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DESIGN AND OPTIMIZATION FOR A FINNED HEAT PIPE-FLUID LOOP RADIATOR

Abstract

The Space Station (SS) requires active thermal control system(ATCS) to manage excess heat and preserve thermal control. Thermal radiators play a very important role for ATCS which provide excess heat rejection to space. The presentation will focus on design and optimization for SS thermal radiators and the purpose is to enable SS radiators to meet high reliability and long mission time for space debris and maximum heat rejection per unit weight. A primary design of SS radiator was presented for high reliability and long mission time which included fin, heat pipe and pumped-fluid loop. Excess heat is transferred from pumped fluid loop to finned-heat pipe and then rejected to space. After seriously analysis, Three complex fitting formulas and one computer program based on conductance parameters, convection parameters and radiation parameters were developed to realize radiator performance optimization. The first formula is used to optimize fin parameters which illustrates the relation of fin efficiency(ηf) with its thickness(δf), its width(Hf), the temperature (T0) on the interface of fin and heat pipe and space heat flux(θs) it absorbs. The second formula is used to optimize length of heat pipe(Lp) and the coupled length of heat pipe and fluid loop(Lc) which illustrates the conductance resistance of heat pipe vs fluid loop. The last formula is used to optimize diameter of fluid loop(Dn), the thickness of tube(δt) and other parameters which illustrates the convection resistance of fluid loop. The computer program is based on the three fitting formulas and millions of iterative computation whose outputs are the optimized parameters including fin thickness(δf), fin width(Hf), coupled length of heat pipe-fluid loop(Lc), length of heat pipe(Lp), diameter of fluid loop(Dn), thickness of tube(δt),etc.. Of course, the program needs a series of initial parameters from former experience . The maximum heat rejected per unit weight is used as the evaluating parameter to make sure of the right results for SS radiators. The maximum heat rejected per unit weight after optimization was obviously excelled to the value from former experience design, more than 12%. At the same time, the weight reduced 12% .