Study and Application of Three-axis Ferrofluid Seals

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ABSTRACT

Automation becomes an inevitable trend for industries to achieve high productivity and high precision in their production lines currently. The use of robot arm is one of the most efficient mean of transportation of materials and products. Generally, in some process, vacuum is required in the whole process or some parts of process, such as semiconductor process or other vacuum required processes. In the vacuum environments, the operation of robot arm needs to be considered not only the mechanism of the robot but also the mechanism that can avoid the destruction of the vacuum environment. Without the destruction of the vacuum environment, the power is transmitted to the robot arm that makes it function as well. In two separate sides (one is vacuum and the other is atmosphere), the power transmission usually is achieved through the aid of rotational or linear ferrofluid seals. Furthermore, robot arms need multiple degrees of freedom in order to achieve its function. Thus, the transportation of materials and products in production lines that requires vacuum environment could be achieved by using systems consisting of multi-axis ferrofluid seal and robot arm. The purpose of this research project is focused on the study of the system consisting of a multi-axis ferrofluid seal that can be use in vacuum environments. In this article, we used the finite elements method to calculate the magnetic field of the three-axis ferrofluid seal, and choose an appropriate magnetic field arrangement to design the three-axis ferrofluid seal. The test results of the three-axis ferrofluid seal, in both the condition of a single magnetic field or multi-magnetic field, indicates that an atmosphere pressure difference can be obtained. However, because of the consequence of the magnetic field coupling, there still have a 19kPa pressure drop. The improvement can be done in the future.

Keywords : ferrofluid ; multi-axis seal ; robot arm ; vacuum process

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