VIDEO TRANSLATION

DCA: Welcome to everyone tuning in - To assist in the transfer of knowledge we will conducting a series of video interviews with partners of the Marie Curie European Exchange Project No 734340 Dew-Cool-4-CDC. Today I am pleased to be joined by Prof. Wansheng Yang, from Guangdong University of Technology Hello Prof. Yang.

Prof Yang: Hello.

DCA: To help those watching could you first tell me a little bit about Guangdong University of Technology and your own daily responsibilities within the organisation?

Prof Yang: Guangdong University of Technology is a Guangdong Provincial engineering university, with a history of more than 50 years, and jointly organised by Guangdong Institute of Technology, South China Institute of Construction and Guangdong Institute of Machinery. Our research group for this project based is in the Department of Civil and traffic engineering. Due to Covid-19, this project has been delayed for 6 – 12 months, but this has been helpful for the growth of our research team. In 2018, we have concentrated on communicating with each of the participating organisations through international conferences, while in the UK there has been an expatriate exchange. Here is the basic information for this project. The Department of Civil and traffic engineering consists of eight majors, in which Built Environment and Energy Application is responsible for this project.

DCA: What are the principal goals and objectives of this project from your perspective?

Prof Yang: Our initial goals were related to the communication and cooperation among researchers. By participating in this project, we have gained much experience. Firstly, we've published a series of high-level papers. Secondly members in our teams like for example Prof. Zhangyuan Wang has been promoted from Vice-Professor to Professor during this project, because of this he was invited to visit University of Hull for two years. So, this project has helped to promote the research ability of our team.

DCA: Specifically what work packages and deliverables are you as an organisation responsible for?

Prof Yang: GDUT is mainly responsible for solid dehumidifying. Dew point cooling air-conditioning would be limited in some hot areas, solid dehumidifying can reduce humidify for hot-humid areas, so that the applied duration of dew point air conditioners can be expanded to improve efficiency. It is a nice coupling application in hot-humid areas like southern China. GDUT has conducted a series of studies on solid dehumidifying, including setting up the platform for testing dehumidifying duration, and developing some experimental facilities, publishing a series of high-level papers, and obtained some authorized patents. Besides, we also wrote specifications about evaporating cooling by cooperating with Bioelectronics Industry Energy Conservation Association. In addition, we built a test platform for cabinet liquid cooling system and solar air storage system, respectively, then coupled these two platforms with solid dehumidifying to conduct experiments for around 4 years – these tests provided us with some good results.

DCA: Next we'll ask some technical questions. Can you introduce to our audience to the sorption/desorption cycle technology that developed or used in this project?

Prof Yang: Solid dehumidifying is based on the designed solid desiccant bed and uses conventional solid desiccant material – silica gel as dehumidizer. During the research process, solid dehumidifying system was found to perform well in dehumidification. The main problem is the regeneration process after the desiccant material is saturated. We've tried several different methods for regeneration. For example, the conventional hot air regeneration was carried out initially, but the energy use was found to be relatively large. Then we proposed a coupling method of solar radiation and hot air, so that the solar radiation energy can be utilized in the regeneration process in this solid dehumidifying system to reduce energy consumption of regeneration. Later we also developed microwave regeneration method, which means using microwaves to resolve the absorbed water in solid dehumidizer then extracting it through the hot air. It is a method coupling microwave and hot air. Meanwhile

we also considered the characteristics of data centre. The exhaust temperature in data centre is around 40-50^{o}C which is not too high, but the humidity in data centre is relatively low because of sensible loads. In this case, we applied the exhausted air with low humidity as the regenerated air, and then coupled it with microwave after passing it through solar collectors. With the detailed tests and analysis of this solid dehumidifying system, coupling microwave and hot air is high-efficient in data centre at the low energy use. The key technical procedure of the whole solid dehumidifying system is the regeneration which accounts for almost 90% of the total energy consumption. By applying the coupling method of microwave and hot air, the energy use can be reduced by 40% compared with the conventional hot air regeneration method.

DCA: : Can you tell us more about GDUT`s work in the development of this technology and why is this technology important to the whole system?

Prof Yang: Actually, the core technique of this project is dew point cooling air conditioner which can be regarded as evaporative cooling air conditioner, although it is more efficient than the evaporative cooling air conditioner. The application of dew point cooling / evaporative cooling air conditioner is highly limited by weather conditions. In hot – humid areas like southern China, the efficiency of these air conditioning systems would be reduced due to the high moisture contents in air. Dew point cooling air conditioner is still capable in northern China because of the low moisture contents in these areas. The limitation of dew point cooling air conditioner in southern China includes the short operating duration and the reduced efficiency. The aim of proposing this solid dehumidifying system is to promote the application of dew point cooling air conditioner in southern China, humidity of air flowing into the DPC can be reduced, so that it may expand the operating duration and enhance the efficiency of DPC. From this perspective, we proposed the coupling of the solid dehumidifying system and dew point cooling air conditioner and applied it in data centre. Data centre always use AC systems all year round for cooling, and the system is different from the conventional one, and provides a long operating life. In wintertime, dry-bulb temperature in south area would reduce, but the moisture content is higher than north areas, so the application of dew point cooling air conditioners may be limited by the moisture contents. In this case, the coupling of solid dehumidifying system and dew point cooling AC system can improve the application of dew point cooling air conditioners in south area. The practice in recent years suggests the higher efficiency of dew point cooling air with the use of this coupling method, compared with the conventional method. Solid dehumidifying systems expand the operating life of dew point cooling air conditioner in south areas, they also enhance cooling efficiency,

