AP42 Section 6.1 Carbon Black

Related:

Title: Materials and test data from 1977, 1983 edition and 1992

Note: This material is related to a section in *AP42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the file number, the AP42 chapter and then the section. The file name "rel01_c01s02.pdf" would mean the file relates to AP42 chapter 1 section 2. The document may be out of date and related to a previous version of the section. The document has been saved for archival and historical purposes. The primary source should always be checked. If current related information is available, it will be posted on the AP42 webpage with the current version of the section.

OhioEPA
State of Ohio Environmental Protection Agency

Southeast District Office
2195 Front Street
Logan, Ohio 43138-9031
(614) 385-8501
FAX (614) 385-6490

George V. Voinovich
Governor

March 20, 1992

Pacific Environmental Services
Mr. Colin Cambell
3708 Mayfair Street
Suite 202
Durham, NC 27702

Mr. Cambell:

Enclosed is the information you requested. If I can be of any further assistance, please contact me at this office.

Sincerely,

Lisa McCandlish

Lisa McCandlish
Environmental Specialist
Air Pollution Control

LM/bjs

OEPA STACK TEST REVIEW SUMMARY FORM

PREMISE NO. 0684010049 Degussa

SOURCE NO. P001 1 primary bag filter

SOURCE DESCRIPTION Carbon Black Process, Unit 1 reactors agglomerator and bag filter

CONTROL EQUIPMENT baghouse

MONITORING EQUIPMENT (CEM) opacity

DATE(S) OF TEST June 19, 1991

FINAL TEST REPORT RECEIVED ON July 19, 1991

POLLUTANT(S) TESTED particulate

TEST FIRM Emission Testing Sources

EMISSION RATES*: OPERATING RATES*:

ACTUAL** 1.57 lb/hr MAXIMUM** 10,000 lb/hr product

ALLOWABLE** 15.5 lb/hr DURING TEST PERIOD** 8820 lb/hr product

COMMENTS:

I HEREBY VERIFY THAT THE INFORMATION CONTAINED WITHIN THE STACK TEST REPORT HAS BEEN REVIEWED AND IT HAS BEEN DETERMINED THAT THE TEST PROCEDURES, ANALYSES, AND CALCULATIONS ARE;

[X] AN ACCEPTABLE DEMONSTRATION OF CONFORMANCE WITH THE APPROVED TESTING METHODOLOGY.

[ ] AN UNACCEPTABLE DEMONSTRATION OF CONFORMANCE WITH THE APPROVED TEST METHODOLOGY.

July 31, 1991
Date of Review

Lisa McCandlish
Reviewed By

* Based on 3 run average
** Specify applicable units

* from Degussa
L Newman - 2-11-92

OEPA STACK TEST REVIEW SUMMARY FORM

PREMISE NO. 0684010049 Degussa

SOURCE NO. P002 2 primary bag filter

SOURCE DESCRIPTION Carbon Black Process, Unit 2, Unit 2 reacotrs agglomerator and bag filter

CONTROL EQUIPMENT baghouse

MONITORING EQUIPMENT (CEM) opacity

DATE(S) OF TEST June 18, 1991

FINAL TEST REPORT RECEIVED ON July 19, 1991

POLLUTANT(S) TESTED particulate

TEST FIRM Emission Testing Sources

EMISSION RATES*: OPERATING RATES*:

ACTUAL** .3168 lb/hr MAXIMUM** 10,000 lb/hr

ALLOWABLE** 15.5 lb/hr DURING TEST PERIOD** 8390 lb/hr*

COMMENTS:

I HEREBY VERIFY THAT THE INFORMATION CONTAINED WITHIN THE STACK TEST REPORT HAS BEEN REVIEWED AND IT HAS BEEN DETERMINED THAT THE TEST PROCEDURES, ANALYSES, AND CALCULATIONS ARE;

[X] AN ACCEPTABLE DEMONSTRATION OF CONFORMANCE WITH THE APPROVED TESTING METHODOLOGY.

[ ] AN UNACCEPTABLE DEMONSTRATION OF CONFORMANCE WITH THE APPROVED TEST METHODOLOGY.

July 31, 1991
Date of Review

Lisa McCandlish
Reviewed By

* Based on 3 run average
** Specify applicable units

*from L. Newman 2-11-92

I. INTRODUCTION

Emission Testing Services, Inc. was contracted by Degussa Corporation, Belpre, Ohio, to conduct stack emission testing on the # 1 and # 2 Primary Bag Filters. Particulate emissions were determined in order to demonstrate compliance within permit limits.

