PASSIVE FOURIER TRANSFORM INFRARED TECHNOLOGY (FTIR) EVALUATION OF P001 PROCESS CONTROL DEVICE AT THE INEOS ABS (USA) CORPORATION ADDYSTON, OHIO FACILITY

SUPPLEMENTAL REPORT

August 2010

SUMMARY OF EVALUATION PROGRAM

Pursuant to the Consent Decree (Civil Action No. 1:09-CV-545) between U.S. Environmental Protection Agency (EPA) vs. INEOS ABS (USA) Corporation (INEOS ABS) and LANXESS Corporation, INEOS ABS performed a Passive FTIR evaluation on the P001 Process control device at the INEOS ABS Addyston, Ohio facility. The purpose of the evaluation was to determine the appropriate Net Heating Value of Flare Gas (NHVFG) limit to be used to operate the control device to ensure 99% control efficiency.

The Passive FTIR (PFTIR) evaluation was performed on the P001 process air pollution control device (the Flare). The PFTIR method was used to estimate emissions from the Flare by measuring carbon dioxide (CO_2), carbon monoxide (CO) and total hydrocarbons (THC) in the Flare output stream (the area above the flame of the Flare) at varying operating conditions and NHVFG values. The PFTIR evaluation was a comparative test only as it is still a developing technology for measuring flare emissions.

The EPA has proposed that a NHVFG of 200 British Thermal Units per standard cubic feet (BTU/scf) yields a control efficiency of 99%. This PFTIR evaluation compared environmental performance at different NHVFG values so as to determine the range of NHVFG that provides optimum environmental performance for operation of the Addyston Flare. The Facility's Title V Permit requires the Process P001 Flare to operate at 99% control efficiency.

INEOS ABS contracted with Industrial Monitor and Control Corporation (IMACC) to perform the PFTIR evaluation of the Flare. The test was performed in a timely manner on November 3 through November 5, 2009.

The evaluation pursuant to the Consent Decree was only being used to provide information to the EPA Office of Enforcement and Compliance Assurance (OECA), Director of Air Enforcement of the Office of Civil Enforcement (OCE) to aid in his/her decision in the establishment of a newly defined lower NHVFG limit to be used to control the P001 Process Flare. This evaluation was not used as a means to determine compliance with the Facility's Title V Permit.

OBJECTIVES AND TEST MATRIX

The purpose of the PFTIR evaluation was to determine the appropriate lower NHVFG limit to be used to operate the P001 Process Flare. The PFTIR method was used to estimate the emissions from the Flare by measuring CO_2, CO and THC in the Flare output stream (the area above the flame of the Flare) at varying operating conditions and NHVFG values.

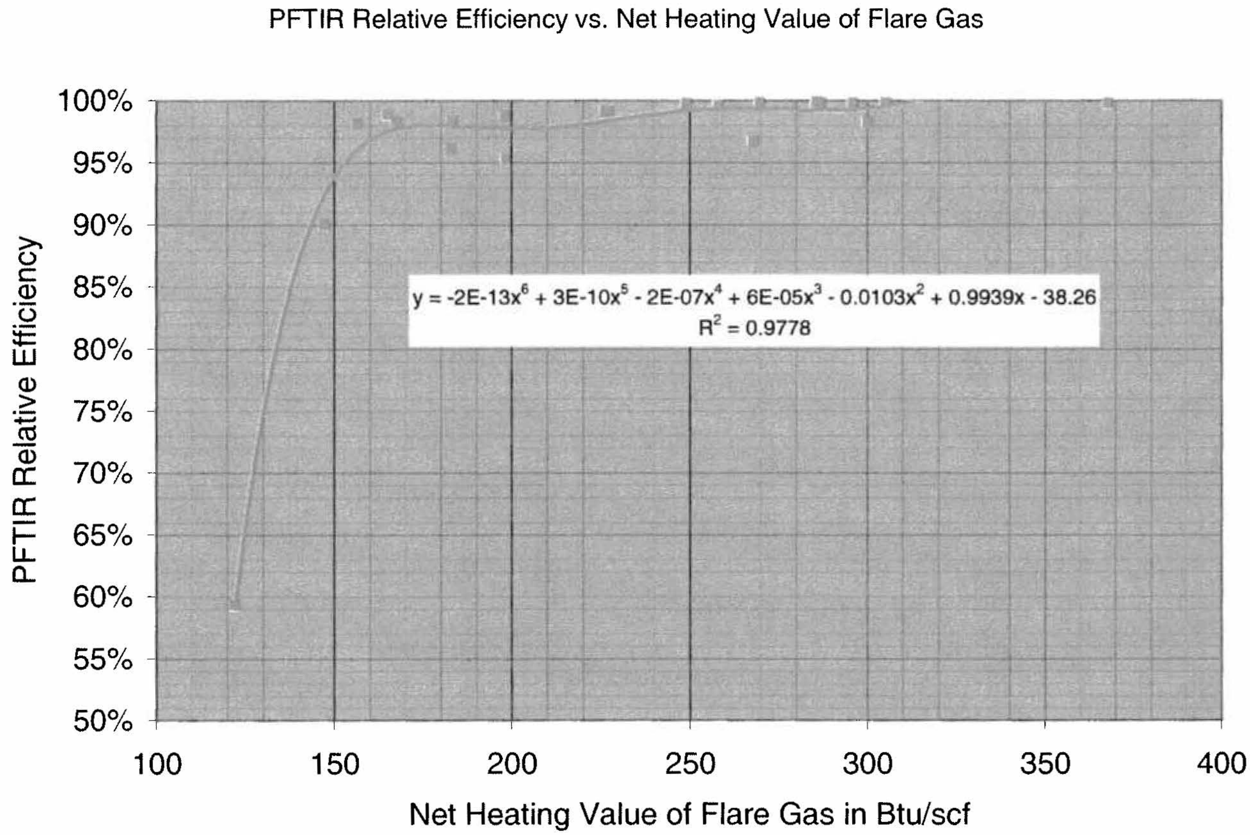
During the evaluation, operating scenarios of the Flare were varied in order to determine which lower NHVFG limit is the most appropriate, i.e. most efficient. Operating scenarios involved varying the flow rates and composition of the stream and the Vent Gas stream. The purpose of this evaluation program was to run multiple scenarios to bracket conditions and to compare emissions at different scenarios. The ultimate goal was to compare the emissions at different scenarios and recommend the future lower limit of NHVFG. It is proposed that any scenarios with lower emissions than those seen at the 200 BTU/scf scenarios would be considered to be representative of control efficiency higher than 99% as the EPA has stated that a 200 BTU/scf NHVFG would achieve a 99% efficiency.

