Transpiration-Cooled Spacecraft-Insulation-Repair Fasteners

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Transpiration-cooled fasteners are proposed that operate like an open-loop heat pipe (self-tapping screws, bolts, and spikes) for use in on-orbit repair of thermal-insulation of a space shuttle or other spacecraft. By limiting the temperature rise of such a fastener and of the adjacent repair material and thermal protection system, the transpiration cooling would contribute to the ability of the repair to retain its strength and integrity in the high-heat-flux, oxidizing environment of reentry into the atmosphere of the Earth.

A typical fastener according to the proposal would include a hollow refractory-metal, refractory-composite, or ceramic screw or bolt, the central cavity of which would be occupied by a porous refractory-metal or ceramic plug that would act as both a reservoir and a wick for a transpirant liquid. The plug dimensions, the plug material, and the sizes of the pores would be chosen in conjunction with the transpirant liquid so that (1) capillary pumping could be relied upon to transport the liquid to the heated surface, where the liquid would be vaporized, and (2) the amount of liquid would suffice for protecting against the anticipated heat flux and integrated heat load.

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