NFPA
Education and
Technology
Foundation

Research Project

Dielectric Spectroscopic Sensor Development for Hydraulic Fluid Contaminant Detection

Project Overview

Most commercially available sensors that provide information on degradation and contamination of fluids acquire only few measurements of various physical properties and try to predict contamination levels. The limitation of these conventional approaches is that there is not enough data required for robustness in sensing. A sensor that can measure dielectric properties of contaminated fluids at multiple frequencies could provide more robust and accurate information on contaminants present in the working fluids.

The goal of this research project was to develop a practical dielectric sensor for detecting contaminants in hydraulic fluids. The sensor was designed and fabricated to be low cost and capable of connecting inline. A hydraulic test circuit was built for the experiment and multivariate technique was used to investigate efficiency of the sensor. The result showed that the dielectric sensor was able to detect different level of iron and ISO test dust contamination in hydraulic fluid.

Unmet Need

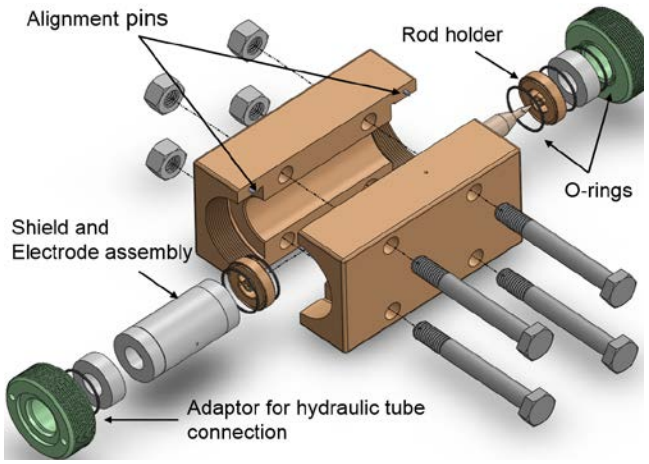
Currently, monitoring fluid cleanliness requires either inline particle counters or fluid sampling techniques, both of which add substantial cost to the condition-based maintenance of hydraulic systems.

A low cost inline sensor capable of providing information on contamination level of the fluid can be a cost effective way to prevent any potential failure of hydraulic components.

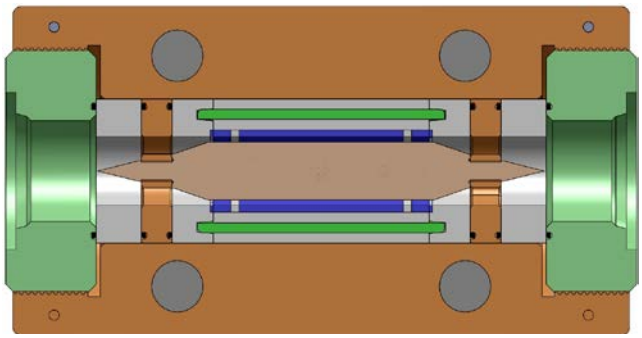
Benefit to Industry

The dielectric sensor will benefit the Fluid Power industry by:

- Providing a low cost means for detecting fluid contaminants on vehicles during operations,
- Eliminating the need for a fluid sampling until a problem is detected,
- Detecting potential problems early before catastrophic failure, and
- Lowering maintenance cost and reducing downtime.



Exploded view of the dielectric sensor

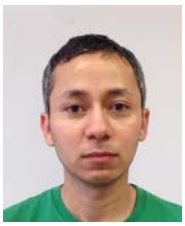


Cut away view of the dielectric sensor

Project Team

Professor
Brian Steward

Associate Professor
Stuart Birrell



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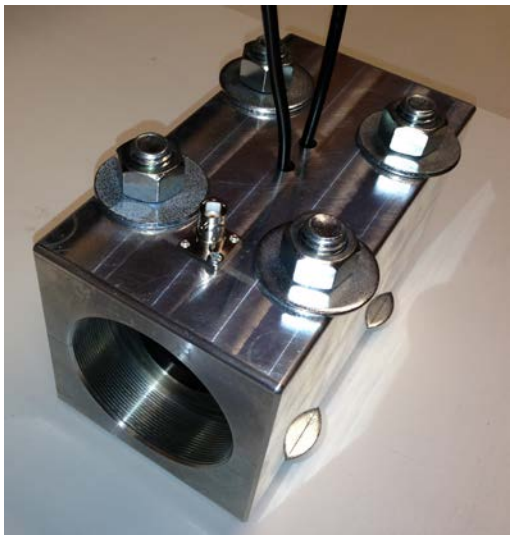
Achievements

The project began in January of 2012. The following tasks were completed to date:

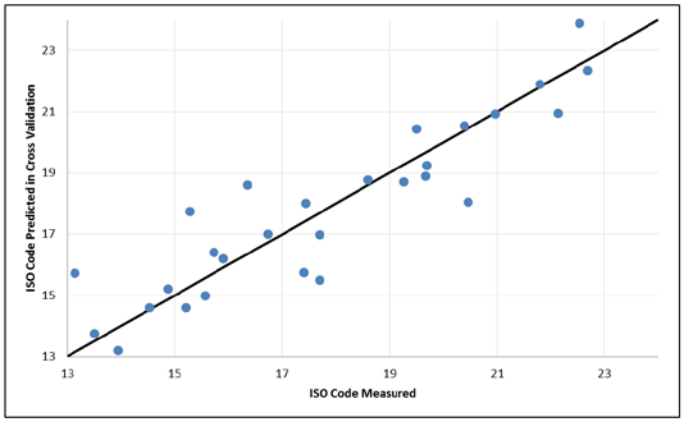
- Designed and fabricated the sensor,
- Developed a hydraulic test circuit to conduct experiments on dielectric sensor,
- Designed experimental procedures and design for testing the sensor with different contaminants,
- Conducted tests using iron particles and ISO test dust,
- Developed statistical prediction models, and
- Predicted iron particle contamination within ± 0.65 ISO code and ISO test dust within ± 0.83 ISO code.



Two rectangular housing blocks fastened together and enclosing the sensing unit. The threaded ports on either side of the housing enable it to be connected to the hydraulic circuit. The sensor measures contamination in flowing hydraulic fluid.

Where the project is headed

- Measurement of oil and water contamination in air stream using the sensor for pneumatic applications.
- Design and fabrication of the electronics to be integrated with the dielectric sensor.
- More extensive testing of sensor with different particulates and water as contaminants.



Test Results using iron particles as contaminants

Technology Readiness Level