CONCLUSIONS

Phase I demonstrated the functionality of eSionic's approach to CO_2 separation: we have established that CO_2 can be removed from simulated cabin air using only electrical input, by a film in a membrane configuration. Membrane synthesis and fabrication techniques were developed that allowed for the successful incorporation and retention of an electrochemically active carrier molecule with eSionic's composite liquid membrane technology. This allowed for the successful demonstration of a continuous CO_2 capture rate at 40% in a single step with no moving parts. Higher capture rates of 80% was also demonstrated in a batch mode during this phase, showing the feasibility of this technology for highly efficient, low energy separation of CO_2 in space exploration activities. Based on these results and efforts during this phase of the program, it is projected that this technology has the potential of replacing the current CRDA on-board ISS with an operational energy savings of 80% in a weight and size footprint that is 75% smaller. eSionic's key enabling technology – composite liquid membrane materials – allows creation of a functional electrochemical membrane in a thin film form factor that enables this technology and application. The next step in the development is to improve the reliability of electrochemical membranes such that they can be deployed in the field. In Phase II, we will demonstrate the reliability of our system to continuous operation in humid air and we will develop a full system for a prototype air purifier.

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Estimation of the Gas-Dynamic Bearing Static Characteristics for Ball Gyroscope

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Gas-dynamic bearing is the support, where spike and bearing completely separated by a gas layer. Bearing capacity is formed due to the appearance of the high pressure in the zone of small gaps. The high pressure causes the appearance of the resulting lift force, which is counterbalanced of spike mass. The lubricant in such supports is air or gas [1].

Application of gas-dynamic bearing (GDB) is mainly determined by the features, which characterize natural gas lubrication [2]. Gas has a low viscosity. Ambient temperature has a little influence on it. Ambient pressure has even smaller impact on viscosity. Such stability of gas viscosity and its small quantity opens a wide range of applications for devices, which operate at high speeds in a wide range of operating temperatures. Gas-bearing also may be used in areas of high radioactivity because organic lubricant in such conditions loses its handling properties. Additionally, gas-dynamic bearing in contrast to any other bearing, practically, has a good stability and has not limitations on service life due to the absence of wear during the operation [2]. Therefore, the gas-dynamic bearing is widely used in the navigation instrument making [1, 2], especially, in sphere of precision gyroscopic devices.

The main goal of the research is to assess the possibility of the sensor construction, which based on gyroscope with a gas-dynamic suspension of ball rotor, for informational-measuring complex of navigation guidance drilling [1].

Ball gyroscope consists of the following main parts: the rotor is a standard ball bearing, which is placed between of two hemispherical bowls. The ball has an axial hole in the pole, where the movable elements of angle sensor are located. The response parts of angular sensor are mounted in an axial bore of bowls.

Spherical surface of bowls treated with a ball diameter, which is more than the actual diameter of the ball on 5 ÷ 10 microns. Thereby, the initial clearance is necessary for working in the regime of gas lubrication. The rotor is rotated by the electromagnetic field of the stator, which is powered by three-phase 36 Volts, with the frequency from 500 to 1000 Hz.

As the rotor rotates, gas, due to its viscosity, is involved in the initial gap between the bowls and the rotor. Further gas, which is inflow in the gap, creates an overpressure, whereby, the rotor "floats", and during its rotation at nominal speed mode provides constant gas lubrication.

Hemispherical configuration of the working surfaces of GDB was chosen precisely because it is the most appropriate in terms of ensuring sufficient reserves for a bearing capacity and stiffness of the gas-dynamic bearings, as well as the stability of the gyroscope rotation axis [1].

Using this type of suspension in the informational-measuring system means that the support will operate in severe mechanical and environmental conditions. Therefore, theoretical and experimental studies are needed to evaluate the working capacity in such conditions.

The principal characteristics, which are totality characterizes the efficiency, reliability and feasibility of units with the gas lubrication include: bearing capacity, stiffness of the bearing, quantity of viscous and dry friction momentums (the latter is important only in the initial startup time) [1].

On the gas-dynamic support characteristics, and especially on its bearing capacity, affect a series of geometric parameters (radius of the bearing, clearance, presence of grooves, etc.) parameters of the gas (viscosity, free path of gas molecules, temperature and pressure), magnetic attraction, which is caused by the electric driver, geometric accuracy of the contact surfaces, as well as the ability to injection of bearing microprofile, if any, and etc. [3].

Modeling of spherical bearings characteristics usually requires a complex mathematical statement. Modern software products allow solving some basic problems of gas-dynamics. Among others, the most suitable for solving this problem are the following: LS-DYNA, ABAQUS, ANSYS, Flow Vision and others.

The mathematical model is based on solving the system of equations, which is based on fundamental laws of mass conservation, momentum and energy. The system closes the initial and boundary conditions, as well as defining relations. When the effects are not taken into account the bundled system of equations, in the system introduced a special equation of turbulence model and so on. In the end, the resulting of synthesized system is the Navier-Stokes equation, which is the general equation of laminar flow of viscous gas.

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Welding in Space Conditions

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Electron Beam Welding is a method which uses a focussed stream of high energy electrons generated by a filament and directed to the joint requiring to be welded. The heating is very localised and the bulk of the assembly therefore remains cold and stable. This results in a very narrow weld with a minimal heat affected zone. There is no need to use filler metal as the parent metal of the assembly is melted. As this is a line of sight method it is not possible to weld around corners or re-entrant angles. Weld depths of up to 30mm can be produced and computer controls ensure minimal operator dependence, thus providing good reproducibility throughout a batch of components, even though this is a piece part process. Since the heat input is very localised it is possible to weld together previously heat treated components, which is a very economical method for producing composite gear shafts, with for example a case hardened gear on a hardened and tempered shaft.

The electron beam welding process (Figure 1).

The key benefits:

- Minimal Distortion - Welds finish machined parts
- Welds difficult and dissimilar materials
- Exceptional Quality and Repeatability
- High Weld Speeds
- Deep narrow welds of close to Parent Metal strength

Producing savings in:

- Cost
- Weight
- Lead time
- Size
- Inventory

EBW is a machine controlled welding process with welding carried out in a vacuum with no filler material resulting in exceptional weld quality and repeatability.

Weld spees are typically 1-2 metre/minute and result in deep, narrow welds requiring less than 5% of the heat input needed for a comparable depth TIG weld.

The remarkably low distortion resulting from Electro Beam welds means precision parts can be finished machined prior to welding, ever ground gears.

Industry who require the high quality weld that is produced by Electron Beam welding are Aerospace, Electronics, Scientific research, Nuclear and General manufacturing both industrial and commercial.

More benefits of Electro Beam Welding: