Turbulent transport mechanisms on the heat confinement in tunnels by using low-velocity air curtains

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Abstract

Simulations with the Fire Dynamics Simulator (FDS) were performed to study the ability of Double Stream-Twin Jets (DS-TJ) air curtains to confine heat. Numerical simulations aimed to model a 1:34 scale tunnel, equipped with a heat source and two DS-TJ air curtains emerging from the tunnel ceiling. The novelty of this work was the imposition of low jet velocities to reduce fans power as much as possible, while ensuring confinement. Streamwise velocity and temperature were contrasted with experimental data.

We observed a systematic deviation towards the faster jet, thus providing a better confinement than perfectly vertical curtains. Kelvin-Helmholtz instabilities related to turbulent transport were identified in the mixing layer, which induced leakage at the impingement on the tunnel ground. These instabilities were observed to amplify Reynolds stresses, playing a role on the flow regimes, the mass and heat balance and the confinement achieved.

Temperature reached plateau values at both sides of the DS-TJ air curtain, thus heat diffusion was attenuated. Temperature drop in the protected zone occurred and the confinement effect was increased. Turbulent heat flux direction depended on the velocity difference between both jets, which defined the confinement characteristics.

Palabras clave

Palabras clave de autor: Air curtain; Double Stream - Twin Jets (DS-TJ); FDS; Confinement cell; Turbulent transport
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