Interplanetary Aircraft
－Concept for Manned Flight in the Atmosphere on the Surface of the Planet except the Earth－

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In the solar system, there are nine planets. Seven planets of them including the Earth and Titan (Moon of the Saturn) have thick atmosphere on each surface. Though so far nobody visits to seven planets except for the Earth, we will be able to aerodynamical flight in each atmosphere of the planet by simulation. Those planets have great value for engineering and resources. If they were there, we have to challenge them.

Thrust Coefficient

In the beginning, I set up the Thrust coefficient of landing vehicle on the Venus surface. And I supposed the nozzle situation is ideal at Venus surface. In addition, each parameter must be proper value. In this time, I used practical values of rocket technology for first conduction of this research, as shown below, because this engine uses Venus air itself as propellant.;

- Chamber pressure; 12MPh
- Exhaust pressure; 9MPh
- Out side pressure; 9MPh
- Rate of specific heat; 1.30

In this way, value of Thrust coefficient of the ideal nozzle at surface of Venus is 0.49. Generally, liquid propellant rocket launching on the Earth have Thrust coefficient between 1~2.

In the comparison between those, the performance on Venus surface is too low in this situation. But in the time of ascent, it is increasing by out side atmospheric pressure from altitude being up. But it must be consider about proper expansion of exhaust gas. On the Earth, changing atmospheric pressure from surface to space is 1~0 atm, but 90~0 atm on the Venus.

The problem of proper expansion of exhaust gas is harder than the Earth.
The solution of my suggestion is setting up ideal nozzle altitude at approx. 50km. (or another high altitude). As a result, nozzle exhaust will be far from proper expansion at low altitude. But high air density at low altitude gives a high lift and buoyancy.

The example of calculation materials are shown as below;

Characteristic Velocity C* -c star-

Chamber temperature	1000°K	1500°K	2000°K	2500°K	3000°K
C*(c star)	647.90	793.51	916.27	1024.42	1122.19

- Propellant is Venus Air itself. (CO_2)
- Average molecular weight of Venus Air is 44.

Exhaust Velocity m/s

Chamber temperature	1000°K	1500°K	2000°K	2500°K	3000°K
Exhaust Velocity	317.47	388.82	448.97	501.97	549.87

$$= \frac{IspGtp}{\zeta}\left[1 + (1 - \zeta\frac{t}{tp})\right]\left[\log(1 - \zeta\frac{t}{tp}) - 1\right]$$

$$IspG = C_F C^*$$