Minimum fuel to climb path

I intend to minimize to the fuel consumption along a required path for an aircraft to reach a desired altitude and velocity. High level aircraft performance equations can provide a minimum fuel path; however this assumes a constant thrust and fuel consumption. This constant can be used as the guess for the desired min fuel to climb path. Aircraft performance parameters and the desired mission profile will be given.

Initially, the engine cycle analysis is intended to be a given but may become part of the optimization depending on the required scope of the project. An engine performance analysis will be generated based on the cycle analysis. The performance analysis will be used to ensure feasibility of the given engine for the given aircraft, then the climb to cruise will be used to generate the guess for the minimum time to climb path.

Required aircraft performance parameters will be the coefficients of lift and drag, takeoff weight, fuel capacity, wing surface area. For the mission profile, the Mach number and altitude will be required for each desired point, as well as the max Mach and max turn conditions. The engine’s parametric cycle analysis will require station pressure/temperature ratios for a minimum of stations 2,3,4,5,9.

The cost function will be based on maximizing fuel consumed specific work, *f*s. This variable is a function of givens as well as changing altitude, Mach number, and time. The original equation is:

Where Ps is a function of weight, drag, thrust, and lift: all of which vary with M, Alt, and time.

The engine performance analysis will be used to put the cost function in terms of variables M, Alt, and time. Then *f*s will be put into an integral bounded by time within the cost function. As of now, I haven’t found a final state condition that creates a cost that isn’t addressed by the integral (i.e. total fuel consumed).

The desired results of this optimization are a plot of the min-fuel-to-climb path and the final cost (likely the amount of fuel consumed).