euspen's 16th International Conference & Exhibition, Nottingham, UK, 2016
www.euspen.eu

Description of an apparatus for testing air bearing pad performance

Mel Liebers, Dan Oss, Sam Arneson

Professional Instruments Company, Hopkins, Minnesota, USA

mliebers@airbearings.com

Abstract
We describe an apparatus for measuring lift-off, stiffness, and air film thickness at various preloads for compound-compensated air bearing pads. Preload is applied with an air bearing piston having a spherical end fitting. A close-coupled indicator measures vertical displacement from a granite surface plate. Results are discussed and a chart compares compound-compensated air bearings vs. two other types.

Keywords: Air pads, air bearing stiffness testing, compound-compensation, air film thickness

1. Introduction

Figure 1. Air bearing pads.

Air bearing pads are made in a variety of sizes and shapes (Figure 1, Ref 1) and naturally they all need to be performance tested. In a recent case the usual test facility was unavailable and an alternative was devised to measure a few parts in order to recommend an appropriate preload.

2. Methodology

2.1 Equipment

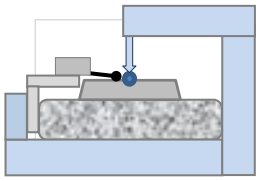

Figure 2. Structural loop.

To find the optimum preload force for a given design, a pad is pressed down on a granite surface plate using a variable force and various inlet air pressures, Figure 2.

In this test, an air bearing piston thrusts up against a mill quill and down through a ball against a pad setting on a small granite surface plate clamped by the mill vise, which also secures the indicator holder, Figure 3.

Force is supplied by an air bearing piston having a known area; because there is no friction, there is no hysteresis and with a good pressure gage and a good regulator the load on the air pad is well known and constant.

With the preload set at a specific level, air pressure to the pad is incrementally increased and the rising air film thickness ("flying height") is recorded.

An indicator measures upward displacement as inlet air pressure increases to the pad. (Displacement was measured on both sides of center and the average was taken to be the stated air film thickness.)

For consistent readings, lateral motion of the air pad was restricted by yellow tape. To ensure uniform loading, the spherical socket in the pad was centered under the mill quill, as was the air bearing piston.

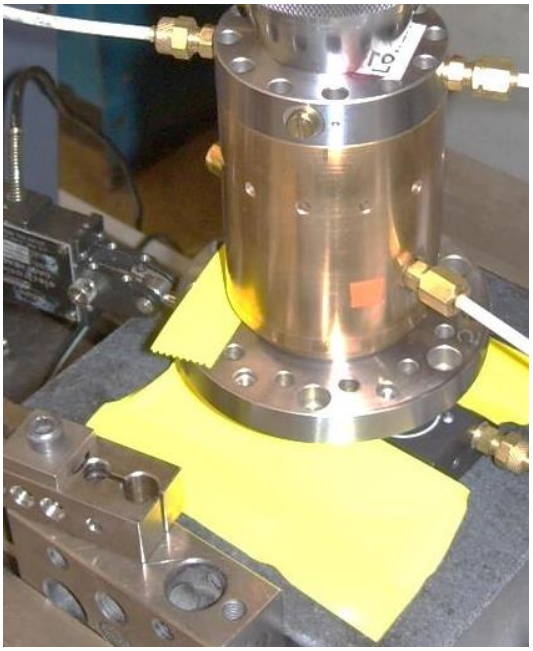

Figure 3. The air pad testing arrangement.

2.2. Procedure

Three different preloads were applied: 225, 333, and 440 newtons; and for each, the inlet air pressure to the pad was raised from zero to 690 kilopascals while noting the increasing air film thickness.

3. Results

Test results are presented in a chart which enables visual comparison of the effects of varying the preload, Figure 4.

Once a desired flying height is selected, a preload range can be specified which will yield the desired stiffness.

Note that increasing the preload increases the stiffness of the air film by increasing the inlet pressure to maintain the desired air film thickness.

4. Conclusion

Based on these tests, we recommended a preload force of 333 newtons and an operating pressure of 575 kilopascals for a flying height of 6 micrometers for that air pad.

Figure 5 illustrates the characteristics of three different types of air bearing compensation; note that compound compensation restricts the air film thickness as air pressure increases and this produces stable operation due to laminar flow through the annulus.

Useful information was quickly obtained by constructing a test rig with readily available components plus a special load cell borrowed from another tester.

References

[1] AIRBEARINGS.COM

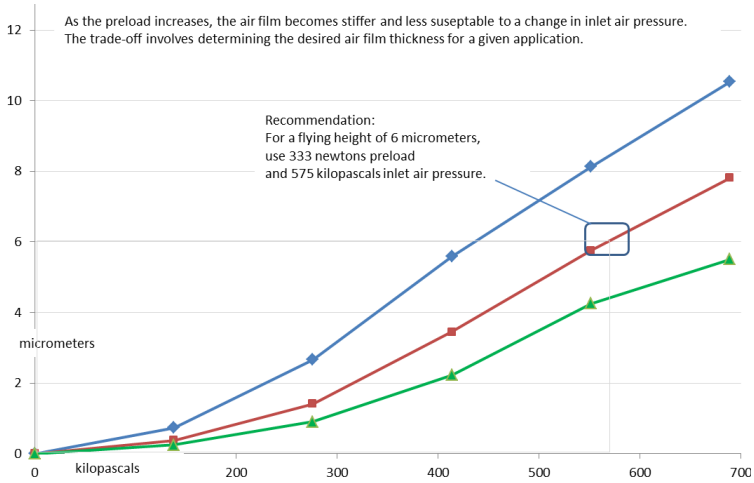

Figure 4. Flying height at 225 N (blue), 333 N (red) and 440 N (green) pre-load.

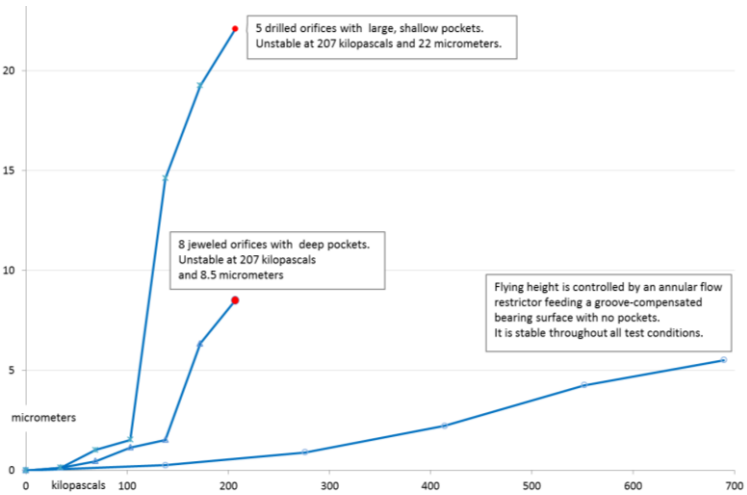

Figure 5. Flying height vs. inlet air pressure at 440 N pre-load for three different compensation strategies.