

EXTENDED LIFE PUMP FOR USE WITH DUST MONITORING INSTRUMENTS

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Introduction

Dust monitoring instruments used in outdoor ambient applications require a known flow rate to determine a mass concentration value. To obtain this flow, one needs to use a pump to maintain a constant flow rate and be able to adjust the pump operation depending on a varying pressure drop through the system. The pump also needs to be robust in its operating range and perform over a long period of time in the field without failure.

A detailed study was done to identify a pump for the new Environmental DustTrak™ Aerosol Monitor that would provide the above characteristics required for this type of application. Initially three different pumps were tested under accelerated conditions to identify which one would be most suited for use in a wide range of environmental conditions. The results of the best performing pump out of the three are presented and discussed herein.

Accelerated Testing Profile

Accelerated testing of pumps was done to simulate extreme conditions that may be encountered in environmental monitoring. Pumps are stressed by working against increased back pressure (by using higher flow rates) and extreme temperatures (both high and low). Table 1 shows the testing protocol.

Group	Flow (L/min)	Back Pressure (Inches H ₂ O)	Temp (°C)	Number of Units
1	3.0	35	-20	5
2	3.0	35	70	5
3	3.0	35	-20 to 70 cycling	5
4	5.0	50	-20	5
5	5.0	50	70	5
6	5.0	50	-20 to 70 cycling	5

Table 1. Pump Accelerated Testing Protocol

Temperature Notes

-20°C is within pump specification (-40°C is lower spec)

70°C is outside of pump specification (60°C is upper spec)



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EXTENDED LIFE PUMP

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Accelerated Testing Profile, continued

Pumps have flow curves that indicate the operation parameters where they are designed to operate. Figure 1 shows the pump curve for the Extended Life Pump used in the Environmental DustTrak Monitor. The pump is designed to work in the "Continuous Operation Region" for long periods of time. The regions of the graph labeled intermittent operation indicate conditions for which the pump can operate for short periods of time. The normal operation conditions for the DustTrak Monitor are shown by the Green point on the graph. This is near the center of the designed operation region.

To put more stress on the pump, the pressure drop was increased to a value 3.5 times greater than normal DustTrak Monitor pressure drop. This value is shown by the Orange point on the graph. To increase the stress further, the flow was increased to 5 L/Min and the pressure drop was increased to 5 times greater than normal DustTrak Monitor pressure drop. This operation condition is near the edge of the continuous operation range and it is shown with the Red point on the graph.

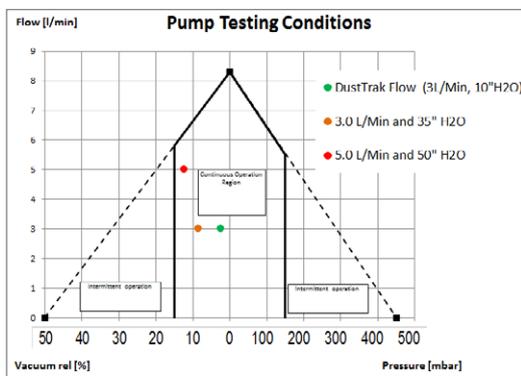


Figure 1. Flow curves from pump stress tests

Lifetime Testing Results

Lifetime tests were conducted to see how long the pumps would last for different back pressures and temperatures.

In the moderately accelerated group (3 LPM, 35" H2O), all 15 of the moderately accelerated test pumps survived testing without any failures. All of the 5 pumps in the freezer test survived for over 15,000 hours. In the heavily accelerated group (5 LPM, 50" H2O), all pumps lasted over 2,500 hours but 6 of the 15 pumps eventually failed.

Group	Flow (L/min)	Back Pressure (Inches H ₂ O)	Temp (°C)	Unit #1	Unit #2	Unit #3	Unit #4	Unit #5
1	3.0	35	-20	All running after 15624 hours				
2	3.0	35	70	All running after 2568 hours				
3	3.0	35	-20 to 70 cycling	All running after 3096 hours				
4	5.0	50	-20	All running after 6312 hours 4 of 5 died before 15624 hours				
5	5.0	50	70	All running after 2568 hours				
6	5.0	50	-20 to 70 cycling	All running after 2568 hours 2 of 5 died before 3096 hours				

Table 2. Results from Life Tests at extreme temperatures

Results

These test results indicate the new pump will last for many thousand hours at low temperatures. At very high temperatures (70°C), all pumps run over 2,500 hours and many last much longer. Under less extreme conditions, these pumps can be expected to perform well and for thousands of hours.



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