

Research on the Ventilation Condensation Problem of the Aircraft

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Abstract: When the aircraft air conditioning ground support equipment supplies cool air for airplane in humid area, water drop usually turns up, which has corrosion on electronic equipment cabin. This paper theoretical analyzes the reason and solution of ventilation condensation problem of aircraft equipment Cabin. However, the aircraft air conditioning ground support equipment firstly supplies heated air, then supplies cold air, it can effectively avoid the problem of ventilation condensation, which has a realistic significance.

1. Introduction

In humid environment or after rain weather, when the air-conditioning support equipment on the aviation ground provides ventilation support to the aircraft, the problem of ventilation and condensation often occurs in the aircraft equipment cabin, affecting the service life and working performance of the airborne electronic equipment and causing hidden dangers for flight safety. The problem of ventilation and condensation is a common problem in aircraft ground air conditioning support, and it also needs to be urgently solved, especially in the eastern coastal areas of China.

2. Theoretical Analysis of Condensation Problem in Ventilation

The problem of ventilation and condensation in the aircraft equipment cabin occurs mainly in the process of ventilation and support of the aviation ground air-conditioning support equipment, which provides dry and clean cold air, hot air or ventilation to the aircraft equipment cabin to control the working environment of the aircraft electronic equipment when the aircraft engine is stopped and the ground is electrified for inspection and maintenance of the aircraft electronic equipment. Understanding its air-conditioning system is the prerequisite for theoretical analysis of the problem of ventilation and condensation, so this paper will make a theoretical analysis of the air-conditioning system of aviation ground air-conditioning support equipment.

3. Air Conditioning System of Aviation Ground Air Conditioning Support Equipment

At present, the aviation ground air-conditioning support equipment is mainly aircraft air-conditioning and its air-conditioning system is mainly vapor compression air-conditioning system, which is composed of two-stage air-conditioning systems. Its working principle is that air passes through the air filter and enters the primary air-conditioning box, dissipating part of the heat in the primary air-conditioning box, reducing the temperature of the air and precipitating moisture in the air; then entering the blower group, the air pressure rises; after being pressurized by the blower, the air enters the secondary air-conditioning box, and the air is further absorbed and cooled by the two sets of evaporators to further remove moisture and meet the set ventilation temperature and humidity requirements. Finally, air conditioning gas meeting the requirements is delivered to the aircraft through the ventilation hose, and the working principle diagram is shown in Figure 1.

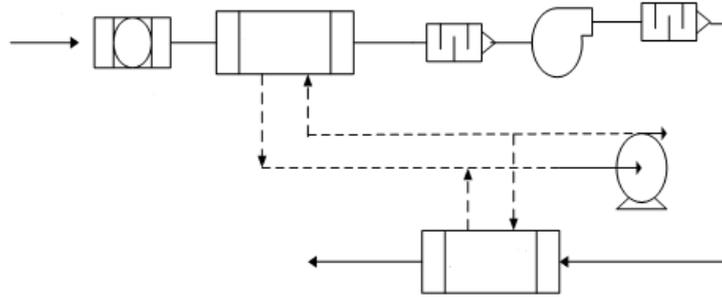


Figure 1 Working principle diagram of vapor compression type air conditioning support equipment

Aviation ground air conditioning support equipment is a brand-new air system. The enthalpy and humidity diagram of cold air working condition in summer is shown in Figure 2. The ambient air state is located at the top A state point of the air treatment diagram. After pre-cooling treatment, the cooling and humidity reduction reaches the B state point. State B to C is the heating process of air in the fan. Then the air at point c is cooled and dehumidified to point d again, so that the air moisture content in this state meets the index requirement ($\leq 8 \text{ g / kg}$ dry air). Finally, according to the requirement of air supply temperature, heat to the state point S with equal humidity.

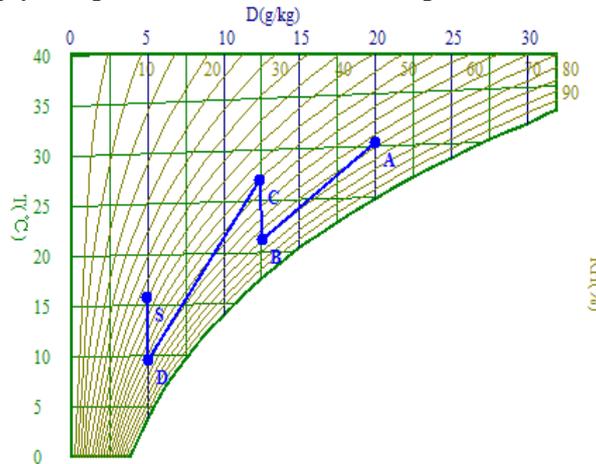


Figure 2 Enthalpy-humidity diagram of air treatment process

4. Analysis of Causes of Condensation in Ventilation

At In the actual flight support process, the temperature and relative humidity of the ambient air are not accurate to a certain point, but an interval (A1), which requires the air supply state to be also an interval (S1), and the air supply temperature of the aviation ground air conditioning support equipment is 10-50°C. The moisture content is less than or equal to 8G / kg of dry air. As long as it is in the air supply section S1, the cabin air condition section A1 can be satisfied, and the representation on the enthalpy-humidity diagram is shown in Figure 3.