EPA Method 5 was used for the determination of particulate emissions. EPA Methods 1-4 were used to determine the number and location of sample traverse points, and stack gas moisture, velocity, and dry molecular weight.

The emission testing team consisted of Troy LeSage and Billy Magee. Sid Bowers represented Degussa and coordinated testing with plant operations. The State of Ohio, Environmental Protection Agency was represented by Dean Ponchak during testing.

Degussa Corp. PO Box 369
614-423-4571 Belpre, OH 45714

Emissions from the # 1 Primary Bag Filter were determined during four test runs conducted on June 19, 1991. Test Run 2 was discarded due to the collection of duct sediment in the sampling train. Sediment in the horizontal duct had built-up to a point that its near proximity to the sample point caused the sediment to become dislodged during sampling at the lower (outermost) sample traverse point. This traverse point was adjusted inward on all subsequent test runs.

On June 18, 1991 emissions from the # 2 Primary Bag Filter were determined. Three test runs were conducted.

TABLE I

EMISSION TESTING RESULTS SUMMARY

DEGUSSA CORPORATION
1 PRIMARY BAG FILTER

PARAMETER	PERMIT LIMIT	RUN 1	RUN 3	RUN 4	AVG.
DATE		6-19-91	6-19-91	6-19-91	
TIME		1055-1218	1803-1915	1958-2110	
PARTICULATE -*					
grain/dscf		0.01065	0.00957	0.01208	0.01077
lb/hr		1.515	1.375	1.790	1.560
STACK GAS DATA					
Oxygen, % - orsat		5.7	5.7	5.8	5.7
Temperature - deg F		413	415	415	414
Moisture - %		39.96	40.28	40.11	40.12
Velocity - ft/sec		40.49	41.21	42.39	41.36
Flow rate - acfm		45735.5	46549.4	47884.2	46723.0
- dry scfm		16592.9	16765.4	17289.4	16882.6

* Percent of isokinetic sampling;
Run 1 - 103.69, Run 3 - 104.64, Run 4 - 106.38

TABLE II
EMISSION TESTING RESULTS SUMMARY

DEGUSSA CORPORATION
2 PRIMARY BAG FILTER

PARAMETER	PERMIT LIMIT	RUN 1	RUN 2	RUN 3	AVG.
DATE		6-18-91	6-18-91	6-18-91	
TIME		1218-1349	1552-1710	1928-2044	
PARTICULATE -*					
grain/dscf		0.00151	0.00221	0.00375	0.00249
lb/hr		0.177	0.273	0.334	0.261
STACK GAS DATA					
Oxygen, % - orsat		5.4	5.7	5.8	5.6
Temperature - deg F		494	488	491	491
Moisture - %		34.97	34.07	25.35	31.46
Velocity - ft/sec		139.47	143.27	135.73	139.49
Flow rate - acfm		38385.4	39429.0	37353.7	38389.4
- dry scfm		13726.3	14395.3	15418.0	14513.2

* Percent of isokinetic sampling;
Run 1 - 102.74, Run 2 - 105.28, Run 3 - 94.31

PROCESS DESCRIPTION

Carbon black is produced through the incomplete combustion and thermal cracking of a highly aromatic hydrocarbon feedstock at temperatures of 1760 C. In the reactor, the combustion of fuel produces heat necessary to crack the hydrogen molecules from the carbon molecules. The essentially pure carbon produced is entrained in the combustion gases which exit the reactor through a water quench section which stops the cracking reaction. The combustion gases also contain the gaseous hydrogen produced in the cracking reaction.

Carbon is separated from the combustion gas in the primary bag filter unit. Bag filters in the unit separate the product carbon from the combustion gases which pass through the filters. The carbon is collected at the bottom of the unit and is removed via a pneumatic conveyor for further processing.

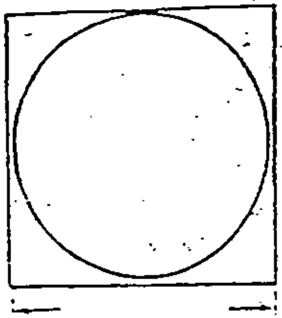
Periodically, the bag filters in the unit are cleaned by reversing the flow of combustion gases. Primary Bag Filter Unit # 1 has 10 compartments and Unit # 2 has 8 compartments. Each compartment in turn is cleaned by reversing the flow of combustion gases. The reverse flow gases dislodge carbon from the inside of the bag filters allowing the carbon to fall to the bottom of the unit. The reverse flow gases are refiltered and removed by the other in-service compartments.

