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Smart and Healthy within the 2-degree Limit

Improve Outdoor Comfort in Urban Spaces

Demonstration of Dry Mist Strategies in tropical climates

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ABSTRACT:
Dry Mist technology targets basic human needs by improving micro climatic conditions to create a healthy and comfortable outdoor environment. The technology can be integrated into the design of public spaces, streetscapes, markets, playgrounds and parks to permit intense outdoor activities and to counter the effects of urban heat islands. This paper is about the results of a performance demonstration of Dry Mist Systems in the Cayman Islands. The systems have been successful tested under tropical conditions in open public spaces, plazas and restaurants.
KEYWORDS: outdoor comfort, active cooling, urban cooling, adiabatic cooling, tropical climate

1. INTRODUCTION

Water and wind can be combined to create human comfort outdoors. This effect, known as adiabatic cooling, is widely used in warm and dry climates. It is counterintuitive to apply this principle in warm and humid climates. Since 2014, with several demonstrations in Singapore, Doha, India as well as the installation at the BREATHE Austria Pavilion for the EXPO 2015 in Milan it was proved that a Dry Mist concept can create great outdoor comfort. When the flows of air and micro droplets are well balanced, people are not sprinkled with water - they experience only a cool breeze.

2. COUNTERINTUITIVE INTERVENTION: DRY MIST FOR HUMAN OMFORT

In warm and humid climates, misting systems are often installed to improve conditions in public spaces. However, people often reject them as they are sprinkled with water droplets and disturbed by noise. When the process is studied with advanced human-biometeorological models [1], it can be found that fully developed adiabatic cooling and elevated air speeds could, in theory, create a great improvement of outdoor comfort. (see Figure 1 for predictions for tropical climatic conditions at Cayman Islands).

Since then several experiments showed that such a process could be realized with very small droplets created by specially designed high pressure nozzles and a focused air flow. As the droplets fully evaporate and people feel only a cold breeze, the technique was called Dry Mist [2].

In warm and humid environments, visitors seek relief in cool resting areas. A reduction of 3°C in the Universal Thermal Climatic Index (UTCI) is a noticeable improvement. With the Dry Mist system tested, a reduction in the UTCI of about 6°C was measured, even in the very humid tropical conditions of Cayman Islands.

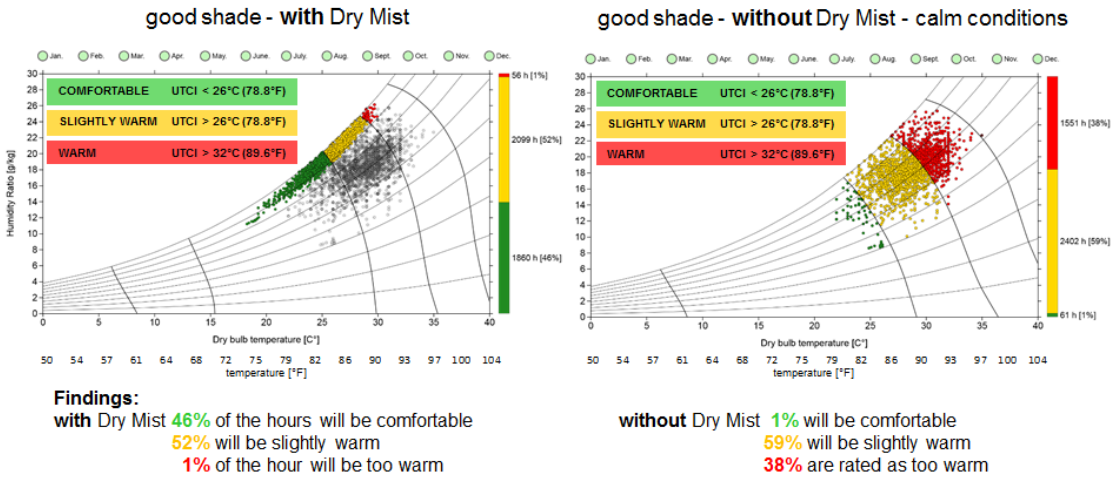

Figure 1: Human Bio-meteorological charts with UTCI comfort envelopes. Predictions for a well shaded streetscape in the tropical climate of the Cayman Islands. The Dry Mist System enhances the perceived outdoor comfort for nearly all hours of operation from too warm (red) to slightly warm (yellow) and comfortable (green).

