IR Rover - Exploring Venus Together.

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Abstract

We proposed an alternative source of energy, infrared photovoltaic conversion, using Venus extreme climatic conditions to power our rover, that theoretically could withstand its challenging environment.

1 Introduction

Our first and foremost goal in our design was to utilize a form of energy that could withstand the extreme climatic conditions presented in Venus. We pondered some of Geoffrey A. Landis's proposals (1) for our Power system. In the following list, we itemize the ideas we contemplated, and the reasons for not choosing them.

- Radioisotope. Our main reasons for not choosing it are the increased size and cost of existing radioistope systems. (1)

- Thermoelectric. Our main reason for not choosing it is that the Seebeck effect, which makes it generate electricity, requires a difference of temperature between the inside of our rover and the outside. In order for it to work, it needs more ample temperature differences to generate more electricity. As cooling it enough to create our power needs would be impractical, we discarded the idea.

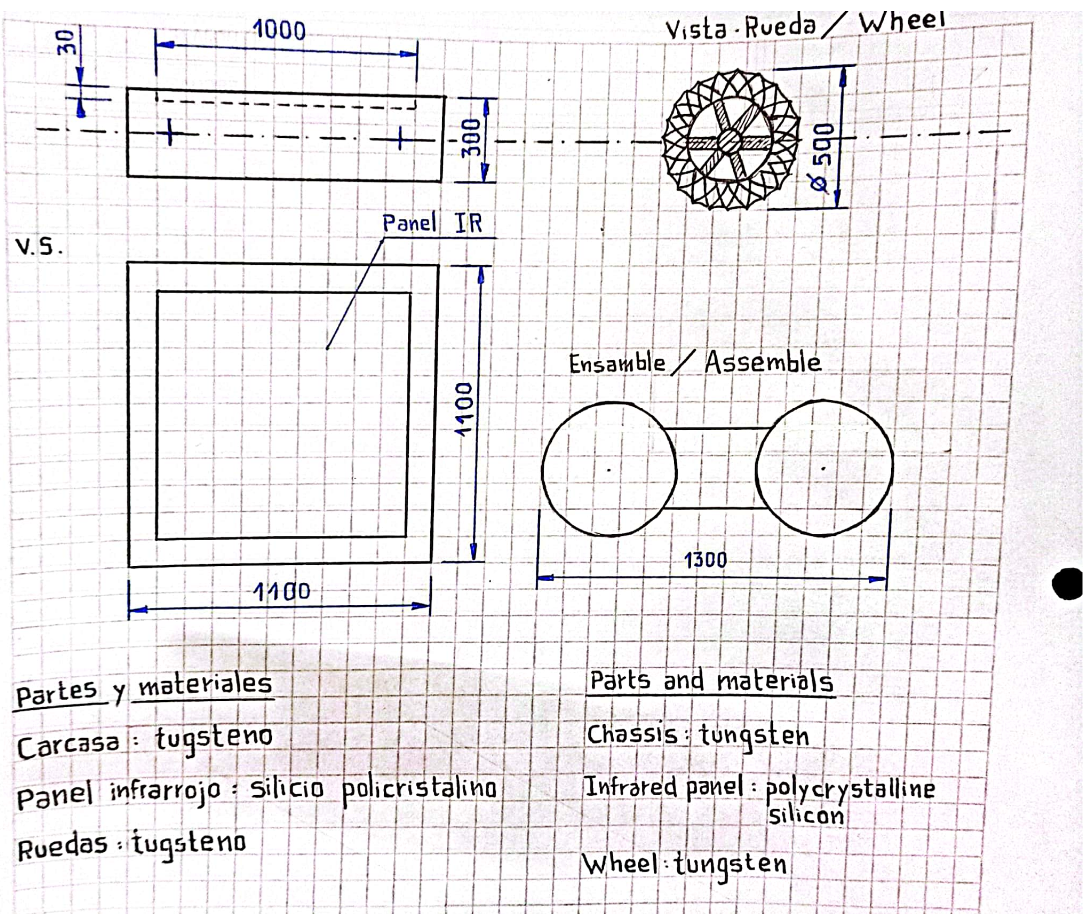
- Wind power. Our main reason for not choosing it is that Venus gusts of wind reach speeds of 360 km/h, making wind turbines unsuitable.

- Beam. Our main source for this option was (Erik J. Brandon, et al. 2020) (4). Although it seemed interesting, this option was determined not to be technically feasible, due to significant atmospheric absorption at these wavelengths. (4).

2 Design of the rover.

Our final design for the rover can be seen in our blueprints, and earth-only functional prototype.

Our earth-only functional prototype, based on an electric car toy.



This blueprint represents the measures of our rover

Following, we will describe item by item the technical considerations.

- Stored energy. First off, we decided not to use any way of energy storage, as all the energy obtained in the following step will be used at the moment. The surplus will be removed with an electric resistance.
- Source of energy. Our source of energy will be power generation by infrared photovoltaic conversion (3). As said in the cited paper, the IR approach is more than suitable for our mission, as the IR power density emitted by the Venus surface approaches two orders of magnitude higher than that emitted by the earth. We took as an example the mass of a Rover in Mars, as the technological payload would be similar. Hence, our mass is of $m = 200kg$. This mass is consistent with the idea of having a heavy rover to withstand the external pressure. The power consumption was roughly calculated as $P = 100W$. Using the current values of efficiency $\epsilon = 0.006$ for infrared photovoltaic conversion from (6), and the infrared flux computing using Planck law (5) for a material at the temperature of Venus surface $T = 734, 5K$, integrated from $8000\mathring{A}$ to $12000\mathring{A}$ foreseeable in the near future, we computed the surface area for our array, $10000cm^2$. Therefore, a collecting surface of $100cmx100cm$ would be enough to power our Rover continually. A bonus feature is that it is independent of its location inside the Rover, and can be in the up or downside (3)
- Whether the system uses in situ resources from Venus (e.g., CO2). The main in situ resource used in our project is the heat of Venus, where we can find surface temperatures of about $462C\circ$ (2).
- Operation temperature range. The operation temperature range is only limited by the melting point of the used materials. As we aimed to only include materials that could withstand the extremely hot temperatures from Venus, up until $1000C\circ$ our rover should have no temperature-related problem.

Table 1: Melting point of our used materials.

Material	Melting point (in $C\circ$)
Gold	$1.064 \times 10^3 C\circ$
Sapphire	$2.053 \times 10^3 C\circ$
Silicon	$1.410 \times 10^3 C\circ$
Tungsten	$3.422 \times 10^3 C\circ$

- Whether a protective enclosure is required. A protective enclosure is required for the IR because of the sulphur acid rains, and as the detector is made from silicon, such acid dissolves it. In order to protect it from such possibility, we decided to implement a sapphire glass.
- Whether the system can be operated in any orientation. Thanks to the size of the wheels, it can be operated even if it turns upside down.
- Whether the system can tolerate the forces and vibrations due to launch, reentry, descent, and landing. It's sturdy and compact design, based on blunt-force resistant materials, can withstand forces and impacts during the launch, reentry, descent, and landing.

3 Conclusions.

After exploring different designs for the generation of energy and the rover's chassis, we arrived at a design which theoretically can withstand the hardships of Venus climate, allowing us to take advantage from its most abundant energy source in place, to discover exciting new knowledge, and explore strange new worlds.

References

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