Elevation diagrams of the # 1 and # 2 Primary Bag Filters are presented on the following pages.

After passing through the bag filters on Units # 1 and # 2, the combustion gases are exhausted to atmosphere through a common central stack.

ETS FIELD DATA, METHOD(S) 1-5

CROSS SECTIONAL SCHEMATIC OF STACK
TRAVERSE POINT LAYOUT



PLANT Degussa
DATE 6-19-91
LOCATION Belpre Ohio
OPERATOR Troy Lesage
STACK NO. 1 - PBF
RUN NO. F

SAMPLE BOX NO. EE
METER BOX NO. 480
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE 29.94
FILTER TARE wt mg
NOZZLE DIAMETER in. ~~0.1974~~ 0.7725

STACK DIAMETER, in. 59.75"
PITOT TUBE NO. P-6-2
PITOT FACTOR 0.840
METER Δ H@ 1.7987
D.G.M.C. FACTOR 1.0274
K FACTOR 5.7413
T=4967.7164

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in.H2O)	STACK TEMP (Ts), °F	VELOCITY HEAD (ΔPs)	VELOCITY HEAD $\sqrt{\Delta P_s}$	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tmin), °F	OUTLET (Tmout), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge
Vertical 1	10:55	-0.640	417	0.225	0.474	1.250	1.274	172.987	86	85	257	57	8.0
2	10:59		418	0.205	0.452	1.150	1.159	174.860	87	85	252	58	8.0
3	11:03		416	0.235	0.484	1.350	1.332	177.125	88	86	256	59	8.5
4	11:07		418	0.215	0.463	1.200	1.216	179.735	89	86	257	57	9.0
5	11:11		418	0.225	0.474	1.250	1.273	182.480	90	87	256	55	9.0
6	11:15		415	0.260	0.509	1.450	1.476	184.850	91	87	250	56	9.0
7	11:19		419	0.280	0.529	1.600	1.582	187.890	91	87	252	54	9.5
8 ½	11:23	10:27	420	0.245	0.494	1.400	1.383	191.155	92	88	253	55	9.0
Horizontal 9	11:50		388	0.265	0.514	1.550	1.552	194.024	95	91	250	57	9.5
10	11:54		386	0.290	0.538	1.700	1.702	197.155	93	90	252	57	9.5
11	11:58		415	0.295	0.543	1.650	1.674	200.820	93	90	254	56	10
12	1202		415	0.265	0.514	1.500	1.504	203.510	93	90	256	54	9.0
13	1206		418	0.225	0.474	1.250	1.273	206.630	93	90	250	54	8.5
14	1210		419	0.235	0.484	1.350	1.328	209.210	93	90	251	56	8.5
15	1214		419	0.235	0.484	1.350	1.328	212.315	94	90	249	57	8.5
16	1218	1222	414	0.225	0.474	1.250	1.278	215.045	94	91	252	58	8.5
AVERAGE	64		413.44	[illegible]	0.494	1.391		212.6[illegible] (44.684)		89.84			

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS				ORSAT MEASUREMENT			
	(237)				CO_2	O_2	CO	N_2
FINAL	789.1	885.7	488.2	673.7	1	1.3	15.7	

COMMENTS: after verticle @ 0.008 FT³/MIN
after Elbo change 0.012 FT³/MIN
PRE-LEAK CHECK GOOD @ 0.004 FT³/MIN.
POST-LEAK CHECK GOOD @ 0.010 FT³/MIN.

