FEB 13 1992

(14)

PRELIMINARY ASSESSMENT OF BYPASSED COKE OVEN GAS: EVALUATION OF EMISSIONS AND CONTROLS

Purpose:

This analysis estimates emissions from by-passed coke oven gas, evaluates the cost and efficiency of flares to control these emissions, and compares uncontrolled emissions from bypassed gas to the emissions associated with charging and leaks from doors, lids, and offtakes.

Background:

During periods of short process upsets or when a catastrophic failure (such as an exhauster malfunction) occurs, raw coke oven gas is vented directly to the atmosphere. Such an event can release tons of organic compounds in a short period of time. Most batteries do not control these emissions. USS has installed ignitors on their coke oven batteries to flare the gas when it is bypassed. Combustion in a flare destroys the organic compounds in the gas and also converts highly-toxic hydrogen sulfide (H_2S) to less toxic sulfur dioxide (SO_2).

Approach:

Data were obtained from EPA Region III and from the Allegheny County (Pittsburgh, PA) Air Pollution Control agency on the frequency, duration, and mass emissions associated with these bypass events. Cost information and an estimate of control efficiency for flares were obtained from the company that installed flares on the 12 batteries at USS Clairton Works (ChemTech Consultants, Inc., Pittsburgh, PA). This information was used to estimate annual emissions and the cost of control.

Results:

The results are summarized in Table 1. The BSO emission estimates are given for the time period indicated (3.75 years for Clairton, 2 years for LTV, and one year for Shenango). The bypassed emissions are higher than the baseline level of emissions from charging and leaks from doors, lids, and offtakes. When MACT and LAER limits are applied (using the limits written into the Clean Air Act), the bypassed emissions dwarf the emissions from the NESHAP sources.

The cost effectiveness numbers also indicate that the bypass emissions should probably be controlled if the NESHAP sources are controlled. However, cost effectiveness comparisons are of limited value for coke oven emissions because of the high toxicity and high residual risk after control. In addition, many other pollutants not included in the total are controlled,

TABLE 1. SUMMARY OF COMPARISON OF EMISSIONS AND COSTS

Plant	Bypass BSO emissions (Mg)	BSO from leaks & charging (Mg) Current	MACT	LAER
USS Clairton 6/87 - 3/91 (3.75 years)	408	160	83	28
LTV Pittsburgh (approximately 2 years)	150	48	20	4.2
Shenango (one year)	1.3	3.6	2.1	0.7
Nationwide BSO (Mg/yr)	470	450	152	44
Nationwide cost ($ millions/year)	2.8	---	16	67
Cost effectiveness ($/Mg BSO)	6,000	---	54,000	165,000

Notes:

1. BSO in bypass emissions are estimated from the emission factor for heavy hydrocarbons.

2. The BSO estimates for the three plants are in Mg for the indicated time period (not in Mg/yr).

3. The estimates of nationwide bypass emissions assume that only USS batteries have controls and that the typical battery vents for 7.8 hours per year.

4. Cost effectiveness calculations for BSO from coke ovens should not be compared with calculations for other pollutants. Coke oven emissions are highly carcinogenic (the unit risk factor for coke oven emissions is 75 times that for benzene).

5. The nationwide cost estimates for MACT and LAER are preliminary and are likely to change.

including volatiles such as benzene and toxic gases such as hydrogen sulfide. For example, the quantity of benzene that is controlled can be estimated as about 65 percent of the quantity estimated for the BSO.

[Note: The emission estimates for bypass emissions will increase if BSO includes more compounds than those identified in the analysis as heavy hydrocarbons. In addition, if the serious bypass events occur more frequently than once every 10 years for each battery, the estimated emissions would be commensurately higher.]

Details:

1. Frequency and duration

The available data on the bypassing of raw coke oven gas are limited. Serious emission episodes were experienced at USS Clairton Works in 1987 to 1989 as a result of startup problems and equipment failures. In the 19-month period from June 1987 to January 1989, there were 12 venting episodes that lasted a total of 37.7 hours. During this time, 10 operating batteries were involved in the venting. The length of each venting episode ranged from 15 minutes to 7 hours. Emission estimates included 374 Mg of heavy organics (probably the closest measure of benzene soluble organics), 238 Mg of benzene, and 71 Mg of hydrogen sulfide. For comparison, the annual emission rate of BSO from charging, doors, lids, and offtakes at Clairton is estimated as 43 Mg/yr for their current level of control, 22 Mg/yr for MACT, and 7.5 Mg/yr for LAER.

