Technical Bulletin

Ceramic Ball Bearings

Overview

Flow Technology has extended the application range of its FT & HS Turbine Flow Meter series through the introduction of ceramic ball bearings that provide superior performance & corrosion resistance over traditional stainless steel and journal bearings in process applications.

Ceramic Ball Bearing Application

In terms of repeatability & turndown, ceramic ball bearings offer the same performance benefits as stainless ball bearings, provide higher corrosion resistance and perform better in low lubricating fluids.

In “zero” or very low lubricating fluids (pure water), ceramic bearings can be used but bearing life will be compromised and for these applications journal bearings provide a more robust solution.

Competitor Testing

Over the past few years several flow meter companies have advertized the benefits of ceramic bearings and; in particular; their suitability for pure water service. In order to substantiate these claims FTI evaluated meters from different manufactures, “Manufacture H”, and “Manufacture C”. Initial calibrations were performed on the meters and then they were placed in a continuous water flow loop operating at 90% of their flow range(8.5GPM). Every week the meters were removed and a calibration check performed; movement in the

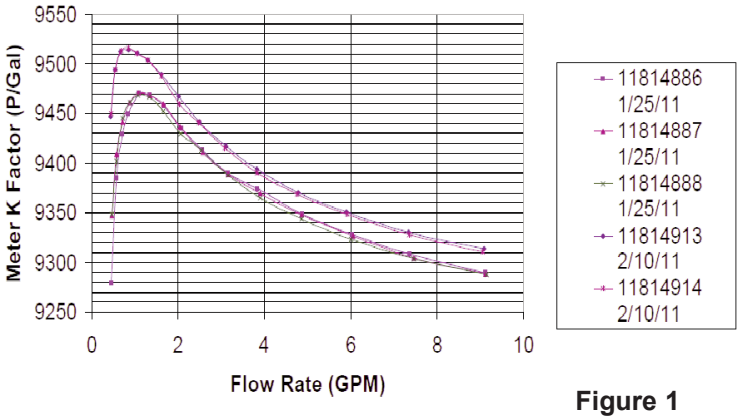

Figure 1

K-Factor curve is typically an indicator of bearing wear. The graph in figure 1 details the performance of Manufacture C’s unit after 1 week of operation; as can be seen significant calibration shifts can already be observed! Manufacture C’s unit failed after 12 days of continuous operation: The bearings wore out, physically disintegrating.

Figure 2 shows the performance of Manufacture-H’s meter after 2 weeks of operation; the meter still continued to perform. However, after 3 weeks of continuous operation the meter showed a sizable calibration shift at which point the test was terminated.

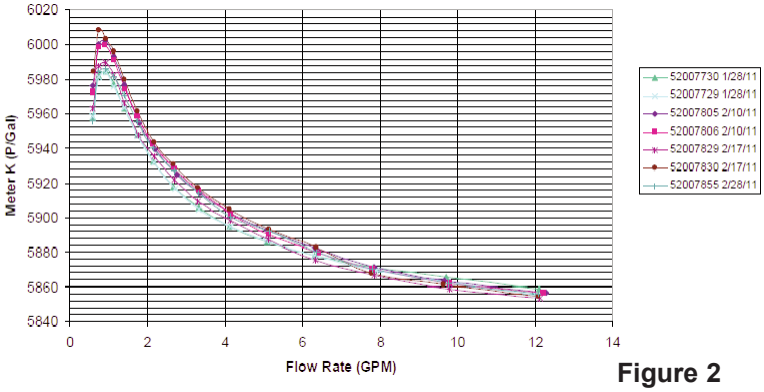

Figure 2

Flow Technology Ceramic Ball Bearings

Flow Technology uses advanced ceramic ball bearings, the newer materials offer the following benefits:

- The ceramic balls have a lower density than steel balls, this reduces the centrifugal loading and skidding of the balls allowing the bearing to operate at faster speeds with less friction.
- In standard 440C ball bearings adhesive wear occurs when microscopic peaks on the ball and race make contact and briefly weld together. As the bearing turns the micro-weld is pulled apart. The continuous cycling of micro welds forming and pulling apart causes the bearing to run at a higher tem perature, run with higher friction, and decreases the life of the bearing. Ceramic bearings cannot micro-weld, so they run at cooler temperatures with less friction (more lin ear, higher achievable turndown) and longer bearing life.
- With no adhesive wear and lower running friction the Flow Technology ceramic bearings are able to perform very well in fluids with poor lubrication. In addition the lower run ning friction provides better performance at all rotational speeds.
- Small contaminants can become embedded into 440C balls causing additional wear on the bearing race with each rota tion of the ball. Because FTI ceramic balls are much harder than 440C small contaminants cannot become embedded into the ceramic balls.
- FTI ceramic bearings have a lower thermal expansion coefficient, allowing the bearings to run with less friction even at higher rotational speeds.
- The bearing races are not 440C, but rather a higher grade stainless with a tighter molecular structure. This provides a more corrosion resistant material & smoother running surface.
- FTI ceramic bearing improve performance in all fluids, com pared to standard stainless steel ball bearings.

FTI Ceramic Bearings

Flow Technology Testing

Two evaluation FT-08 Flow Technology turbine flow meters were fabricated using state of the art ceramic bearings. Initial calibrations were performed on the meters to establish a performance base line. Information for one of these meters is presented in fig ure 3 below: Note how linear the meter is over the 10:1 range.