CROSS SECTIONAL SCHEMATIC OF STACK TRAVERSE POINT LAYOUT

ETS FIELD DATA, METHOD(S) 1-5

PLANT Degussa
DATE 6-19-91
LOCATION Belpre OHIO
OPERATOR Tregleloge
STACK NO. 1-PBF
RUN NO. 3

SAMPLE BOX NO. EE
METER BOX NO. 480
AMBIENT TEMPERATURE 86°
BAROMETRIC PRESSURE 29.95
FILTER TARE wt mg
NOZZLE DIAMETER in. 0.3725

STACK DIAMETER, in. 58.75
PITOT TUBE NO. P-6-2
PITOT FACTOR 0.840
METER Δ H@ 1.8987
D.G.M.C. FACTOR 1.0274
K FACTOR 5.7413
T= 4967.7164

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMP (Ts), °F	VELOCITY HEAD (ΔP_s)	$\sqrt{\Delta P_s}$	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tmin), °F	OUTLET (Tmout), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge
Horizontal 1	1803		394	0.305	0.552	1.250	1.274	264.490	99	98	243	50	7.0
2	1807		413	0.320	0.565	1.800	1.820	267.095	98	98	246	56	7.5
3	1811		413	0.275	0.524	1.550	1.564	270.180	98	97	249	56	7.0
4	1815		415	0.275	0.524	1.550	1.561	273.245	98	97	254	56	7.0
5	1819		417	0.285	0.533	1.600	1.614	276.930	98	97	255	55	7.0
6	1823		419	0.215	0.463	1.200	1.215	279.950	97	95	256	55	6.0
7	1827	OFF@	420	0.215	0.463	1.200	1.213	282.620	97	95	255	54	6.0
8	1831	1835	419	0.195	0.441	1.100	1.102	285.210	97	95	256	54	6.0
9	1847		410	0.205	0.452	1.150	1.170	288.987	97	96	254	59	6.0
10	1851		417	0.245	0.494	1.400	1.387	290.910	98	96	257	58	6.0
11	1855		415	0.260	0.509	1.500	1.476	293.405	98	96	259	58	6.0
12	1859		415	0.260	0.509	1.500	1.476	296.550	99	96	254	58	6.5
13	1903		420	0.280	0.529	1.600	1.580	299.290	98	95	258	59	6.5
14	1907		418	0.220	0.469	1.250	1.244	302.490	98	95	252	59	6.0
15	1911		418	0.245	0.494	1.400	1.386	305.755	98	95	250	57	6.0
16	1915	1619 OFF@	418	0.245	0.494	1.400	1.386	308.850	98	95	256	57	6.0
AVERAGE	64		415.06		0.500	1.409		310.624	96.93				

46.134

6447

Before vertical - 0.004 ft³/min
After elbow change 0.009 ft³/min

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS			
FINAL	787.3	873.4	521.0	705.8
INITIAL	539.7	757.5	0.1001	91.972

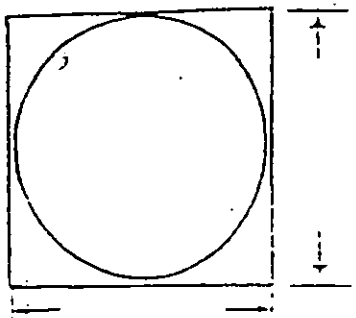
ORSAT MEASUREMENT

	CO_2	O_2	CO	N_2
1	1.3	57	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]

COMMENTS:
0.004 ft³/min
0.007 ft³/min

ETS FIELD DATA, METHOD(S) 1-5

CROSS SECTIONAL SCHEMATIC OF STACK
TRAVERSE POINT LAYOUT



PLANT Degussa
DATE 6-19-91
LOCATION Del Pro Ohio
OPERATOR Troy Lelaco
STACK NO. 1-PAF
RUN NO. 4

SAMPLE BOX NO. #1
METER BOX NO. 470
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE 29.94
FILTER TARE wt mg
NOZZLE DIAMETER, in. 0.3725

STACK DIAMETER, in. 58.25
PITOT TUBE NO. P-4-7
PITOT FACTOR 0.840
METER Δ H@ 1.7937
D.G.M.C. FACTOR 1.0270
K FACTOR 5.70.3
T= 0957 7:50