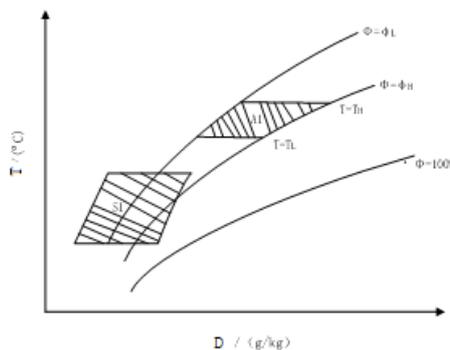


Figure 3 Enthalpy - humidity diagram of air condition in aircraft equipment cabin

However, there is a big difference between the summer ambient air area A1 and the air supply area S1, that is, the airport ambient air temperature is high and the relative humidity is high. In the process of supporting air-conditioning equipment on the ground, when the low-temperature supply air enters the aircraft equipment cabin, the air with high relative humidity in the cabin is quickly cooled to saturate the water vapor in the air, resulting in white mist condensation into water droplets, which causes corrosion to the aircraft electronic equipment cabin, which is the reason for the ventilation and condensation in the aircraft equipment cabin.

5. Measures to Solve the Problem of the Ventilation and Condensation

Aviation ground air conditioning support equipment is a vapor compression refrigeration cycle and an air conditioning system with temperature and humidity coupling control. In order to avoid the problem of ventilation and condensation, the air-conditioning support equipment on the aviation ground can adopt the ventilation mode of first supplying hot air to the cabin of the aircraft equipment and then supplying cold air. The enthalpy-humidity diagram of the air supply state of the air-conditioning support equipment on the ground is shown in Figure 4 indicates that the aviation ground air-conditioning support equipment directly supplies cold air to the aircraft equipment cabin at the state point n to reach the state point s, as can be seen from the figure, the relative humidity in the air in the aircraft equipment cabin reaches almost 100 % in the process of supplying cold air, and water drops easily precipitate from the air, causing corrosion to the electronic equipment in the aircraft equipment cabin. It means that the aircraft first heats the equipment cabin of the aircraft to N1 at the air condition point N and then passes cold air to the air condition point S, and the relative humidity of the air in the process of passing cold air reaches only 70 %, thus avoiding the occurrence of ventilation and condensation problems.

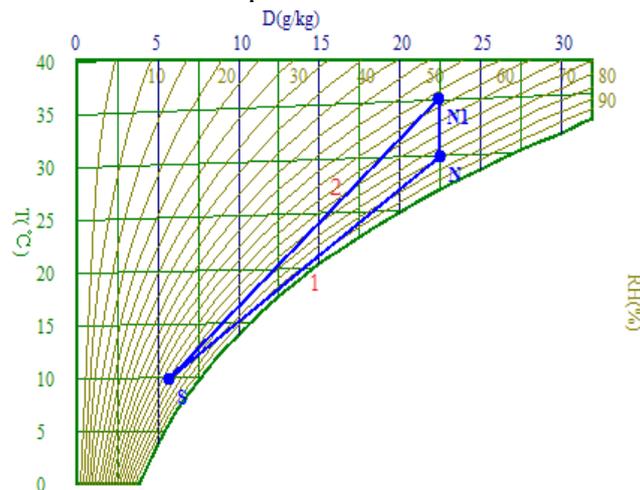


Figure 4 Enthalpy and Humidity Diagram of Air Supply Status for Air Conditioning Support Equipment

The air supply temperature of the aviation ground air-conditioning support equipment is 10-50°C, of which the hot air is 30-50°C. Therefore, in the high humidity environment in summer, the hot air of 30-50°C should be introduced first to increase the air temperature in the cabin of the aircraft equipment, thus reducing the relative humidity of the cabin air. When the cold air is introduced for the aircraft ground air-conditioning support, the heat-moisture ratio of the cabin air increases, and the relative humidity of the cabin air during the cooling process is much lower than 90%, thus realizing safe dehumidification.

In order to verify the theoretical analysis of the problem of ventilation condensation, this paper will conduct a ventilation condensation test to further explain the causes of ventilation condensation and the effectiveness of the measures to solve it.

6. Conclusion

In the view of the problem of ventilation and condensation in the aircraft equipment cabin during the flight support in summer, it was found that the relative humidity of the air in the aircraft equipment cabin first increased and then decreased during the air supply process of the aircraft ground air conditioning support equipment. Water vapor in the air tends to reach saturation and condense water droplets, causing corrosion to the electronic equipment in the aircraft equipment compartment.

References

- [1] Zhu Richun. Current situation and development trend of air-conditioning support equipment abroad. *Journal of Sichuan Engineers*, 2012, 33 (10): 66 - 69.
- [2] Zhang Ke, Zhou Zhigang, Wu Zhaolin. Application and Development of Aircraft Ground Air Shunting. *Refrigeration Technology*, 2009, 37 (8): 52 - 55.
- [3] Tang Huajie, Wu Zhaolin, Zhou Zhigang. Application and Development of Aircraft Ground Air Shunting and Military Aircraft Ground Liquid Cooling Vehicle. *Fluid Machinery*, 2006, 34 (2): 72 - 75.
- [4] Li Li, Tao qihua. energy consumption simulation and indoor temperature setting in summer for residential buildings. *Building thermal ventilation and air conditioning*, 2008, 27 (6): 78 - 80.