TEST REPORT R17VAN SENSORS, SN 798457 and 153743

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INTRODUCTION:

Two (2) R17VAN oxygen sensors Sn 798457 and 153743 were returned by Vandagraph to Teledyne for evaluation. Vandagraph indicated that the 2 sensors were faulty and were not performing correctly. The purpose of this failure analysis is to determine if at all possible the nature of the defect.

PROCEDURE:

First, both sensors were externally inspected: none of the sensors showed any external damage or abnormal appearance. Next outputs readings of the sensors were measured in air. Both sensors passed mV output test criteria.

Then, internal evaluation was performed: The sensor labels, front threaded diverters, diverter caps and pcb assemblies were removed to examine internal components of the sensors (expansion membranes, side stainless steel cylinders and pcb assemblies). Also, the current outputs (in air) of both sensors were measured and re-measured several days later.

Finally, the clamp rings, wire mesh clamps and protective white Zitex membranes over the sensing surface were removed to examine the physical condition of the sensing membranes and their heat-seals. If there is electrolyte leaking, it can be easily identified by the residues left over the sensing membrane or cylinders. Table 1 & 2 listed all the findings.

EQUIPMENT:

- Fluke digital multimeter, Model 189 (Cal No 367168-5).
- Microscope, Bausch & Lomb, Model Stereo Zoom 7, 10x -70x
- CTI/VTEK Explorer 2000 High Resolution Camera

RESULTS:

Table 1: Test Data1 and External Inspection

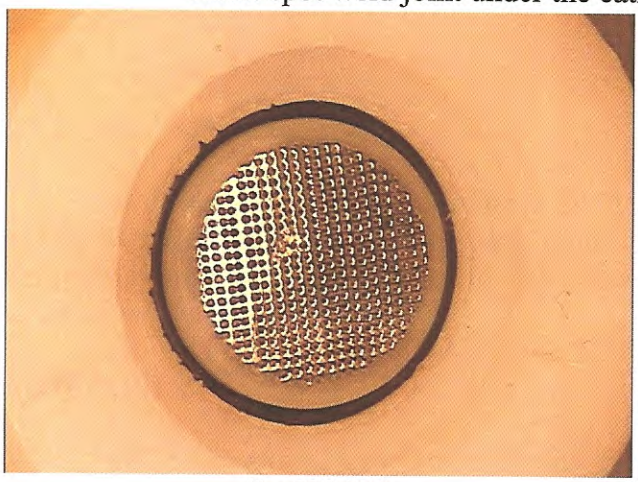
S/N	Ship Date	Mfg Date	Output in Air, mV	External Inspection
798457	12/08/06	Nov '06	9.3	Good, no physical damage or defect
153743	01/08/08	Dec '07	8.4	Good, no physical damage or defect

Note: The output requirement of an R17VAN is: 7-13 mV in air

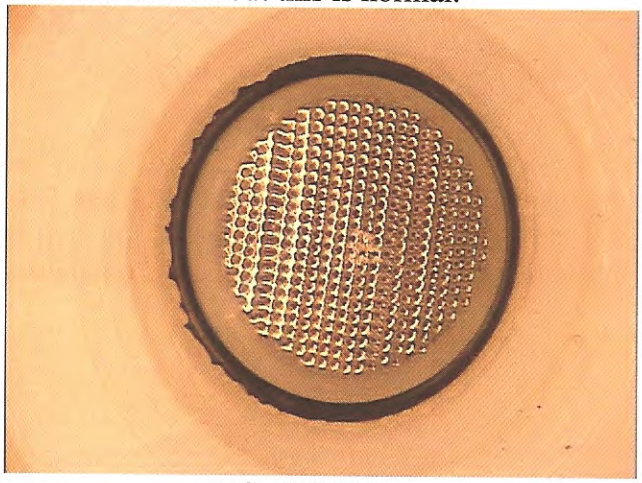
Table 2: Test Data2 and Internal Inspection Results

S/N	Internal Inspection	Sensor Sub-Assy, Current (Air)		PCB assy, Resistance w/10k load	Probable Cause of Failure
		11/14/08	11/19/08		
798457	Good - good heat-seals, no physical damage, no leaks	120 uA	124 uA	78.2 ohms	None detected
153743	As above	104 uA	103 uA	80.2 ohms	None detected

Sensing surface appearance (good – good seals, no defect, no leakage)
Note: spot weld joint under the cathode can be seen but this is normal.



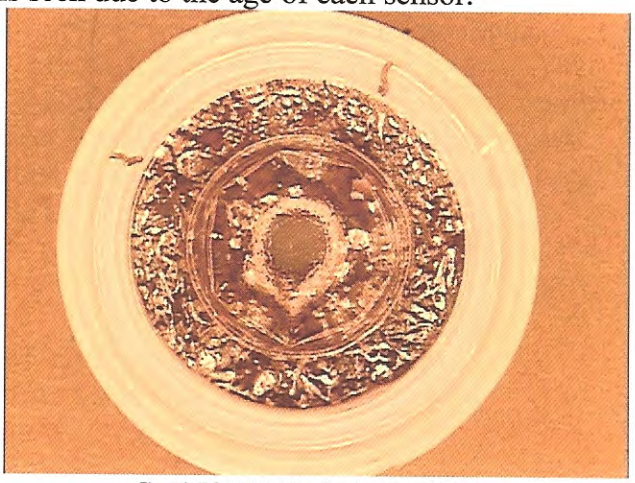
Sn 798457



Sn 153743

Anode appearance (good)
Note: dark red lead oxide coloration is seen due to the age of each sensor.

Sn 798457 (mfgd Nov '06)



Sn 153743 (mfgd Dec '07)

CONCLUSION:

From the test results performed on both R17VAN sensors Sn 798457 and 153743, the mV outputs (9.3 and 8.4 respectively) were within the required range of 7-13 mV. Also, measuring the raw current outputs of both sensors, the readings were normal (measuring 124 and 103 uA respectively). Note, nominally the current reading should be 113 uA (with a +/-30% tolerance) at 25 deg C. After checking the pcb assemblies' network resistance at room temperature, 24.5 deg C, (78.2 and 80.2 ohms respectively), the resistance readings were well within the required range of 72-90 ohms at 24.5 deg C.

From all testing and inspections performed externally and internally, no physical damage or defects were seen. In addition, no electrolyte leakage was seen and all heat seals were good. From this evaluation, no problems areas were seen and therefore, nothing was seen or observed to determine the nature of their failure - both sensors were good.