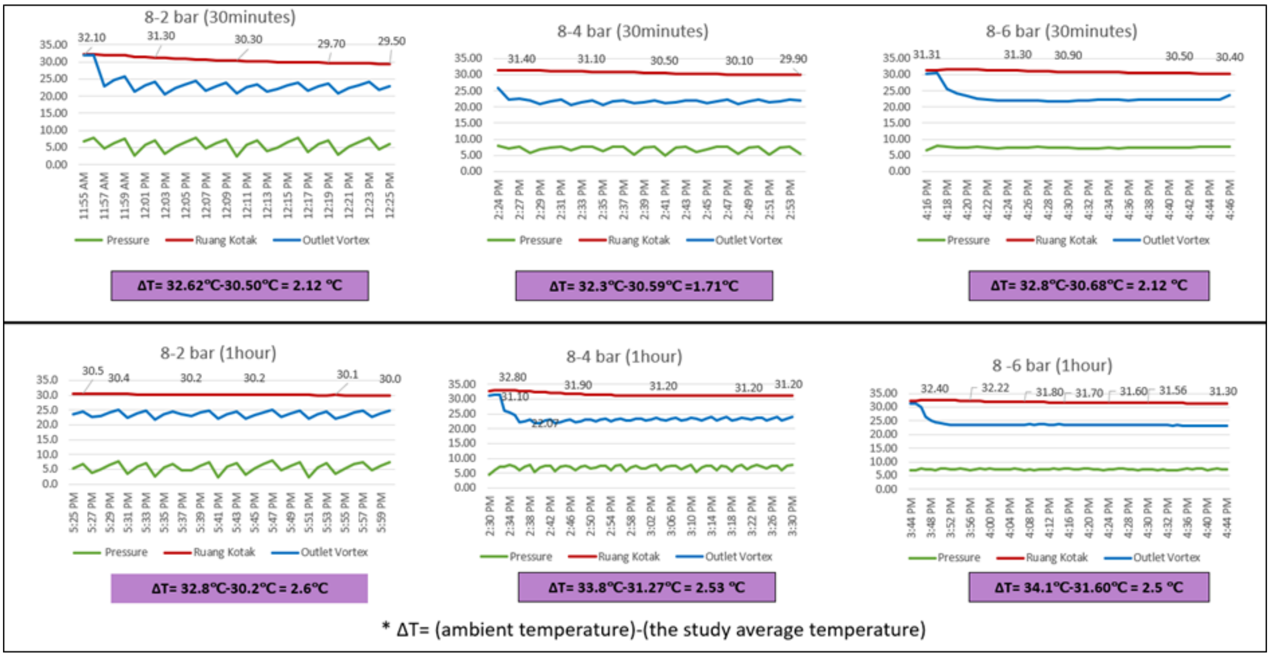
PROCEDURE

The vortex tube was turned on for two set of testing time which is thirty minutes and an hour testing time in each experiment, with varying regulating pressures inlet (8-2bar, 8-4bar, and 8-6bar). Compared to that, the 3hp 110 L compressor pressure was regulated at (6-4 bar, 7 -4bar, 8-4bar, 8-5ba5 and 8-6bar). For every compressor, the resulting cooling temperature in the experimental box chamber is monitored, examined, and the outcomes are compared