Table 3-1 in Appendix A presents the sampling and analytical evaluation matrix that was proposed to be used to help establish the appropriate lower NHVFG limit. The runs were divided into four different flow rates of 1,3-butadiene. Different NHVFG were proposed within each of these flow rates. At the beginning of the evaluation, it became apparent that achieving and keeping steady flows to the Flare would be challenging. Due to these complications, several runs were modified and not performed in the order that was proposed. These runs were modified after consulting and receiving the approval of representatives of the EPA and Hamilton County Department of Environmental Services who were observing the evaluation on site. The modified sampling and analytical evaluation matrix that was followed during the field test is shown in Table 3-2 in Appendix A. All values presented in Tables 3-2 have been corrected to account for the nitrogen content compensation in the calculation of molecular weight of the stream and the corrected calculation of mass flow rate of 1,3-butadiene by the percent mass method. The nitrogen content compensation was completed using a propriety algorithm provided by GE Sensing.

SUMMARY OF RESULTS

The graph in Figure 1 depicts the relationship that was determined between NHVFG and estimated relative efficiency as determined by PFTIR analysis. The individual data points represent the averages of all data collected for each test condition. The solid curve represents a polynomial curve fit with a R^2 confidence of 0.98, which indicates an excellent mathematical model of the data set. Data summary of the exit velocity of the Flare Gas, 1,3-butadiene flow to the Flare, NHVFG of the Flare gas, and the relative efficiency for each test run is summarized in Table 3-3. The raw field data and the calculated NHVFG of each test run are included in Appendix B; the flare monitoring data during the test runs is included in Appendix D.

Figure 1



The shape of the curve in Figure 1 is very similar to the relationships between Lower Heating Values and combustion efficiency established by previous EPA flare studies. These previous EPA flare studies identified that there is a lower limit of the Heating Value of the flare gas that below that value a rapid decline in flare combustion efficiency would occur.

Excerpt from an Article in *Combustion Science and Technology* (50:4, pp. 217-231) titled "Combustion Efficiency of Flares" by John H. Pohl; Joannes Lee; Roy Payne; Bruce A. Tichenor:

> "The conditions which may lead to inefficient combustion in flare flames are graphically shown in Figure 8. The figure was constructed by determining the relative minimum heating value at a given velocity by using the lower 95 percent confidence interval of Figure 5. Figure 8 shows that only one flare flame, operated at a heating value more than 10 percent above the minimum, resulted in combustion efficiencies less than 98 percent. The scatter in the data near the stability limit of the flame is thought to be caused by the difficulty of operating a flame near the stability limit."

