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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

[18-066]

Notice of Centennial Challenges CO_2 Conversion Challenge Phase 1

AGENCY: National Aeronautics and Space Administration (NASA).

ACTION: Notice of Centennial Challenges CO_2 Conversion Challenge Phase 1.

SUMMARY: This notice is issued in accordance with the NASA Prize Authority. Phase 1 of the CO_2 Conversion Challenge is open, and teams that wish to compete may now register. Centennial Challenges is a program of prize competitions to stimulate innovation in technologies of interest and value to NASA and the nation. NASA envisions this competition having two phases with a total prize purse of up to $1 million. Phase 1 (the current phase) is the Concept Phase with a prize purse of up to $250,000 to demonstrate capabilities to develop technologies to manufacture "food" for microbial bioreactors from CO_2 and hydrogen molecules, with the ultimate goal of producing glucose. The initiation of Phase 2, a Demonstration Challenge with a prize purse of up to $750,000, is contingent on the emergence of promising submissions in Phase 1 that demonstrate a viable approach to achieve the Challenge goals. The official rules for Phase 2 will be released prior to the opening of Phase 2. NASA is providing the prize purse, and NASA Centennial Challenges will be managing the Challenge with support from Common Pool.

DATES: Challenge registration for Phase 1 opens August 30, 2018, and will remain open until 6:00PM Eastern Time on January 24, 2019.

Other important dates:

February 28, 2019	Phase 1 Submission Deadline – no further requests for review will be accepted after this date

ADDRESSES:

Phase 1 of the CO_2 Conversion Challenge will be executed at the participants' facility or lab.

FOR FURTHER INFORMATION:

To register for or get additional information regarding the CO_2 Conversion Challenge, please visit:

www.co2conversionchallenge.org

For general information on the NASA Centennial Challenges Program please visit: http://www.nasa.gov/challenges. General questions and comments regarding the program should be addressed to Monsi Roman, Centennial Challenges Program, NASA Marshall Space Flight Center Huntsville, AL 35812. Email address: hq-stmd-centennialchallenges@mail.nasa.gov.

SUPPLEMENTARY INFORMATION:

Summary

Future planetary habitats on Mars will require a high degree of self-sufficiency. This requires a concerted effort to both effectively recycle supplies brought from Earth and use local resources such as CO2, water and regolith to manufacture mission-relevant products. Human life support and habitation systems will treat wastewater to make drinking water, recover oxygen from CO2, convert solid wastes to useable products, grow food, and specially design equipment and packaging to allow reuse in alternate forms. In addition, In-situ Resource Utilization (ISRU) techniques will use available local materials to generate substantial quantities of products to supply life support needs, propellants and building materials, and support other In-Space Manufacturing (ISM) activities.

Many of these required mission products such as food, nutrients, medicines, plastics, fuels, and adhesives are organic, and are comprised mostly of carbon, hydrogen, oxygen and nitrogen molecules. These molecules are readily available within the Martian atmosphere (CO_2, N_2) and surface water (H_2O), and could be used as the feedstock to produce an array of desired products. While some products will be most efficiently made using physicochemical methods or photosynthetic organisms such as plants and algae, many products may best be produced using heterotrophic (organic substrate utilizing) microbial production systems. Terrestrially, commercial heterotrophic bioreactor systems utilize fast growing microbes combined with high concentrations of readily metabolized organic substrates, such as sugars, to enable very rapid rates of bio-product generation.

The type of organic substrate used strongly affects the efficiency of the microbial system. For example, while an organism may be able to use simple organic compounds such as formate (1-carbon) and acetate (2-carbon), these "low-energy" substrates will typically result in poor growth. In order to maximize the rate of growth and reduce system size and mass, organic substrates that are rich in energy and carbon, such as sugars, are needed. Sugars such as D-Glucose, a six-carbon sugar that is used by a wide variety of model heterotrophic microbes, is typically the preferred organic substrate for commercial terrestrial microbial production systems and experimentation. There are a wide range of other compounds, such as less complex sugars and glycerol that could also support relatively rapid rates of growth.

