Proceedings of the Canadian Society for Mechanical Engineering International Congress 2023
CSME Congress 2023
May 28-31, 2023, Sherbrooke, QC, Canada

Investigation of photovoltaic roof fire-induced smoke spread under wind effect

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ABSTRACT

Photovoltaic (PV) panels have been installed seven times more over the last decade. However, the number of fires caused by PV panels has also increased. Based on the forecast, PV power generation capacity is expected to exceed 1 TW in 2022, and 30% of PV installations are rooftops. A statistical prediction indicates that 27,166 fires will occur in 2021 and 28,900 fires will occur in 2022, with 8,670 of those fires occurring on solar roofs. In buildings, however, there are very few studies on the spread of PV fire-induced smoke, especially when it is accompanied by wind, which is essential for life safety. This study fills this research gap by proposing a new similarity law and a method for substituting pure helium gas for real fire smoke in order to study PV roof fire-induced smoke movement in the non-fireproof wind tunnel. As a result, the heat release rate (HRR) of PV fires, wind speed, and roof angle of the wind tunnel are tested. It is possible to substitute the HRR and smoke temperature for a certain volumetric flow rate and helium concentration. As a next step, the critical values are determined by a parametric study of HRR, wind speed, and roof angle. Based on the findings, three conclusions can be drawn: 1) a greater HRR results in greater smoke infiltration; 2) a lower wind speed causes stronger separation flow to blow smoke into the building via the leeward skylight; 3) flat roofs and 15° roofs are the most dangerous because of smoke infiltration; conversely, 60° roofs are the safest.