2.1 Demonstration to prove perception

Anyhow, many people have bad experiences with conventional misting installations and are not convinced by good scientific numbers. Also, people are not familiar with the meaning of advanced outdoor comfort parameters such as UTCI. But people are human sensors! So a series of demonstrations were initiated. For the testing and demonstration in the Cayman Islands the Dry mist systems were installed in several streetscapes, plaza and restaurants. Besides taking scientific readings, movies were taken of visitors passing by. The visitors did not know that they were part of an experiment. Their reaction indicated that the cool breeze was more than welcome; it made them slow down, rest and enjoy the ambience. The direct perception - not the carefully taken scientific readings - convinced the clients to install the Dry Mist system.

Figure 2: People rest and enjoy cool breeze by the Dry Mist Fans at Cayman Islands

3. DRY MIST TECHNOLOGY

The Dry Mist Technology fans have been developed to create an adiabatic cooling effect of 4 to 6 °C UTCI with a noise level < 30 dBA at a typical distance of 3 m.

The design is highly energy-efficient. The measured power demand per fan is about 26 W for fan speed 2, 71 W for fan speed 3 and 160 W for fan speed 4. Because of efficient performance, the fans are typically operated at fan speed 3.

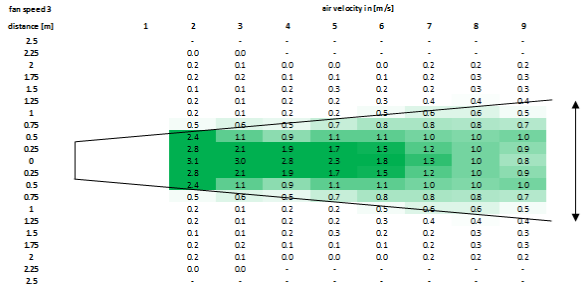

Figure 3: Measured flow patter and air velocities at optimized Dry Mist Fan for fan speed 3.

Each fan can treat an area between 9 and 15 m^2 while using a maximum of 5.4l of water per hour.

3.1 Performance measurements at Cayman Islands

To verify the performance at Cayman Islands and to determine the UTCI, relevant environmental parameters including solar radiation, globe temperature, air temperature, air humidity, air velocity have been measured with data loggers on 6 min sampling rate. Figure 4 shows the reduction of the UTCI with the distance to the Dry Mist Fans. Reference, with 35.4 °C UTCI, is measured in shade with still air. With a fan speed of 3 UTCI is reduced by 5.5 °C at 2 m and about 4.5 at 4 m and. In 9 m distance the reduction is about 1 °C UTCI. Different fan speeds have been tested.

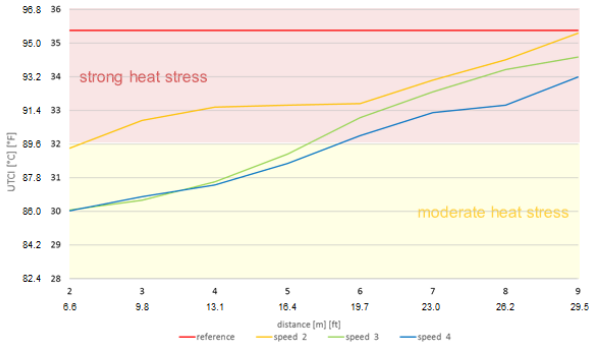

Figure 4: UTCI comfort depending on distance to Dry Mist Fan and fan speed

4. CONCLUSION

For outdoor conditions, elevated air speed can be combined with Dry Mist Technology to create human comfort. This low-tech and low-energy solution has the potential to improve public spaces ranging from outdoor train stations to public plazas and parks. The Dry Mist Systems can form part of a holistic outdoor comfort design considering shading and wind [2]. Applying a technical adiabatic cooling process, the Dry Mist Systems can be well integrated with well-watered green areas to mitigate heat urban heat island effects on a local human scale [3,4].

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