RESULTS AND DISCUSSION

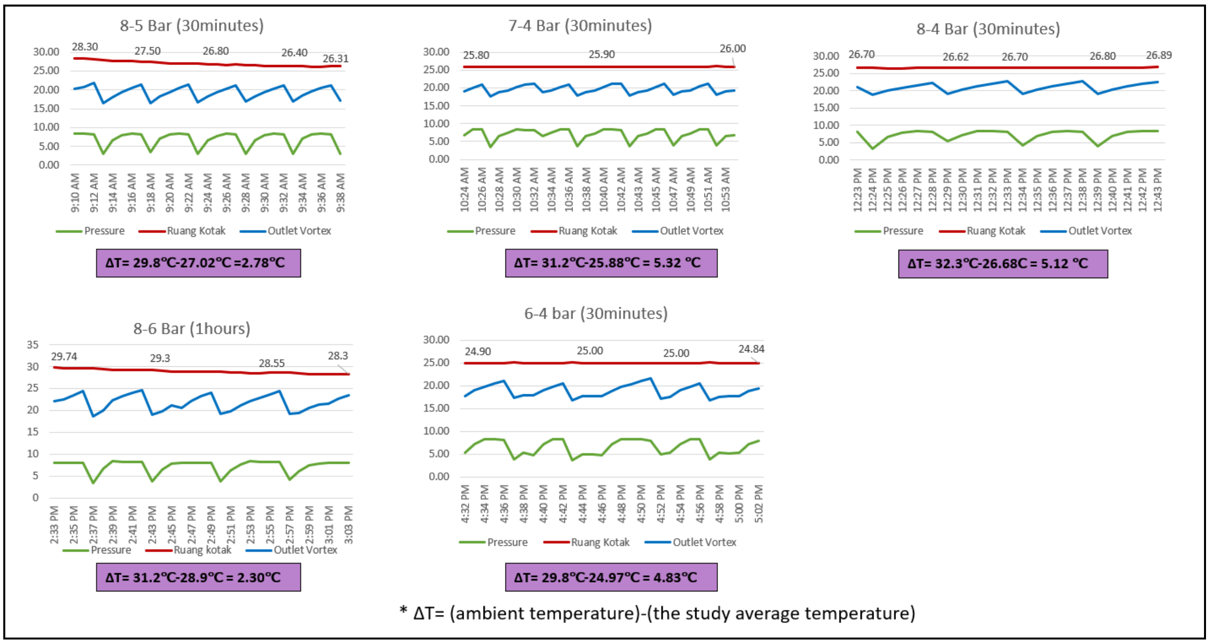
In order to reach the desired temperature in the experimental box chamber, the expected cooling optimizer is identified. The experimental results, which are displayed in Figure. 3 and 4 for the results of the two compressors have demonstrated that the compressor tank capacity and pressure have an impact on generating of this cold temperature.

Figure 3: An air compressor with a 110L tank capacity performs cooling.



The 110L air compressor cooling system is shown in graph Figure 3. The box chamber (red graph) cooling temperature can be averaged at 30°C for the duration of the research set (30 minutes and 1 hour). Additionally, it can be shown that the temperature at the outlet vortex (blue graph) is exactly correlated with the wind entering value at the inlet vortex. A longer study session allows for additional cooling in the box chamber. Cooling also considers the temperature of the surrounding air. The study findings indicate that a 110 L air compressor will not be sufficient to maintain a 24 °C temperature in the box chamber, where the air compressor must run nonstop. This circumstance may result in harm to the air compressor itself, and there will be a rise in the amount of power used.

Figure 4: An air compressor with a 237L tank capacity performs cooling.



The use of an air compressor with a capacity of 237L can make cooling in the box chamber (red graph) with average for the entire research is 26.72°C. The graph presented in Figure 4 illustrates this. Throughout the entire investigation, it is seen that the 30-minute research period exhibits a larger ΔT than the others for the air pressure adjustment of 7–4 bar. The ambient temperature has an impact on the temperature change as well. The study findings indicate that using air compressors with greater capacity can result in both a higher temperature change and a reduced working period for that particular system while also saving energy.

CONCLUSION

The findings demonstrate that using a Vortex A/C enclosure with a 5000Btu cooling capacity necessitates a greater intake air pressure, requiring for a powerful air compressor and a bigger air tank. The results of a research on the usage of air compressors with capacities of 237 L and 110 L show that achieving the cooling objective of 24°C takes longer. The ambient air and cooling area are two aspects that affect how well the system cools. Further research on the use of this compressed Air Fit system, which concentrates on smaller rooms, as well as the choice of equipment requirements for a reduced cooling capacity, is suggested. This is because a bigger air compressor is needed to handle a higher cooling capacity. The recommended adjustments must be made in order to ensure that this system is used in a more effective and energy-efficient approach. Based on space appropriateness and modification, this system's relevance is thought to be useful in agriculture for cooling purposes related to plant growth.

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