

Long-term missions

With bioreactors and 3D printers to Mars

By *Holger Dambeck*

A manned Mars mission would take three years - and require extremely heavy cargo. Now researchers have calculated how it could be easier: microbes and 3D printers to produce fuel and food.

Who wants to live perfectly sustained, could apply for a flight to Mars. In such long-term mission a wholly owned recycling all possible waste and sewage is inevitable. In addition, the astronauts must use all available resources on Mars, for example, to gain oxygen.

The best ways for an efficient use of scarce resources could provide synthetic biology. Genetically modified microbes are from the waste water produced in the spaceship, and raw materials from Mars produce fuel for jets and protein for the dinner plate. In the journal "*interface*" of the British Royal Society researchers expect before detailing how the material cycle might look like in a space ship and a station on the Red Planet.

"There are many challenges for a Mars mission," says author Amor Menezes of the University of California at Berkeley. For each kilogram of payload in space must be added expect 99 kg rocket and propellant mass. It adds the long mission duration. "We propose a new biological approach to solve these problems."

Fuel from the reactor

The flight to Mars takes 210 days. The astronauts then would have around 400 days left on the Red Planet until its position in relation to the earth again allowed a return flight within 210 days. Menezes and his colleagues have meticulously recorded the payments that amounts of carbon dioxide, urine and wastewater during long duration flights. Only the outward flight to Mars are at a six-man crew 1.3 tons of carbon dioxide by breathing, 1.9 tons of urine and three tonnes of other waste water.

You could drain out the waste water and exhaust gases theoretically from the spaceship into space. But they must be recycled so that the payload of the spacecraft and the mission costs are not too large. For CO₂, nitrogen, hydrogen and oxygen contained in the urine both fuel, food, biopolymers (plastic) and medicines can be produced.

"The production of medicines in space is particularly important," says Menezes. Because of the cosmic radiation aging drugs much faster than on Earth. You must therefore be prepared as required in the spaceship. The researcher points to a recent experiment, in which modified cyanobacteria the painkiller paracetamol have synthesized.

Astronauts could therefore take colonies of different microbes in small doses lead on their flight. The lead protect against radiation damage. If required, we would then take the microbes from the tin and leave in a bioreactor perform their work.

Total mass of the rocket: 8.5 tons

In the longer 400-day stay on Mars, astronauts would naturally make use of all available resources there - as nitrogen and CO₂ from the atmosphere and water ice from the polar caps of the planet. Just the start for the return flight requires a lot of fuel that must be synthesized locally. "On the moon would to some excavations carbon dioxide, nitrogen in the form of ammonia and water vapor available," said Menezes.

According to the calculations of his team small bioreactors can reduce the load significantly for a flight to Mars. The mass of food would drop about 3.5 to 3.8 tons to just 2.3 tonnes. The reactors would dry biomass production, cultivation of plants would then not be necessary.

Play an important role, according to Menezes and 3D printer. With them construction segments for the Mars base and spare parts as needed were finished. The biopolymers, which came as a material used also came from bioreactors. Instead of the estimated 11.4 tons of raw materials for building materials would have the Mars travelers will take only 1.6 tons to print out their Mars base on site.

If all ideas on the use of synthetic biology could implement, the total mass of the Mars spacecraft would be about 8.5 tons, says Menezes. On the technical concept NASA is already working together with the aerospace company Lockheed Martin. "Orion" you mean the cargo and passenger vans. The first unmanned test flight is planned for early December.

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