[Note: Following the Clairton venting incident, USS installed flares on all of the batteries at Clairton and also on all the batteries at their only other coke plant in Gary, IN.]

The Allegheny County Air Pollution Control agency required reporting of all bypass events starting in April 1990. The County forwarded their available data for the 3 coke plants (19 batteries) located in the county:

- USS Clairton had 20 venting episodes over a one-year period (4th quarter 1990 through 1st quarter 1991). The worst episode was the venting of 12 batteries for 2.8 hours. The vast majority of the reported episodes was for single batteries that vented for 1 to 3 minutes. The average venting time for each battery was 3 hours/year.

- Data for Shenango's two batteries revealed 7 venting episodes over a one-year period. The venting ranged from 10 seconds to 45 minutes. The average venting time for each battery was 2 hours/year.

- Data for the LTV plant in Pittsburgh showed no venting over a one-year period; however, problems were experienced in January 1992. During this time there were 5 venting episodes that involved all 5 batteries at the plant. The venting time ranged from 2 minutes to 9 hours, with an average of 6 hours per year per battery (on a 2-year basis from 2nd quarter 1990 to 1st quarter 1992).

- The LTV plant also had a catastrophic malfunction (explosion and fire at the exhauster) in April 1989. All 5 batteries were vented to the atmosphere for 17 hours.

Combining all of the recent Allegheny County data (excluding the 1987 - 1989 episodes at Clairton and LTV), the average battery vented for a total of 4.1 hours/year. The more serious episodes (37 hours and 17 hours) are believed to occur very infrequently. For this analysis, assume that the 37 hours of venting at Clairton from a serious malfunction occurs every 10 years, which yields an annual rate of 3.7 hours/yr. Adding the infrequent (but long) events to the average obtained from Allegheny County for short episodes yields an annual venting rate of 7.8 hours/year per battery.

2. Mass emissions

EPA Region III reported their estimates of emissions from the venting of raw coke oven gas, which was based on an analysis of the gas supplied by USS. Although their analysis included many different compounds, this comparison focuses on heavy hydrocarbons as a measure of the benzene soluble organics found in coke oven emissions. Emissions of benzene and hydrogen sulfide are also included. Emissions of heavy hydrocarbons were estimated as 34.6 lb/ton of coal. Benzene and hydrogen sulfide were estimated as 22 and 6.6 lb/ton, respectively.

As a reality check on the EPA estimates, the emission factors were compared to the reported yields of tar and benzene. Tar is composed primarily of the heavy hydrocarbons that comprise BSO. The tar does contain some particulate matter that is not soluble in benzene; however, the quantity of tar should provide an upper bound on BSO emissions when none of the tar is recovered (it remains in the raw coke oven gas vented to the atmosphere). The yield of tar ranges from 30 to 45 liters per Mg of coal, which gives a range of 70 to 110 lb/ton (compared to 34.6 for the emission factor). The yield of benzene ranges from 9.5 to 15 liters per Mg of coal, which converts to an emission estimate 14 to 23 lb/ton. The estimates from EPA Region III appear to be reasonable.

Naphthalene, tar acids, and tar bases may also contribute to BSO. If these compounds are added to the emission factor, the estimate becomes 42.8 lb/ton, an increase of 24 percent in the emission estimates.

3. Cost of flares (ignitors)

ChemTech Consultants estimated the installed cost of a flare system for a coke oven battery as $100,000 to $200,000 per flare with two flares per battery (one on each end of the battery). The upper end of the range is for some batteries that may require additional structural support to install the flare system or to provide the ducting required to carry the gas to the flare. The company suggested a midrange value of $150,000 per flare or $300,000 per battery as a reasonable estimate. Operating costs are minimal. The gas used for the pilot flame is negligible, and the only labor requirement is to steam clean the pilot system once per week. The labor cost, based on one hour per flare (2 hours per battery) and $25/hour, is $2,600/year. The life of a flare system was estimated as at least 10 years and probably closer to 20 years. A midrange value of 15 years was used for the cost analysis (capital recovery factor of 0.1315 at 10 percent).

4. Control efficiency

ChemTech stated that the destruction efficiency of the flare was 99.6 percent based on data supplied by the flare manufacturer.