Abstract

The doctoral dissertation is based on a series of articles devoted, in the most general sense, to evaporative cooling. Initial theoretical studies focused on refrigerants have shown that water (R-718) and air (R-729) are promising in terms of application in cooling. This is related to the pursuit of using refrigerants with the least negative impact on the environment.

The literature review allowed for the identification of current trends in evaporative cooling. It was shown that one of the directions of development of evaporative cooling technology is the use of porous materials for the construction of exchangers or for covering their surfaces. These materials, due to their ability to store water in their structure, allow for the introduction of non continuous water supply to the exchanger. Thanks to this phenomenon, intermittent water spraying of the exchanger was introduced to evaporative cooling, which allows for reducing the operating time of the water supply system. However, the result of the literature review turned out to be a research gap - the use of intermittent water spraying on non-porous exchangers.

The experimental part, which allowed for providing results filling the research gap, was carried out on a test rig prepared for these purposes. The first part of the research focused on the operation of the non-porous Dewpoint Indirect Evaporative Cooler (DIEC) after stopping the water supply. In this way, the drying phases of the exchanger were determined. In addition to the experiment, a mathematical description was also proposed using non-linear regression. It was shown that immediately after turning off the spraying, a period of 4–6 minutes occurs, during which an increase in cooling power was noted (due to the drop in the temperature of the treated air). Therefore, an experiment was planned in which, with a spraying break of 7 minutes, 3 spraying times (30, 60, 90 seconds) were used, as well as continuous spraying. In order to compare the effect of the application of time to continuous spraying of the non-porous exchanger, the effect was described using the cooling power and the Coefficient Of Performance (COP) indicator.

The results of the work are supplemented by a description of the microbiological hazard occurring in evaporative coolers. This is an inherent problem that occurs in these devices due to the use of water and air as refrigerants.

The results of the work allowed us to state that it is possible to use timed spraying on non-porous evaporative heat exchangers (DIEC). By limiting the operating time of the water supply system, the consumption of electricity was reduced. The effect of using such a spraying strategy is not only the improvement of its efficiency, but also an increase in cooling power.