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INVESTIGATION OF HEAT AND MASS TRANSFER PROCESSES AND PHASE TRANSFORMATION IN MOTION OF WATER DROPLETS THROUGH HIGH-TEMPERATURE GAS AREA

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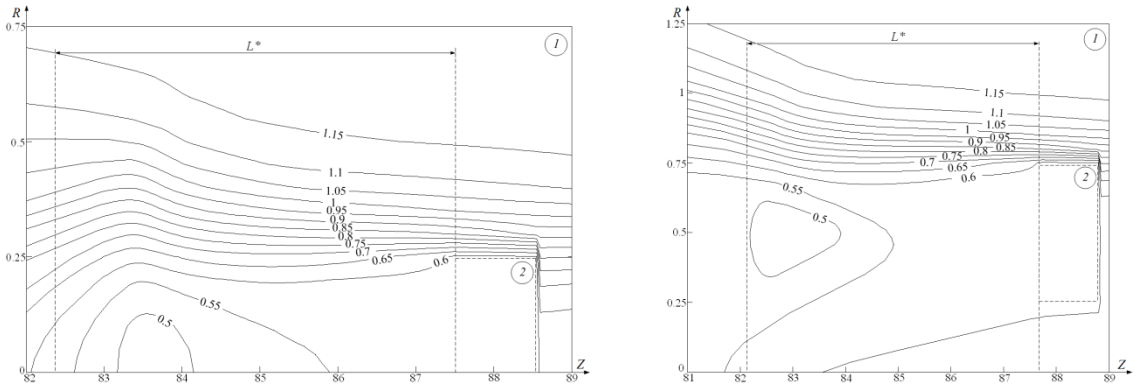
Numerical and experimental investigation results were adduced of water droplets evaporation during its interaction with combustion products of typical combustibles and materials. The influence of water droplets position relative to each other, water droplets shape and different effects on heat and mass transfer processes in the considered system was investigated numerically. Experimental investigations results were presented of single, several and large set water droplets evaporation in its motion through high-temperature gas area. Recommendations were formulated for effectiveness improvement of water usage under flame containment, fire response and fire extinguishing.

Technology development and perfection of fire extinguishing by water spray under ever-increasing burning number conditions is the high priority objective [1–4]. Problems of this technology development are determined by the need of large-scale theoretic and experimental researches of water spray droplets and flame cooperation processes.

Laws of heat and mass transfer and phase transformation in motion of single water droplet, paralleled and consistent motion of two droplets, groups of four or five droplets in high-temperature gas area have been investigated with using the created numerical models [3]. What is more, the optimum distance between neighbouring droplets for the most effective temperature reduction and combustion products concentration in droplet motion trace has been determined (Picture 1). Also the influence of water spray droplet shape on evaporation integral characteristics has been studied. The numerical analysis of diffuse-convectional heat and mass transfer processes in motion of water droplet through high-temperature combustion products has been conducted.

Experimental investigations of water spray droplet evaporation laws in high-temperature gas area were conducted with using of stream diagnostics optical methods and velocity field determination («Particle Image Velocimetry» (PIV) and «Interferometric Particle Imaging» (IPI)) [4].



a *b*

Picture 1. Isotherms (Θ) for models with two consistent droplets with L_n=5 (*a*) and five droplets with L_n=2 (*b*) (τ=0.1, R_d=0.25, Z_d=1): *1* – high-temperature gas area, *2* – water droplets

Determination of mass and water droplets characteristic dimension before and after its passing a hot gas zone were measured for investigation of water droplet evaporation fullness.

Table. Aggregate rates and velocities of power fluid droplets motion

R_d^m, mm	0.52	1.03	1.54	2.13	2.52	3.01	3.56
R_d^{m*}, mm	0,39	0,89	1,38	1,87	2,36	2,85	3,41
v_d^{m*}, m/s	0,82	1,15	1,34	1,52	1,74	1,93	2,16

* – after zone of high-temperature combustion products

Also experiments have been conducted of optimum initial droplet size determination for supplying of the most complete evaporation in motion through high-temperature gas area. What is more, the influence of water spray droplet initial temperature, impurities presence in spray liquid on evaporation integral characteristics has been investigated numerically. Features of water droplet motion in hot combustion products area have been studied.
Recommendations for supplying of the most effective water spray usage for extinguishing of fire and ignition have been formulated from the results of conducted numerical and experimental investigations.

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