

MEMORANDUM

To: NETAC Technical Committee
From: Ron Friesen, Amnon Bar-Ilan and Greg Yarwood
Date: July 27, 2007
Subject: Review of Emissions Testing at BP Findley Compressor Station

Background

On August 29, 2006, exhaust emissions from a Waukesha F-1197 compressor engine operated by BP were tested near Marshall, Texas. This test was part of the Northeast Texas Air Care (NETAC) pilot project to demonstrate the effectiveness of using a non-selective catalytic (NSCR) system in reducing nitrogen oxide (NOx) emissions from compressor engines used in gas production operations. In addition to this engine, four additional compressor engines operated with NSCR systems were tested during the same time period. A summary of the tests conducted in 2006 are contained in the Final Report dated October 31, 2006.¹ Test results were not reported for the BP compressor engine on the basis that the results were not considered reliable. Figure 1 shows the compressor at the Findley Compressor Station with the catalyst installation.

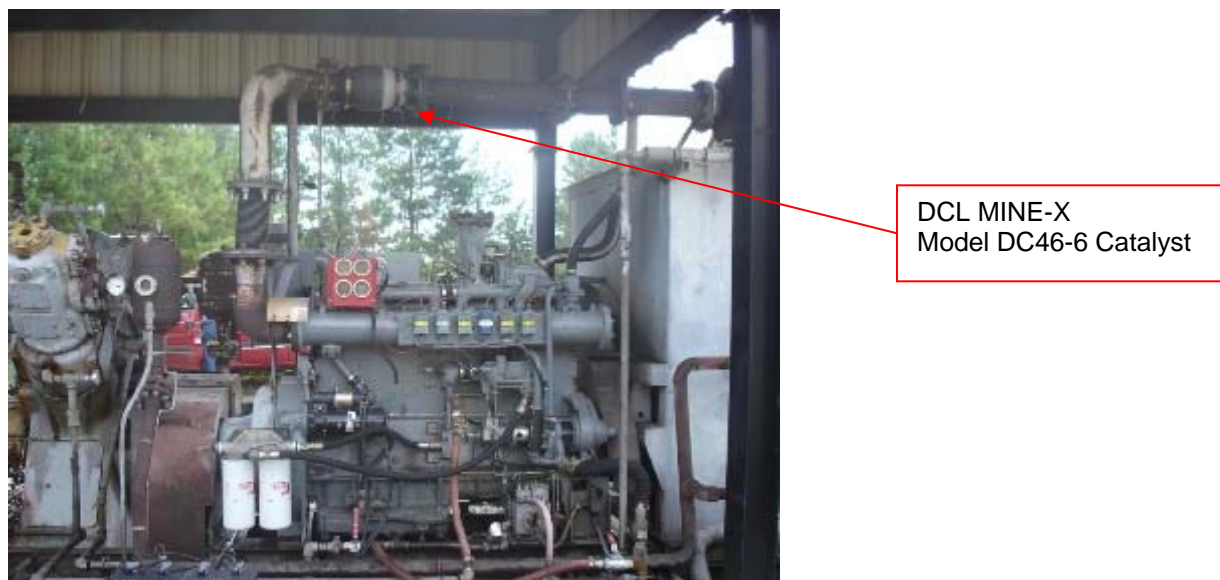


Figure 1. BP Findley Compressor Station with Catalyst Installation.

¹ Friesen, R., Russell, J., Lindhjem, C., and Yarwood, G., 2006 Update On A Pilot Project to Assess the Effectiveness Of An Emissions Control System for Gas Compressor Engines in Northeast Texas, October 31, 2006

