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Application of syngas as main fuel of engine-generator with plasma assisted reforming and combustion for life support systems of stationary extra-terrestrial stations

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One of the main processes for life support systems is fuel production and combustion for energy production along with oxygen generation and steam generation. For manufacturing a propellant on Mars, methane combustion in oxygen with the stoichiometric ratio of oxidizer and fuel of 2:1 is proposed. However, one pass through the Sabatier reactor produces a ratio of methane: oxygen of only 1:1. In the syngas (synthesis gas) combustion, it can produce heat from dry or steam reforming process of a hydrocarbon feedstock when oxygen oxidation is used as the main fuel for the power unit. For the reforming process, CO2 (from Mars atmosphere) or H2O (from Sabatier reactor) can be used as carrier gas in plasma feedstock reactor. Calculations of the stoichiometric ratios of different syngas compositions showed that the value of (syngas): (O2) stoichiometric ratio that can be achieved is of the range (0.17-0.32):1 and this ratio depends on the syngas composition, in comparison to (CH4): (O2) stoichiometric ratio. However, the composition of the produced syngas has low heat values between 4-20 MJ/kg, which is around 2.4-10.1 times less than methane. It creates a necessity to increase the amount of fuel and the amount of oxygen in the syngas combustion in order to provide the same heat values as provided in the methane combustion to the engine power. In addition, the ratio of the oxygen produced to oxygen consumed in the combustion has to be decreased to values of about (0.58-1.07):1. However, the ratio can be increased by decreasing the lower flammable limit of syngas through plasma assisted combustion.

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Real-time graphene based scale monitoring smart sensor systems

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The scale deposition at the internal surface of the pipelines under the supersaturation conditions leads to unavoidable damage of the equipment parts. Consequently, suspension of oil operations becomes essential in order to replace the damaged parts. Such interruptions are escorted by extremely high costs. In this project, the sensitivity and selectivity of Carbon Nano-Materials (CNMs) to detect scale in oil and gas pipelines is the main goal. Two different methods will be investigated to fabricate sensors that can detect the presence of any new molecule at the surface of CNTs. These sensors can be used as chemical and gaseous sensors that can function in the oil and gas industry's hostile environments. The first method of making the sensors is the smear casting technique. In this method, CNTs are dispersed in a polymer matrix (epoxy) using ultra high sonicator. This technique provides strong nanocomposites with electrical properties that respond to changes in chemical composition at its surface. The second technique is using CNTs ink and printing of CNT films using inkjets, which after curing do the same function that casted CNTs do.

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