which means the application of dew point cooling air conditioners are expanded. Our research team proposed to couple solid dehumidifying system with DPC. However, there is still a problem during coupling, which is the regeneration in dehumidifying system. Since we were using silica gel which performs well in desiccant, and it may consume some energy during regeneration/desorption process after the desiccant material is saturated. It is a key technical issue in the application. Conventional hot air regeneration or heater regeneration method always leads to a long time to regenerate. We set up four dehumidifiers utilizing microwaves to resolve the absorbed water in desiccant materials and took the vapour away by exhausting dry-hot air in data centre. The regeneration efficiency of the whole solid dehumidifying system can be improved in this way, which solved the key issue of the AC system application – regeneration time and efficiency, and proposed a new direction of the couple method of dew point air conditioner. Coupling method of microwave and hot air was only applied in dry areas, and rarely used in solid dehumidifying regeneration. The regeneration conditions are investigated through experiments, including the microwave power and operating time. These are all investigated into by experimenting to find out the best operating conditions. For example, the microwave power should be no more than 500 kW and no less than 100 kW, and the operating duration in solid dehumidifying system is off and on, the microwave is not in operation all the time, it resolves the water for a period and then stops to take away the vapour by dry air, after that, resolves again. In this way, the water can be desorbed fully after a period. It is known to us that there are three states for the water in solid materials. The first is free water, existing among solid particles. The second is absorbed water, existing in pores of silica gel with high molecular binding rate, and it requires a long time to desorb by hot air. The other state is chemical water, accounting for a small part, and it cannot be desorbed by hot resolving method. We focused on the water insides pores of silica gel, then the regeneration issue can be solved. These is the detailed research and analysis work for the coupling regeneration of microwave and hot air in dehumidifying. The relevant results were also published in papers.

DCA: Can you introduce our audience to the CDC waste heat recovery system that developed or used in this project?

Prof Yang: For air cooling, there is only one type of waste heat – hot air. The temperature of exhausted hot air was tested at around 40-60^{o}C which is not very high and is not advantageous in heat recovery. The latent loads of data centre are too small while sensible loads are large, thus the moisture content of air in data centre is too low at around 10-20% according to tests. In this case, the exhaust hot air can be used to regenerate the solid dehumidifying system. It

is explained by the low moisture content, so the vapour pressure can be lower than outdoors, resulting in the large vapour pressure differences between air and solid dehumidifying system, so that the water can be desorbed easily. This is one advantage of CDC exhausted waste heat to improve the regeneration in solid dehumidifying. But considering its relatively low temperature, we increased the temperature of dry air from 40 ^{o}C to over 80 ^{o}C by passing the solar air collector, in order to fulfil the temperature requirement of regeneration in solid dehumidifying AC system. The efficiency of the applied solar collector is at a high level. On the other hand, some CDC have applied the method of coupling air cooling and liquid cooling, there should be two types of waste heat – the one is hot air, utilized for solid dehumidifying regeneration, the other is the liquid-cooled system, where the temperature of refrigerant can reach over 80 ^{o}C. We can utilize the temperature in liquid-cooled system as heat recovery to supply domestic heating or floor radiant heating. These liquid-cooled systems occupy almost 40% while the exhausted heat from air-cooled system accounts for nearly 40%, then the sum of them can reach over 80%. These are two basic types of waste heat that can be used.

DCA: why is this technology important to the whole system?

Pro Yang: Currently the total energy consumption of data centre is larger and larger. Guangdong Province requires the PUE of CDC to be less than 1.3 if priority funding to build this data centre. It is hard to achieve the required PUE less than 1.3 if we use the conventional vapour compression refrigeration for cooling. These are the consequences from our investigation on south areas. We combined dew point cooling air conditioner with the vapour compression refrigeration system together in CDC. In summertime, we operate the vapour compressions refrigeration system to ensure the cooling of equipment cabinets. In transition seasons at low temperature and moisture contents, we can apply the natural cold source to providing cooling for CDC, which is dew point cooling or evaporative cooling air conditioner and combine it with vapour compression refrigeration system to form a multi-direction cooling method for low PUE. The only vapour compression refrigeration system cannot achieve the required PUE less than 1.3, because it always consumes a lot of energy although it provides high efficiency.

DCA: Finally, can I ask you to summarise why it was so important for Guangdong University of Technology to participate in this project and highlight the value of what it has and or will deliver?

Prof Yang: It is our first project in cooperation with the EU and is very meaningful for us. Firstly, the whole project plays a part to develop our research team and cultivate our young

researchers. In this project, we've cultivated two post doctors, three doctoral students. Our post doctors even applied the funding from China Scholarship Council to visit University of Hull, UK to study this project for one year. Our young professor Zhangyuan Wang also obtained the funding from this Marie Curie European Exchange Project to study in UK for two years. Meanwhile the research ability of our team has also been enhanced quickly. Before this project, we only published 1-2 SCI papers per capita. Further to the start of this project, the number of published high-level papers have increased rapidly. It has also led to our team getting involved in some projects related to the 13th Five Year Plan in our nation. This project is very helpful to improve our research ability, cultivate young professors, doctoral & master students and post doctors, as well as enhance the academic atmosphere. With the funding of this project, we have visited University of Hull for academic exchange in 2017 and 2018, but unfortunately this exchange plan was cancelled due to Covid-19 in the last two years. Three doctoral students were studying during this project and one of them graduated with good research results. Two post doctors also obtained good research achievements.

DCA: That's great Prof. Yang, and just about leaves me enough time to thank Prof. Yang, from Guangdong University of Technology for taking the time today to explain a little more about the Marie Curie European Exchange Project and the valuable contribution it has made to the research and development of the Dew Point Cooler technology. This interview will be available to view on the project website shortly, where you will also find interviews with all the partners involved in this project. Thank you.