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in.H₂O)	STACK TEMP (Tₛ), °F	VELOCITY HEAD (ΔPₛ)	√ΔP	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H₂O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm in), °F	OUTLET (Tm out), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge
1	1958		408	0.325	0.570	1.850	1.860	310.737	95	95	246	54	9.0
2	2002		415	0.320	0.565	1.800	1.816	314.310	95	94	247	56	9.0
3	2006		417	0.300	0.547	1.700	1.699	317.720	95	94	252	55	7.0
4	2010		417	0.295	0.543	1.650	1.671	321.540	94	93	254	56	9.0
5	2014		418	0.250	0.500	1.400	1.414	324.050	93	92	253	57	8.0
6	2018		419	0.225	0.474	1.250	1.271	327.110	93	91	259	57	8.0
7	2022	OFF E↓	420	0.260	0.509	1.450	1.462	329.350	93	91	261	57	8.0
8	2026	2030	417	0.240	0.489	1.350	1.359	332.150	93	90	260	56	8.0
9	2042		391	0.220	0.469	1.300	1.284	335.412	94	91	260	56	8.0
10	2046		410	0.245	0.494	1.400	1.393	338.180	94	91	261	56	8.0
11	2050		415	0.245	0.494	1.400	1.390	341.250	94	91	256	57	8.0
12	2054		417	0.255	0.504	1.450	1.444	344.010	94	92	258	57	8.0
13	2058		419	0.310	0.556	1.750	1.751	346.810	95	91	254	55	8.5
14	2102		417	0.305	0.552	1.700	1.727	349.765	95	92	252	56	8.5
15	2106	↓OFF B	417	0.260	0.509	1.500	1.472	353.050	95	92	250	56	8.0
16	2110	2114	414	0.210	0.458	1.200	1.190	356.810	94	92	247	54	8.0
AVERAGE	64		414.56		0.514	1.509		358.824 (48.037)	93.06				

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS			
FINAL	561.5	819.0	527.9	686.7
INITIAL	562.2	562.2	426.1	669.5

671.1

ORSAT MEASUREMENT

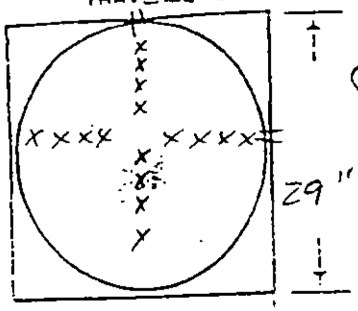
	CO₂	O₂	CO	N₂
1	1.4	15.8		
2				

COMMENTS:

PRE-LEAK CHECK GOOD @ 0.003 CFM
POST-LEAK CHECK GOOD @ 0.004 CFM

ETS FIELD DATA, METHOD(S) 2

CROSS SECTIONAL SCHEMATIC OF STACK
TRAVERSE POINT LAYOUT



EPA
R.H.

PLANT Degussa
DATE 6-18-91
LOCATION Belpre OHio
OPERATOR Troy Lesage
STACK NO. #2 - PBF
RUN NO. 1

SAMPLE BOX NO. #EE
METER BOX NO. 480
AMBIENT TEMPERATURE 87°
BAROMETRIC PRESSURE 29.87
FILTER TARE, wt mg
NOZZLE DIAMETER, in 0.1751

STACK DIAMETER, in 29.0"
PITOT TUBE NO. P-6-2
PITOT FACTOR 0.840
METER Δ Ho 1.8987
D.G.M.C. FACTOR 1.0274
K FACTOR 0.4449
T= 426.2888

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in.H2O)	STACK TEMP (Ts), °F	VELOCITY HEAD (ΔPs)	$\sqrt{\Delta P_s}$	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm in), °F	OUTLET (Tm out), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge
1	12:18	-1.950	494	2.200	1.483	0.980	0.983	040.720	103	102	246	59	5.5
2	12:22		490	2.600	1.612	1.150	1.166	043.045	104	102	249	56	6.0
3	12:26		496	2.700	1.643	1.200	1.203	045.560	104	100	257	57	6.0
4	12:30		496	2.950	1.717	1.300	1.315	048.430	104	101	258	59	6.5
5	12:34		492	2.650	1.627	1.150	1.186	051.115	104	100	257	58	6.5
6	12:38		492	2.350	1.532	1.050	1.052	054.030	105	100	246	56	5.5
7	12:42		496	2.550	1.596	1.150	1.137	056.740	105	100	247	55	6.0
8	12:46	OFF @ 12:55	495	2.450	1.565	1.100	1.093	059.190	106	100	256	58	6.0
9	13:21		492	2.550	1.596	1.150	1.140	061.544	108	102	255	56	6.0
10	13:25		492	2.650	1.627	1.200	1.186	064.420	108	104	257	56	6.0
11	13:29		492	2.700	1.643	1.200	1.209	067.150	108	105	256	57	6.5
12	13:33		496	2.850	1.688	1.300	1.270	069.890	108	105	257	56	7.0
13	13:37		498	2.850	1.688	1.700	1.268	072.590	109	105	258	58	7.0
14	13:41		494	2.750	1.658	1.200	1.228	075.370	109	105	256	58	7.0
15	13:45		493	2.900	1.702	1.300	1.297	078.170	110	106	255	57	7.5
16	13:49	1353	492	2.350	1.532	1.050	1.052	080.090	109	105	258	56	6.5
AVERAGE	64		493.75		1.619	1.174		083.258 (42.478)	104.781				

