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AN EXPERIMENTAL STUDY OF POWER GENERATION SYSTEM USING HEAT OF CHEMICAL DECOMPOSITION OF NITROUS OXIDE

Abstract

These days, scientific planetary explorations with various spacecrafts are conducted actively to probe the solar system. In the exploration distant from the sun, there are two problems. One is a power supply drop of solar cells, the other is a low-temperature environment. Hence, we need to use low melting-point propellants to decrease the power consumption of propellant heaters. The freezing-point of nitrous oxide is 183 K under ordinary pressure, so we think that it is suited for the space exploration. Moreover, its decomposition heat 82 kJ/molN_2O can convert to electric power using thermoelectric devices. So, this power might be used for electric devices on-board. To realize this, we purpose to apprehend the characteristic features of such power generation system because, as far as we know, this is a new field of study. To generate electricity from heat, we can choose some power generation devices such as Peltier devices, Stirling engines and steam turbines. In our experiment, we used a Peltier device because it was simple structure and had no mechanical moving parts so that we could easily design a new system. N_2O decomposition makes two levels of temperatures, which create a hot and a cold side. These represent N_2O decomposed gas and N_2O gas respectively. Therefore, we can generate electricity by sandwiching the Peltier device between these two thermal sources. This is the concept of the system. By using thermocouples, we can measure temperatures of the catalyst and surfaces of the Peltier device. And we can measure the voltage and the current of the Peltier device. In the first experimental phase, we heat up the catalyst until N_2O decomposition temperature. Subsequently, N_2O is injected at constant flow rate. After the device becomes a stationary state, we measure the voltage and the current of the Peltier device to get the I-V curves. Our results have shown, while N_2O is injected into the device, the catalyst temperature is more than 1073 K. Additionally, the difference between surface temperatures of the Peltier device became a stationary state earlier than these temperatures. And the I-V curves of the Peltier device could be obtained. In conclusion, we confirmed the self-heating-up-decomposition of nitrous oxide and realized power generation using decomposition heat of nitrous oxide. Because the generated voltage of Peltier device is proportional to the difference in temperature, it is important for the difference in temperature to achieve a stationary state earlier than these temperatures.