SUMMARY OF TEST REPORT
TS-017-00

SKAGWAY TOURING TRAIN PROJECT REPORT

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1.0 ABSTRACT

A DCL catalytic converter was tested on a locomotive engine at Skagway, Alaska. The converter was found to have very good conversion efficiency of carbon monoxide, hydrocarbons and odor across the operating conditions.

2.0 PURPOSE

The purpose of this test was to evaluate the emissions performance of a DCL catalytic converter unit installed on a passenger locomotive tractor. The locomotive is equipped with a single Alco 251B engine. The engine is inline 6-cylinder diesel developing approximately 900 HP.

Figure 1 – WP&YR Scenic Train Ascending Mountain

3.0 TEST EQUIPMENT

3.1 The ECOM-AC, a microprocessor based portable emission analyser has been used for this test. The analyser is capable of measuring NO, NO_2, CO, O_2, HC, Exhaust gas temperature, ambient temperature, and visible smoke emissions. An on-board printer allows vital parameters to be stored and printed at the touch of a button. The analyser has been calibrated before performing the tests.

3.2 Alco 251B diesel engine
Bore: 9.0”
Stroke: 10.5”
Power: 900 HP

3.3 Load bank (to simulate engine loading for repair and rebuild)

3.4 DCL catalytic converter

Figure 2 – DCL Catalytic Converter Installed on Locomotive

4.0 TEST PROCEDURE

Emissions performance was evaluated in four separate tests over a two-day period. The first day's tests were performed without the catalyst installed. The engine raw emissions were sampled while the tourist train ascended the mountain on its usual route, and again during the descent. The catalyst was installed on the second day. Catalyst emissions performance was then determined in the workshop area by using the load bank to simulate full power.

4.1 Day one: Ascending without catalyst

First test was performed on Tuesday, August 1st, 2000 when train was going uphill from sea level to 2880-ft elevation without the catalyst installed. The analyzer was setup inside the engine compartment and a port was drilled just at the outlet of the turbocharger in order to insert the gas-sampling probe. Readings were taken every 10 or 12 minutes. All the way to up, the engine was running at full load with 1000 RPM. The average temperature at the exhaust was found 549ºC.

4.2 Day one: Descending without catalyst

Second test was performed when the train was descending down to the sea level. Readings were taken every 5 minutes. All the way to down, the engine was running at idle and the average exhaust temperature was found 152ºC. Engine RPM was 370.

4.3 Day two: Full load with catalyst (load bank)

After the converter was installed on top of the engine compartment roof on the same day. Another set of readings was taken at full load condition with the help of load bank. This time gas-sampling probe was inserted at the outlet of the converter using the standard DCL port. Readings were taken at full load with 1000 RPM. Temperatures at full load condition were found to be above 500ºC

4.4 Day two: Idle with catalyst (load bank)

After the converter was installed on top of the engine compartment roof on the same day. Another set of readings was taken at idle condition with the help of load bank. This time gas-sampling probe was inserted at the outlet of the converter using the standard DCL port. Readings were taken at idle at 365 RPM. Temperatures at idle condition were found to be 174ºC.

5.0 RESULTS

5.1 Day one (raw emissions only, no catalyst)

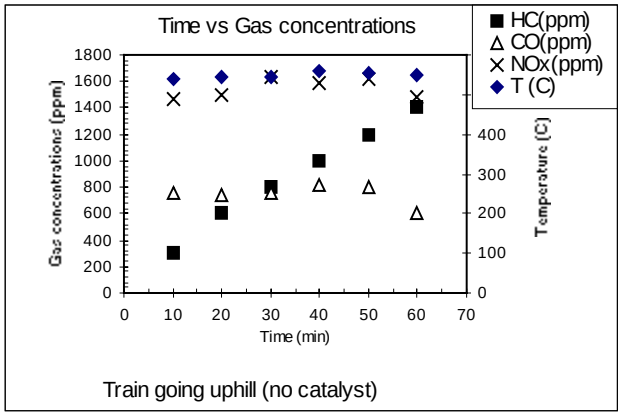

Figure 3

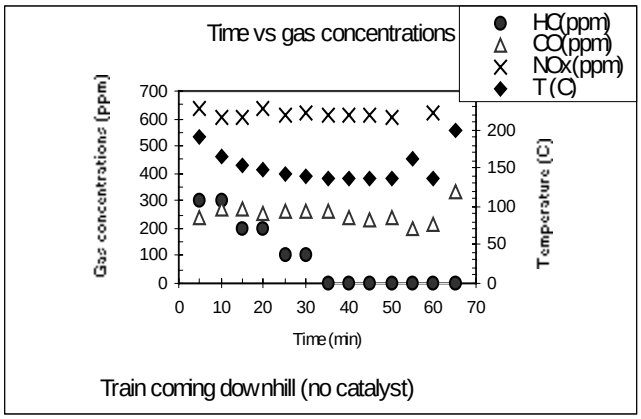

Figure 4

5.2 Day two: Catalyst performance with load bank

Full Load	Catalyst Inlet	Catalyst Outlet	% Conversion
CO (ppm)	823	1	**99.9**
HC (ppm)	1000	100	**90.0**
Ex.Temp.(^{o}C)	556	577	
Idle	Catalyst Inlet	Catalyst Outlet	% Conversion
CO (ppm)	197	2	**99.0**
HC (ppm)	300	250	**16.7**
Ex.Temp.(^{o}C)	162	174	

Figure 5

6.0 DISCUSSION

With full load it was found that the conversion of carbon monoxide (CO) is greater than 99% and the conversion of HC is 90%. This is due to ideal high exhaust temperatures of above 500^{o}C.

At idle condition the exhaust temperature is low (174ºC). However the conversion of CO is again greater than 99% because we are still above the light off temperature for CO.

7.0 CONCLUSION

The DCL catalytic converter is operating normally. High temperature performance under load is excellent.

Low temperature performance is excellent for CO. HC performance can be improved with modifications to raise the exhaust temperature above light off.

Figure 6 – Locomotive With DCL Catalytic Converter Installed