

# ALCHEMIST

## Extracting Oxygen from Lunar Regolith

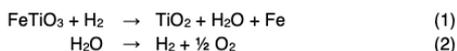


### Context

The venturing of humans deeper into space and rise of commercial cis-lunar activities calls for the affordability and sustainability that Space Resources Utilisation (SRU) can provide. While Oxygen and water are readily available on Earth, they are extremely valuable in space, oxygen being the first resource that can be produced on the Moon in support of human missions and as a source of oxidizer for rocket propulsion, having the potential to reduce radically launch costs.

### Overview

ALCHEMIST is a Lunar mining demonstrator that uses the hydrogen reduction of ilmenite (a titanium-iron oxide mineral present in the Lunar regolith) to produce water (Eq. 1), which can be subsequently electrolysed, (Eq. 2):



After electrolysis, the hydrogen can be recycled and returned to reaction (1) while obtaining oxygen as the desired product.

ALCHEMIST is an ESA <120kg payload flying on a commercial Lunar lander designed to demonstrate for the first time the in-situ production of water, up to 100g, on the Lunar surface. It includes regolith acquisition, handling, beneficiation and processing elements.

### ALCHEMIST

#### A Scalable Process

ALCHEMIST uses a verified, relatively low complexity process which already has been tested with Apollo lunar samples, uses a low-mass reagent, is designed taking into account decades of Earth industry expertise and uses a well-characterised feedstock. Solar thermal power can be used (instead of electrical power) to provide an even more efficient larger-scale energy delivery to the reaction.

Our terrestrial demonstrator has assessed process performance with various types of regolith simulant and with varying concentrations of ilmenite.

Space Applications Services has performed initial conceptual designs, of a scaled-up plant producing 1.4 tonnes of Oxygen per year, which would be sufficient to provide oxygen to a large human outpost. Further scaling-up is possible in order to satisfy cis-lunar operations' needs.

#### Water Extraction

The permanently shadowed regions (PSRs) near the poles of the Moon harbour significant quantities of water in the form of ice but significant unknowns remain. Once robotic prospectors such as Space Applications Services' LUVMI have confirmed this water ice, ALCHEMIST derived technology (hot reactors and cold traps) will be used to extract water from lunar regolith.

#### APPLICATIONS

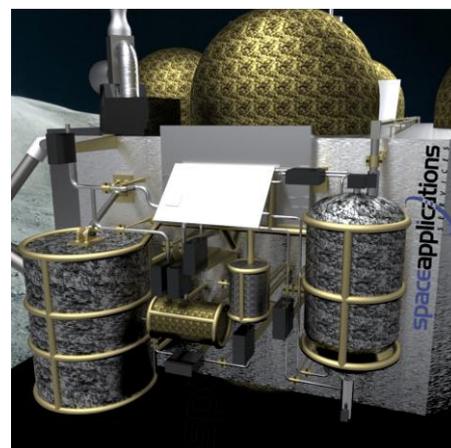
- Oxygen and water ISRU
- Regolith handling and beneficiation

#### SERVICES AVAILABLE

ISRU design, test and verification using our testbed.

For more information please visit:  
<https://www.spaceapplications.com>

or contact us:  
[Diego.Urbina@spaceapplications.com](mailto:Diego.Urbina@spaceapplications.com)



The ALCHEMIST demonstration payload

#### ABOUT SPACE APPLICATIONS SERVICES

Space Applications Services NV/SA is an independent Belgian company founded in 1987, with a subsidiary in Houston, USA.

Our aim is to research and develop innovative systems, solutions and products and provide services to the aerospace and security markets and related industries. Our activities cover manned and unmanned spacecraft, launch/re-entry vehicles, control centres, robotics and a wide range of information systems.



#### Space Applications Services NV/SA

Leuvensesteenweg 325  
1932 Sint-Stevens-Woluwe  
(Brussels Area)  
Belgium

+32 (0)2 721 54 84

[info@spaceapplications.com](mailto:info@spaceapplications.com)  
[jobs@spaceapplications.com](mailto:jobs@spaceapplications.com)

[www.spaceapplications.com](http://www.spaceapplications.com)  
[www.icecubesservice.com](http://www.icecubesservice.com)  
[www.aerospaceapplications-na.com](http://www.aerospaceapplications-na.com)