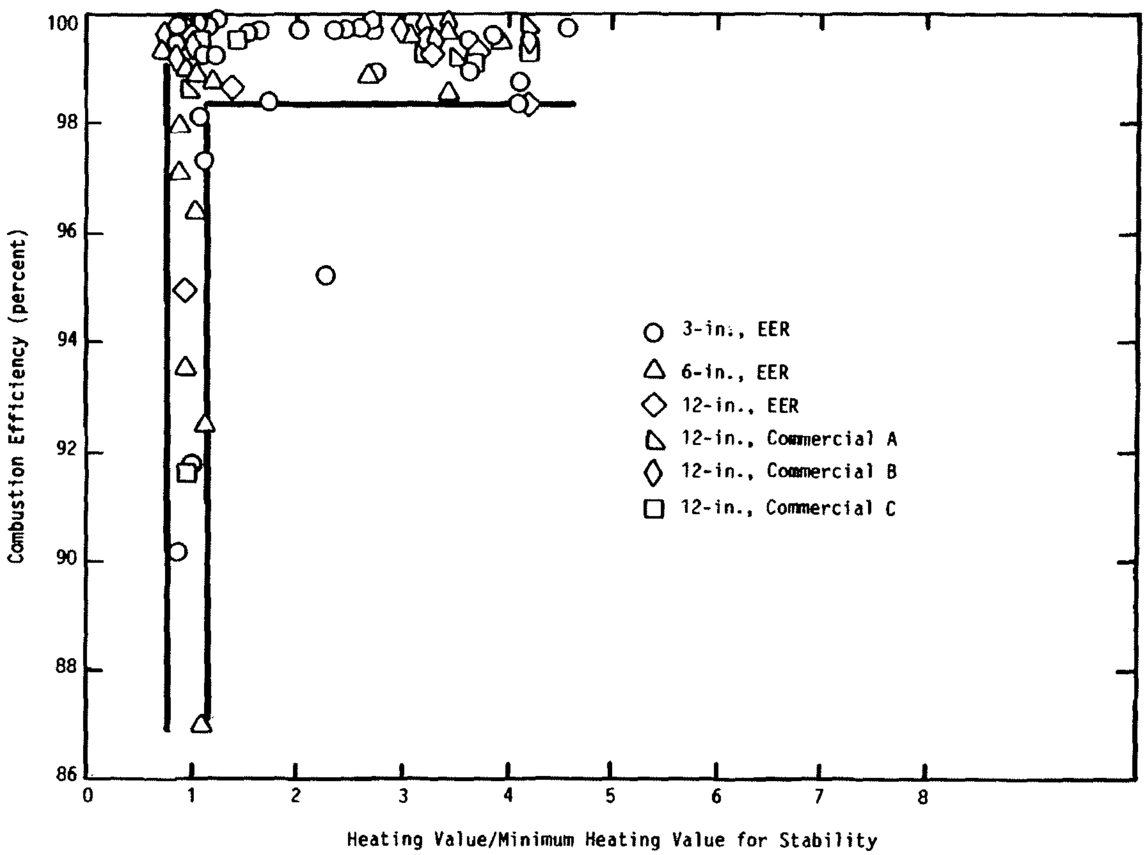


FIGURE 8 Combustion efficiency near the limits of flame stability.

The EPA has proposed that the lower limit for the new NHVFG limit should be 200 BTU/scf in order to assure the required control efficiency. The relative efficiency determined from the polynomial curve fit for the PFTIR data of the Addyston Flare is equivalent from NHVFG values of 169 through 200 BTU/scf. Below a NHVFG of 169 BTU/scf, the model predicts declining efficiency. The EPA study referred to above identified that operation at a level of 110% of the minimum stable Heating Value provided confidence that high combustion efficiencies would be observed. INEOS ABS proposes that a value of 110% of the NHVFG value of 169 BTU/scf, or 186 BTU/scf, is the most appropriate lower NHVFG limit to operate the P001 Process Flare.

Table 3-3 Data Summary Table
INEOS ABS – Addyston, Ohio

Test Run	Proposed Exit Velocity (ft/min)	Actual Exit Velocity During Test Run (ft/min)	Proposed Butadiene Flow (lb/hr)	Actual Butadiene Flow During Test Run (lb/hr)	Proposed NHVFG (BTU/scf)	Actual NHVFG During Test Run (BTU/scf)	PFTIR Estimated Relative Efficiency (%)
1	110	81	300	295	120	183	96.1%
1A	NA	102	NA	325	NA	122	59.3%
1B	NA	119	NA	297	NA	147	89.9%
2	120	135	300	540	200	258	99.6%
3	110	123	300	488	150	198	95.3%
4	160	160	300	543	180	226	99.2%
5	110	121	300	509	230	305	99.8%
6	180	152	600	640	150	198	98.8%
7	270	212	600	763	210	270	99.8%
8	250	177	600	787	190	249	99.8%
9	250	172	600	729	230	285	99.9%
10	75	105	50	41	120	165	98.8%
11	90	115	50	63	200	227	99.2%
12	40	64	50	159	200	295	96.7%
13	90	101	50	73	140	183	98.3%
14	80	87	50	202	160	167	98.3%
15	80	84	50	44	180	156	98.1%
16	90	98	50	171	220	287	99.8%
17	50	60	10	21	140	283	98.2%
17A	NA	54	NA	49	NA	368	99.7%
18	60	81	10	26	200	296	99.8%