VOLUME OF LIQUID WATER COLLECTED				
IMPINGER WEIGHTS (465.1)				
FINAL	776.8	779.3	447.8	680.0
INITIAL	541.4	571.8	447.3	669.9

ORSAT MEASUREMENT

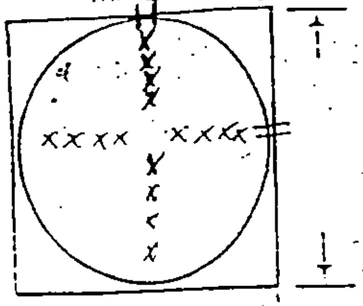
	CO_2	O_2	CO	N_2
1	1.6	5.4	0.0	
2				

COMMENTS:

PRE-LEAK CHECK GOOD @ 0.006 FT³/MIN
POST-LEAK CHECK GOOD @ 0.005 CFM

ETS FIELD DATA METHOD(S) 23

CROSS SECTIONAL SCHEMATIC OF STACK
TRAVERSE POINT LAYOUT



PLANT Degussa
DATE 6-18-91
LOCATION Belpre OHIO
OPERATOR Troy Lesage
STACK NO. 2 PBF
RUN NO. 2

SAMPLE BOX NO. #1
METER BOX NO. 480
AMBIENT TEMPERATURE 83°
BAROMETRIC PRESSURE 29.89
FILTER TARE WT. mg
NOZZLE DIAMETER, in 0.1051

STACK DIAMETER, in 29"
PITOT TUBE NO. P-6-2
PITOT FACTOR 0.840
METER ΔH@ 1.8987
D.G.M.C. FACTOR 1.0274
K FACTOR .4810
T= 449.2171

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMP (Ts), °F	VELOCITY HEAD (ΔPs)	$\sqrt{\Delta Ps}$	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm in), °F	OUTLET (Tm out), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge
1	15:52	-1.935	486	2.800	1.673	1.250	1.241	083.930	102	103	250	58	6.5
2	15:56		487	2.900	1.702	1.300	1.305	086.535	102	102	251	57	7.0
3	16:00		488	3.00	1.732	1.350	1.349	089.260	102	101	254	57	7.0
4	1604		487	2.850	1.688	1.300	1.292	092.510	101	100	254	58	6.5
5	1608		492	2.900	1.702	1.300	1.301		101	98	255	57	7.0
6	1612		492	2.850	1.688	1.350	1.344	093.245	101	97	256	57	7.5
7	1616		490	2.950	1.717	1.400	1.394	101.050	101	98	255	56	7.0
8	1620	OFF 1624	483	2.900	1.702	1.400	1.375	104.290	101	98	258	57	7.0
9	1642		485	2.300	1.673	1.300	1.330	106.621	100	98	257	56	8.5
10	1646		487	2.900	1.702	1.410	1.375	109.710	100	98	256	57	8.0
11	1650		486	2.750	1.658	1.300	1.305	112.130	101	93	256	57	8.0
12	1654		488	2.700	1.643	1.300	1.279	114.905	102	98	257	54	8.5
13	1658		487	2.900	1.702	1.400	1.375	117.980	102	99	258	56	8.5
14	1702		485	2.850	1.688	1.350	1.354	120.945	102	99	254	56	8.0
15	1706		486	2.650	1.627	1.250	1.258	123.810	103	100	255	56	8.0
16	1710	OFF 1714	489	2.450	1.565	1.150	1.159	126.505	102	100	257	57	7.0
AVERAGE	64 min	-1.935	487.5	√	1.679	1.319		[illegible]					

(45.2145)

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS			
FINAL	893.3	703.0	431.0	651.8
INITIAL	657.7	622.3	421.7	644.0