The power rating for this engine is 248 hp at 1800 rpm. However, during the tests, the engine was operating at 900 rpm or approximately 37 hp. The original compressor engine was sized (in terms of hp) for a time when production was high at the well site. Over time field production has dropped, and the load on the engine has dropped to the point where the engine is operating at low load. The catalyst and an air-fuel ratio controller were installed as part of the program to determine the potential to reduce emissions. During the test it appeared that the air-fuel ratio controller was not able to stabilize the engine with exhaust emissions of Oxides of Nitrogen (NOx) varying from as high as 5,000 ppm to as low as 10 ppm. To help resolve the situation, representatives from the engine manufacturer replaced the fuel regulator with a larger regulator that would provide the ability to obtain smaller incremental changes in the air to fuel ratio. As a result of these difficulties, only one 60-minute test run was obtained. During this run, exhaust emissions of NOx varied from as high as 3,000 ppm to as low as 8 ppm. The post-catalyst average NOx emissions measurement during the one run was 200 ppm and the pre-catalyst emissions measurement was 1568 ppm or an overall NOx emission reduction of 87 per cent. As a result of the inability to stabilize the operation of the engine and the inability to obtain the standard 3 test runs before and after the catalyst, it was determined that the results were not reliable. BP representatives agreed to do some work on the engine and conduct another emissions test over the next several months.

Steps to Resolve Issues

In January 2007, the BP installed another fuel regulator and some preliminary tests were conducted on the engine. They informed us that the tests were still quite variable, however, they managed to get the exhaust emissions of NOx down to 720 ppm and the CO to less than 1000 ppm. In subsequent follow up with the BP representative in April 2007, the BP representative, Gary Burns informed us that no additional effort has been put into the compressor engine. The representative thought about changing the catalyst and controller to be more compatible with the engine and low load condition but the necessary equipment were not available. In May 2007, BP indicated a willingness to work with us to conduct another round of testing but only if we furnish the equipment.

We then contacted the catalyst manufacture (DCL) to evaluate what our options might be given the situation with the BP compressor engine at the Findley Compressor Station. We reviewed the operating conditions (i.e., low load, low rpm, fluctuating pressures and low exhaust temperatures). The catalyst was sized for operating at much higher loads (248 hp at 1800 rpm). Conditions during the tests were 37 hp at 910 rpm. More importantly, the average exhaust temperature during the test was measured at 554 °F. The minimum temperature for activation of the catalyst is 750 °F (This seemed to be the major difficulty in successful performance of the catalyst). Under the most stabilized conditions, pre-catalyst NOx ranged from 1400 ppm to 2,200 ppm and post-catalyst NOx ranged from 10 to 1,100 ppm. The DCL representative felt the catalyst was slightly oversized for the low load conditions and that is why we were able to get reductions even though temperatures were too low. At that point we asked the BP representative to obtain some additional stack gas exhaust temperatures. In July 2007, the representative reported the temperature before and after the catalyst on that particular engine to be more than adequate (873 °F in and 874 °F out) to activate the catalyst. Therefore, we suggested that we



clean the catalyst and retest the engine sometime in August.

On July 13, 2007, the BP representative called to inform us the catalyst at Findley had blown out. He forwarded the following photo:



Figure 2. Failed Catalyst.

Conclusion

We forwarded the photo to the catalyst manufacturer and asked their opinion on what could have caused this failure. The DCL technical support group speculated that an ignition failure in one or more cylinders could lead to this type of catalyst failure.² This could happen if the spark plug in one or more cylinders was weak and failed to ignite the air/fuel mixture. Ignition failure would also explain the difficulties in the AFRC achieving the correct air-fuel ratio. An ignition failure results in the air/fuel mixture igniting on the catalyst and raising the catalyst temperature by several hundred degrees. This will melt the catalyst substrate or make it very brittle so that it breaks apart. We spoke with another engineer³ that has extensive experience working with catalysts such as these and he also felt that the obvious and only reason they melt had to do with A/F ratio controller getting out of control. The exhaust can get to the FECRALLOY melting temperature if the air/fuel mixture is tuned to the lean side under idle or normal operation.

Recommendation

The current focus of the NETAC Pilot Project is monitoring the performance over time of functional catalysts that have been installed on engines in the last 2 years. We recommend no further testing at the BP Findley compressor station under the NETAC Pilot Project.

² Personal conversation with Tawnya VanGroningen, Technical Sales Engineer, North American Industrial Catalyst Division DCL International Inc. July 17, 2007

³ Personal communication with Amiram Bar-Ilan, President, Süd-Chemie Inc., July 17, 2007.