

SUMMARY

The paper considers the possibility of using a viscous disk clutch with electrorheological fluid as an actuator in the gripper of an industrial robot. It was assumed that the change of the pressure force of the gripper's jaws on the object carried by the gripper will take place by changing the voltage of the electric current, activating the electrorheological working fluid. The selection of the electrorheological fluid was based on the analysis of flow curves prepared for three selected electrorheological fluids.

During the design, optimization of the structure was used, which was carried out on the basis of the developed mathematical models: the electrorheological fluid and the geometry of the clutch. Increasing the accuracy of the electrorheological fluid model was obtained by taking into account the influence on the parameters of rheological models of fluid describing the dependence of shear stresses on the shear rate, external operating conditions of the clutch, such as temperature and humidity, and by adding equations describing the influence of leakage current to the mathematical model of the fluid.

The following design optimization criteria were adopted: torque transmitted by the clutch, volume of the clutch and the steady temperature of the clutch operation. The aim of the optimization was to search for the values of decision variables, such as: angular velocity of the input shaft, the number of clutch working gaps and clutch selected dimensions, for which the clutch with electrorheological fluid transmits a large torque with small dimensions at low operating temperature. The structure optimization was carried out by minimize two different objective functions describing: the ratio of the clutch volume to the transferred torque and the operating temperature, using two methods: the Monte Carlo method and the genetic algorithm. Assuming that the decision variable is the number of clutch working gaps, which is a natural number, the values of the objective function were discrete. Optimization calculations were performed for two sets of decision variables, consisting of 3 and 8 elements.

During the optimization of the structure, it was found that the calculations for the 3 decision variables lead to orderly and meaningful results, and the obtained meridional cross-section of the clutch was similar to the cross-sections of the existing structures. For 8 decision variables, there are greater discrepancies between the test results, and the obtained optimal meridional cross-section of the clutch has too thin or too thick housing walls, which indicates failure to meet the stability conditions and strength conditions of the resulting structure.

As a result of the structure optimization the viscous clutch with the ERF # 6 fluid was designed and built for the industrial robot gripper, with a diameter of 160 mm and a width of 37 mm.

The prototype of the clutch was tested on a test stand specially built for this purpose. As a result of the verification based on the results of these tests, the correctness of the mathematical models used for optimization was confirmed.