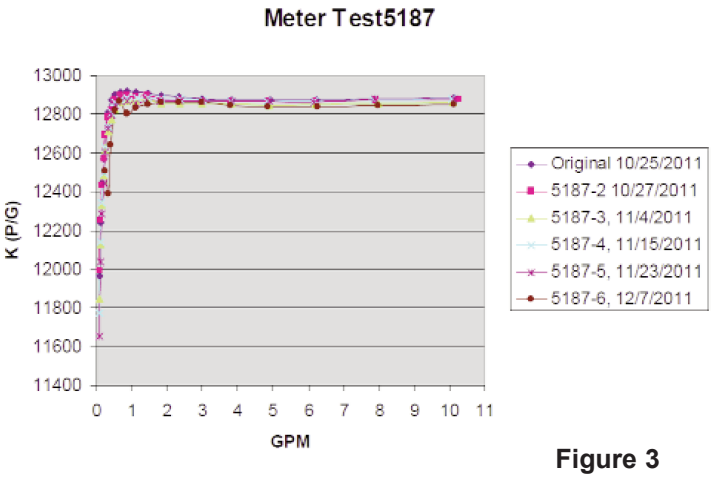

Figure 3

The meters were then installed in a recirculation water loop at ~7.5 GPM (see Figure 4) and were periodically removed to perform a calibration check. Approximately 450,000 gallons of water

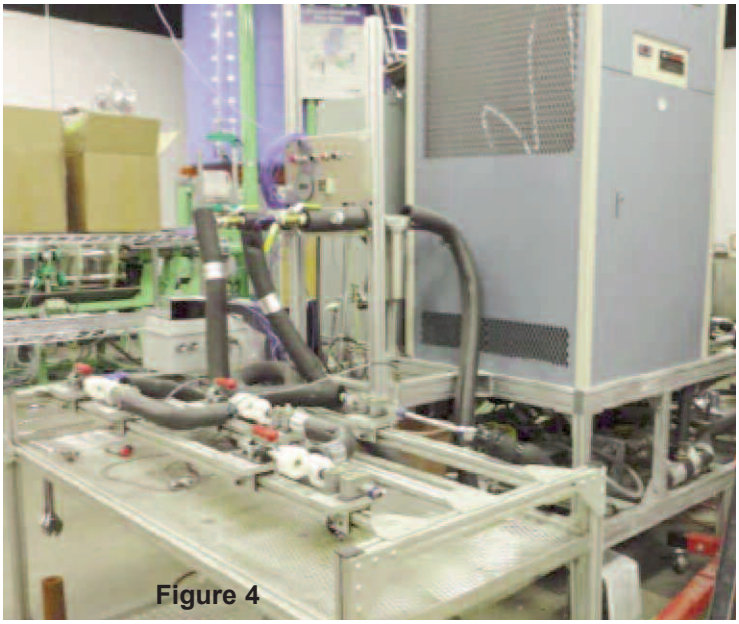

Figure 4

was flowed through the meters corresponding to approximately 41 days of continuous operation. It should be noted that these meters were run at ~90% of their flow range (i.e. at high speed) and due to the heating effect of the pumps water circulated at approximately 70°C. These factors will have a tendency to accelerate bearing aging reducing the life expectancy of the bearings. Figure 5 details the shift in K-factor for both units over the evaluation period.

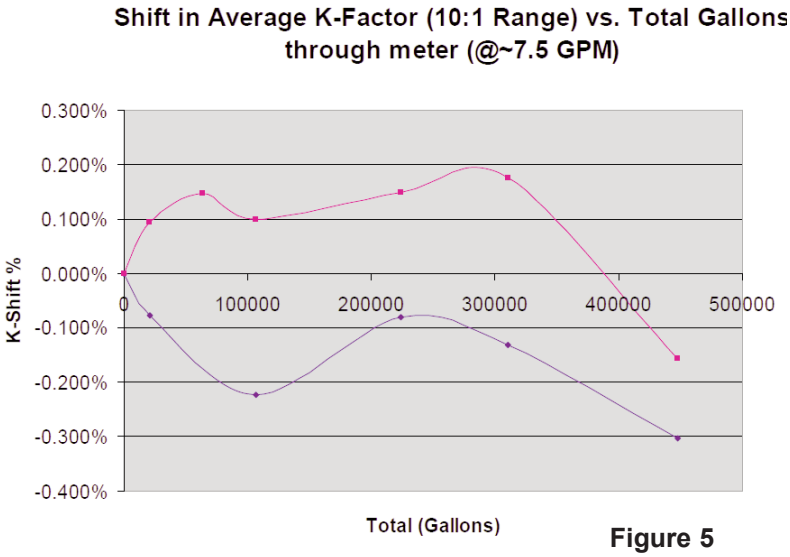

Figure 5

As can be seen, up to 300,000 (~28 days of continuous operation) gallons both flow meters performed within specification. Between 28 days and 41 days, where the test was ended, the meters showed a noticeable drop in performance. On further investigation it was determined that there was wear on the bearings at the end of the evaluation period.

Conclusion

Flow Technology ceramic ball bearings offer some unique benefits over traditional stainless steel bearings in most applications due to their lower frictional drag and corrosion resistance.

In water applications, where there is minimal lubrication, the FTI ceramic ball bearing performed well for 41days under continuous operation when operated at close to the meters upper flow rate and at elevated temperatures. It is anticipated that if the meter was operated lower in its flow range, at lower temperatures, or not under continuous flow, durability would improve.

For continuous operation in non lubricating fluids where the benefits of ball bearings are not valued (improved linearity, stability & repeatability and increased turndown) the journal bearing is the preferred solution. However, for water mixtures such as glycol/water where a level of lubrication exists ceramic ball bearings hold up well in these types of applications: In lubricating fluids ceramic ball bearings will outperform traditional stainless steel ball bearings and journal bearings.

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