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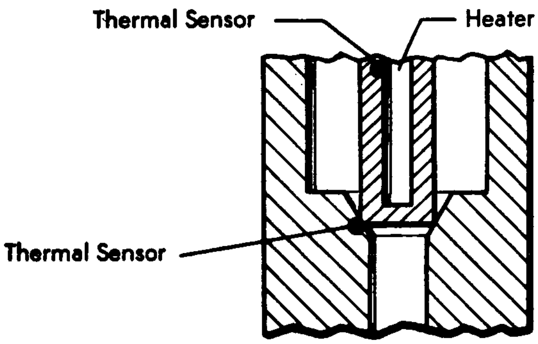
NASA TECH BRIEF

Ames Research Center

Valve Degradation Detector

The problem:

To determine the corrosive degradation of a valve while it is in service.



(1)

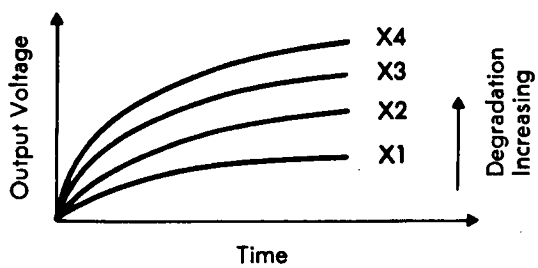
The solution:

Detect changes in surface roughness or the presence of corrosive layers at the junction of poppet and seat by measuring temperature gradients created across the junction by a small heat source.

How it's done:

The degradation detector consists primarily of a heater (or cooler) in combination with a pair of thermal sensors which can be thermistors or resistance thermometers. As shown in figure 1, one sensor is imbedded or cemented in the poppet and the other in the seat. The heater or cooler need provide a difference of only a few degrees of temperature, and is preferably located in the poppet. The electrical power for a heater can be either ac or dc; in the usual spacecraft valve, power minimum should be about 0.5 watt.

The sensors are connected in a Wheatstone Bridge configuration which is brought to a zero balance at the start of the measurement. The output is sensed by a high-resolution voltmeter as a function of time and transmitted; transmitted values are plotted or compared to calibration curves which indicate the thermal resistance or thermal time constant of the junction formed by one or both surfaces as a measure of surface roughness or corrosion layer. A typical calibration curve is shown in figure 2. The slope of the output voltage, $\Delta V/\Delta t$, increases with surface degradation, so that X1 could indicate a well-functioning valve. The X2 curve could indicate the beginning of degradation, and X4 could mean degradation has reached the danger level and that corrective action should be taken.



(2)

In the absence of fluids, as shown by tests, surface roughness of the order of nanometers is measurable in a matter of seconds. Sensitivity in the presence of fluids is reduced because of their thermal conductivity, but it is still sufficient to allow detection of valve seat degradation; sensitivity can be improved by the use of a lock-in amplifier as well as by increasing the heat flux.

Each valve in a system would require an individual heater-sensor combination, but commutation can reduce the amount of electronics required for transmitting the data. Electrical power can be used more

(continued overleaf)

efficiently, and undesirable additional heat source in the system can be avoided, by alternately heating every other valve while cooling those in between.

Note:

No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
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Patent status:

NASA has decided not to apply for a patent.

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