ABSTRACT

As scientists and engineers continue to make improvements to modern machinery, many of the new microturbines and turbocompressors are now smaller, more compact, and are equipped with more advanced bearing systems. They are designed to withstand extreme conditions covering very high rotational speeds (over 100,000 rpm) and high temperatures (above 200 °C) as well. Rolling bearings are extensively used under such conditions where oil-film slide bearings simply would not work. Therefore, it is necessary to develop new, unconventional bearing systems [1]. One of such solutions is a gas foil bearing in which there are additional components (made of very thin sheet metals) mounted between the journal and the bush so as to improve stiffness and damping properties of the bearing [2]. A set of thin foils demonstrates superior vibration damping properties which vastly improves dynamic properties of a rotating system equipped with such bearings, even at very high rotational speeds [3].

Because a set of foils comprises the components of a relatively high flexibility, its geometry varies according to the rotational speed, temperature and load [4]. In other words, the bearing tailors itself to the actual operating conditions of a rotating system. In addition to the excellent damping of rotor vibration and high resistance to external loads, a flexible bush makes it possible to obtain an optimal thickness of the lubricating gap along the entire perimeter of the bearing. It may, therefore, be concluded that the foil bearing’s capacity for adjustment is unique among bearings, making it a great candidate for operation under very harsh conditions, like high temperature, speed, etc.

This article presents the results of computational simulation and experimental research performed on gas foil bearings, with the special attention paid to the properties of a flexible set of foils, as one of the decisive factors contributing to a proper functioning of the bearings. The issues such as the nonlinear nature of the foil bearing's supporting structure and significant changes in its stiffness depending on the load and deformation were discussed in detail. The article also fully explains the mechanism of dissipation of energy that can come from the vibration of the rotating system and from external loads as well. It was demonstrated that thanks to the phenomena occurring in its flexible components, the foil bearing can and does adapts itself to varying operational conditions over a large range of speeds and loads. The conclusions that were drawn on the basis of theoretical analyses were successfully verified with the results from the experimental research. It was shown that vibrations of the rotor supported by well-designed foil bearings can remain at very low levels, even at very high speeds.

REFERENCES