To effectively employ microbial bio-manufacturing platforms on planetary bodies such as Mars, it is vital that the carbon substrates be made on-site using local materials. However, generating complex compounds like glucose on Mars presents an array of challenges. While sugar-based substrates are inexpensively made in bulk on Earth from plant biomass, this approach is currently not feasible in space. Alternatively, current physicochemical processes such as

photo/electrochemical and thermal catalytic systems are able to make smaller organic compounds such as methane, formate, acetate and some alcohols from CO2; however, these systems have not been developed to make more complex organic molecules, such as sugars, primarily because of difficult technical challenges combined with the low cost of obtaining sugars from alternate methods on Earth. Novel research and development is required to create the physicochemical systems required to directly make more complex molecules from CO2 in space environments. It is hoped that advancements in the generation of suitable microbial substrates will spur interest in making complex organic compounds from CO2 that could also serve as feedstock molecules in traditional terrestrial chemical synthesis and manufacturing operations.

The CO_2 Conversion Challenge is devoted to fostering the development of CO_2 conversion systems that can effectively produce singular or multiple molecular compounds identified as desired microbial manufacturing ingredients and/or that provide a significant advancement of physicochemical CO_2 conversion for the production of useful molecules.

I. Prize Amounts

Phase 1 of the CO_2 Conversion Challenge total prize purse is up to $250,000 (two-hundred fifty thousand dollars) to be awarded to up to five (5) top teams. Up to five (5) top teams will be selected based on judges' scoring and awarded $50,000 (fifty thousand dollars) each.

II. Eligibility to Participate and Win Prize Money

NASA welcomes applications from individuals, teams, and organization or entities that have a recognized legal existence and structure under applicable law (State, Federal or Country) and that are in good standing in the jurisdiction under which they are organized with the following restrictions:

1. **Individuals must be** U.S. citizens or permanent residents of the United States **and must be** 18 years of age or older.
2. **Organizations must be** an entity incorporated in **and** maintaining a primary place of business in the United States.
3. **Teams must be** comprised of otherwise eligible individuals or organizations, **and** led by an otherwise eligible individual or organization.
4. **Teams must** conduct their demonstration work in facilities based in the United States, to include AK, HI and U.S. territories.

U.S. government employees may enter the competition, or be members of prize-eligible teams, so long as they are not acting within the scope of their Federal employment, and they rely on no facilities, access, personnel, knowledge or other resources that are available to them as a result of their employment except for those resources available to all other participants on an equal basis. U.S. government employees participating as individuals, or who submit applications on behalf of an otherwise eligible organization, will be responsible for ensuring that their participation in the Competition is permitted by the rules and regulations relevant to their position and that they have obtained any authorization that may be required by virtue of their government position. Failure to do so may result in the disqualification of them individually or of the entity which they represent or in which they are involved.

Foreign citizens may only participate through an eligible US entity as:

i. An employee of such entity
ii. A full-time student of such entity, if the entity is a university or other accredited institution of higher learning,
iii. An owner of such entity, so long as foreign citizens own less than 50% of the interests in the entity, OR

iv. A contractor under written contract to such entity.

No Team Member shall be a citizen of a country on the NASA Export Control Program list of designated countries in Category II, Countries determined by the Department of State to support terrorism. The current list of designated countries can be found at http://oiir.hq.nasa.gov/nasaecp/. As of July 12, 2018, only 4 countries are in category II (Iran, North Korea, Sudan, and Syria). Please check the link for latest updates.

A team-designated team lead shall be responsible for the actions of and compliance with the rules, including prize eligibility rules, by all members of his or her team.

The eligibility requirements can also be found on the official challenge site:

www.co2conversionchallenge.org

III. Intellectual Property

Each application should reflect the anticipated ownership, use, and licensing of any intellectual property. The Team represents and warrants that the Entry is an original work created solely by the Team, that the Team own all Intellectual Property in and to the Entry, and that no other party has any right, title, claim or interest in the Entry, except as expressly identified by the Team to NASA in writing in the application. NASA claims no right, title, or interest to any such intellectual property solely as a consequence of the Team's participation in the competition, including the winning of a prize. NASA reserves the right to share any submissions received with its civil servants and contractors, and reserves the right to approach individual participants about any future opportunities at the conclusion of the competition.

IV. Official Rules

The complete official rules for Phase 1 of the CO_2 Conversion Challenge can be found at:

www.co2conversionchallenge.org

Cheryl Parker,
NASA Federal Register Liaison Officer.
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