Mathematical modeling of burning surface in parallel flow of oxidant

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The condensed fuel burning in an oxidant gas flow occur in investigations of various processes, for example: burning of fuel in hybrid engines; interaction of hypersonic flying vehicles with the atmosphere; exo- and endothermic reactions in chemical engineering; spreading of flame over the fuel surface, the origination of explosions and the propagation of detonation in unmixed two-phase systems of the gas-film type.

For all of the above processes it is necessary to calculate the heat and mass transfer between a chemically reacting gas layer and a reacting, melting, subliming, or otherwise destructing, surface. The methods of investigations in this field are very complicated, because the motion of a gas is governed not only by force and temperature fields but also by chemical processes depending in turn on velocity and temperature fields. This requires a conjugate solution of dynamic, thermal and diffusional problems with allowance for the equations of chemical kinetics, multi-component diffusion and variability of thermophysical properties of a medium with distributed parameters. The process incorporates the thermochemical destruction of the surface when vapours of fuel substances, comprising the surface material, diffuse into a boundary layer and react chemically with the external flow.

Of special interest is the flame propagation in microgravity. The air flows in the atmosphere of the space station and the heat flows in the inner coating materials exert primary control over this process. An investigation of material flammability is especially important to space flight safety, but this topic is not completely understood. To study of the combustion process in microgravity NASA with the European Space Agency and the group of experts, which includes scientists from Russia, conducted a series of experiments under the name «Saffire». The experimental setup for modeling the ignition and flame propagation over the material sample was created and placed in a specialized block «Cygnus». After that Cygnus was mounted in the rocket. In space Cygnus separated from the main part, and the experiment started. The experimental data were transferred to the NASA center, and the block «Cygnus» burned in the Earth atmosphere.

The present work investigates the burning of the flat surface of fuel in an oxidant flow.