easiest way to provide this liquid film is to arrange bigger amount of fuel or oxidizer injectors on the outer perimeter of the injector face. This way it can be created a ring of extra fuel flowing around the outer perimeter that won't have enough amount of oxidizer needed to burn. Such liquid ring can stop the heat transferring from the main combustion gases to the walls and flow it away. Additionally that fuel will be used later in the combustion process but it already has grater temperature which increases the efficiency of engine [1].

Conclusion

It is completely inefficient and impractical to make the walls of the nozzle thick due to a sharp increase in the weight of the structure and the price. It is much easier to use the ablation cooling method, it has no moving parts and self-regulating, although in this case the engine cannot be used again due to the wear of the walls of the ablation chamber. In film cooling, there is a risk of coolant leakage from the system, which can lead to loss of thrust or damage to the nozzle. Although the design is complex, it involves complex systems for supplying the coolant, as well as ensuring a higher wall pressure than in the combustion chamber – the regenerative cooling method is widespread among modern rockets, such as SpaceX Falcon 9 and Blue Origin New Shepard etc.

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ANALYSIS OF POSSIBLE SOLUTIONS FOR MOST COMMON SPACESUIT DESIGN PROBLEMS

Artur Tkachuk, Sophia Maslakaeva, Bohdana Holota
National aviation university, Kyiv

Supervisor – Volodymyr Krasnopolskii, PhD, associate professor.

Key words: Spacesuit, shoes, knapsack, gloves.

The design of modern spacesuits has several disadvantages: the bulkiness of the gloves, the too short time of using the knapsack, a large number of layers of materials, which in turn makes the design bulky and heavy. The high probability of throwing an astronaut away from the station is also a big problem. Therefore, it is worth considering options for solving these problems.

Shoes for spacesuits must protect the feet from mechanical damage, cooling and overheating and various other external factors. Spacesuit boots for walking in zero gravity have a simple design, since astronauts do not normally walk on the surfaces of space objects, but they must be comfortable, quick and easy to put on and take off. Already for staying on space objects, shoes must be more carefully thought out, for example, for landing on the moon or Mars. Another problem is the high probability of throwing an astronaut away from the station, for example, due to an accidental unsuccessful movement, which is why it is necessary to create additional safety devices. The solution to this problem is the creation of shoes with magnetic soles – can be used electromagnets that will be sewn into the soles of these shoes [1].

Spacesuit materials are also an aspect that should be improved. The Apollo A7L spacesuit was created for landing on the surface of the Moon under the Apollo program in 1969-1972. This spacesuit was of the soft type and consisted of 17 layers of various strong materials. A thermoregulatory suit, penetrated by a network of tubes with water circulating in them, was worn under the outer spacesuit. The mass of the lunar spacesuit was about 90 kg. The autonomous life support system was designed for six hours of operation on the lunar surface plus 30 minutes of emergency reserve. But now Axiom Space is collaborating with Prada to create spacesuits that will be worn by NASA's next astronauts on the Artemis missions. Prada will assist Axiom in working on the outer layer of its spacesuit, which has to protect the suit's inner layers from the space environment, including lunar dust, without hindering its mobility and also using composites for parts of the torso and pants of the suit, he said, could make the suit lighter [2,3].

The gloves are one of the most important parts of the spacesuit as they are meant to give astronauts ability to operate in the outer space. That is why they must be as mobile as possible in order to make the astronauts' work comfortable. Originally, the spacesuit glove consists of three main layers: the pressure, restraint and Thermal Micrometeoroid Garment (TMG) layers. The pressure layer is meant to keep the air inside the spacesuit, the restraint layer keeps the shape and the size of the gloves permanent and TMG layer protects astronauts from fast moving particles. But still, all this layers mentioned above make gloves inflexible. So, the Smart Astronaut Glove was invented. The essence of its work is that astronauts would operate a joystick interface that would repeat all the movements given by the astronaut. It would make the work much easier for astronauts as they would not have to make a lot of effort to keep the tools in theirs hands. Furthermore, the reduction of physical fatigue will increase the quality of the astronauts' work performance [4].

For movement, astronauts use a knapsack with auxiliary engines. Now H_2O_2 is used as fuel. 1 kilogram of hydrogen peroxide can create an impulse of 100 kgf*s. However, this substance can be used as an oxidizer for more powerful fuels, such as methane. Then, with the same mass of fuel and oxidizer, will be got a greater impulse, which in turn will make it possible to increase the operating time of this equipment. An additional impulse will be provided through an increase in thrust, which in turn will be provided by the combustion of methane and an increase in the pressure and rate of leakage of used gases. For example, modern spacesuits contain about 14 kg of compressed hydrogen peroxide, which provides a total impulse of 1400 kgf*s. From the equation for the reaction of methane and hydrogen peroxide: $CH_4+4H_2O_2 \rightarrow CO_2+6H_2O$, is understandable that it is necessary to take 4 mols of hydrogen peroxide for 1 mol of methane. So, if the total mass of these substances will be 14 kg, then the mass of methane and hydrogen peroxide should be 4.48 kg and 9.52 kg, respectively. But, there are also disadvantages. Possible increase in weight due to the complexity of the system, as well as the fire hazard of such a solution. So, in this way, by replacing only 4.48 kg of compressed hydrogen peroxide with methane, can be achieved a longer operating time of this equipment.

Conclusion

A spacesuit is a complicated, heavy and expensive technical solution of the human work problem in outer space. To make it more safe, easy, convenient and comfortable the further research and improvements are strongly recommended.

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ГРАФЕН: РЕВОЛЮЦІЙНИЙ МАТЕРІАЛ В АВІАЦІЇ

Софія Бурейко
Національний авіаційній університет, Київ

Науковий керівник – Михайло Свирид, к.т.н., доцент

Ключові слова: графен, матеріал, літакобудування.

Вступ. Використання новітніх матеріалів, таких як графен, у літакобудуванні відкриває безліч можливостей для поліпшення продуктивності, зниження ваги та покращення ефективності палива літаків. Ця технологія може значно підвищити безпеку та довговічність літаків, знизити витрати на їх експлуатацію та зменшити негативний вплив на навколишнє середовище.

Матеріали та методи. Проаналізовано фізичні властивості графену, які можуть мати вирішальну роль у вибору цього матеріалу. Серед них такі як:

- висока міцність: в 200 разів міцніший за сталь. У порівнянні із алюмінієвим сплавом Д16Т витримує навантаження у 100 разів більше (графен 130 ГПа, алюміній 480 МПа);
- легкість: в 5 разів легший за сталь і в 3,5 разів за алюміній;
- електропровідність;
- теплопровідність;