Group 20 - Mars LOX_LCO

Since 2021, the Perseverance rover has been exploring the Jezero crater on Mars, curating highly valuable samples of the Martian surface with the intention of sending them back to Earth to be examined in greater detail. The Mars Sample Return (MSR) mission has been scheduled to retrieve these samples within the next few years but has unfortunately run into some hurdles along the way. In April 2024 NASA made a request for proposals to make the MSR mission faster, more affordable, and more achievable. At the same time, an ESA study is underway to assess the feasibility of In-Situ Resource Utilisation (ISRU) for the purposes of this mission, building upon findings from Perseverance's Mars Oxygen ISRU Experiment (MOXIE)

Mission Objective

The goal of this exercise is to create and assess the feasibility of a conceptual design for two systems: a Mars Ascent Vehicle (MAV) powered by liquid oxygen (LOX) and liquid carbon monoxide (LCO) produced from Martian resources, and its corresponding Sample Return Lander (SRL). These systems will be key components of the Mars Sample Return (MSR) mission, which is a complex mission with many interdependent elements. It is therefore essential that the final design adopts existing MSR components from the baseline architecture, and account for any system interfaces these components need. Particular attention should also be paid to technology that has already been designed for past Mars missions, as these may provide a shortcut in project development and reduce the cost of creating a completely novel system.

System Design

The project presents a design for both the SRL and the MAV. The SRL is a platform equipped with more than $17m^2$ of solar panels to meet the substantial energy requirements of the system. Aboard the SRL is an electrolyser, very similar to that in the MOXIE experiment, that generates the LOX and LCO propellants for the MAV. The propellants are cooled and compressed until they liquefy and stored until needed for launch, at which point the SRL fills the tanks of the MAV, raises it vertically, and prepares for liftoff. The MAV is a two-stage rocket powered by an electric pump-fed first-stage engine and a pressure-fed second-stage engine. With these engines, the MAV is capable of placing the sample container into a 500km Mars orbit where it can be intercepted by ESA's Earth Return Orbiter. This approach not only reduces the need to transport large quantities of fuel from Earth but also aligns with sustainable exploration practices by utilising local resources. The team's two comprehensive designs integrate well with the existing MSR components ensuring that the mission objectives can be met despite the challenges faced. This innovative strategy not only addresses current obstacles but also sets a precedent for future Mars missions, emphasising the importance of ISRU processes to facilitate long-term exploration and potential colonisation of the Red Planet.