480.4

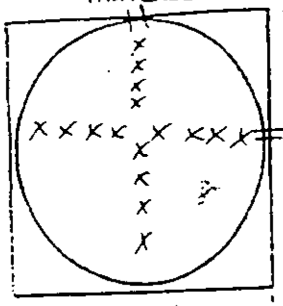
ORSAT MEASUREMENT

	CO_2	O_2	CO	N_2
1	11.6	5.7	10.8	
2				

COMMENTS:
PRE-LEAK 0.005 FT³/min.
POST-LEAK 0.004 CFM

ETS FIELD DATA, METHOD(S) 1-5

CROSS SECTIONAL SCHEMATIC OF STACK
TRAVERSE POINT LAYOUT



PLANT Degussa
DATE 6-18-91
LOCATION BelPre Ohio
OPERATOR Troy LeSage
STACK NO. #2-PBF
RUN NO. 2

SAMPLE BOX NO. EE
METER BOX NO. 480
AMBIENT TEMPERATURE 98°
BAROMETRIC PRESSURE 29.90
FILTER TARE wt mg
NOZZLE DIAMETER, in. 0.1951

STACK DIAMETER, in. 29"
PITOT TUBE NO. P-6-2
PITOT FACTOR 0.840
METER Δ H@ 1.8987
D.G.M.C. FACTOR 1.0274
K FACTOR 0.4710
T-449.2171

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H2O)	STACK TEMP (Ts), °F	VELOCITY HEAD (ΔPs)	√ΔPs	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm in), °F	OUTLET (Tm out), °F	SAMPLE BOX TEMPERATURE, °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER, °F	PUMP VACUUM, in. Hg gauge
1	1928	-1.400	489	2.400	1.549	1.150	1.136	129.412	88	87	245	57	8.0
2	1932		493	2.550	1.596	1.200	1.201	131.625	87	86	249	56	7.5
3	1936		493	2.550	1.596	1.200	1.201	134.050	88	86	253	56	7.5
4	1940		493	2.650	1.627	1.250	1.249	136.735	86	84	252	55	7.5
5	1944		491	2.800	1.673	1.300	1.322	139.410	86	84	254	55	7.5
6	1948		490	2.600	1.612	1.250	1.229	141.999	86	84	253	54	7.5
7	1952		493	2.750	1.658	1.300	1.286	144.460	86	83	254	55	7.0
8	1956	OFF @ 2000	494	2.700	1.643	1.250	1.271	147.175	85	83	258	57	7.0
9	2016		484	2.400	1.549	1.150	1.142	149.713	85	84	252	55	7.5
10	2020		485	2.400	1.549	1.150	1.142	152.120	87	84	257	55	7.5
11	2024		492	2.500	1.581	1.200	1.179	154.590	85	83	256	5.5	7.5
12	2028		492	2.600	1.612	1.250	1.224	157.540	85	83	254	57	7.5
13	2032		492	2.650	1.627	1.250	1.250	160.410	85	83	257	58	7.5
14	20[illegible]		492	2.750	1.658	1.300	1.247	163.045	84	83	255	56	7.5
15	2040		494	2.800	1.673	1.300	1.318	165.910	84	82	252	54	7.0
16	2044	OFF @ 2048	494	2.450	1.565	1.150	1.153	168.650	54	52	254	55	7.0
AVERAGE	64 min	-1.400	491.3		1.611	1.228		171.611	84.75				

42.199

302.9

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS			
FINAL	800.6	596.6	450.9	662.4
INITIAL	570.7	157.5	444.4	654.7

ORSAT MEASUREMENT

	CO2	O2	CO	N2
1	1.4	5.8	0.0	
2				

COMMENTS:

PRE-LEAK CHECK GOOD @ 0.006 FT³/min.
POST-LEAK CHECK GOOD @ 0.010 FT³/min.

5.3 CARBON BLACK

EMISSION FACTOR DOCUMENTATION

The revision of this section was prepared in September 1981, by Pacific Environmental Services, Inc., under EPA Contract No. 68-02-3511, Work Assignment No. 12, for EPA Project Officer, Mr. Arch MacQueen

The following revisions were made:

Figure 5.3-1, the flow diagram for the oil furnace carbon black process, was corrected. The number assigned the oil storage tank vent gas did not agree with Table 5.3-1. This was corrected. Also stream 37 was labelled "Combined Dryer Vent Gas" to indicate it consists of the both bag filter and dryer exhaust. Stream 27 in Table 5.3-1 was relabelled "Dryer Heat Exhaust After Bag Filter."

The "C" emission factor rating for the thermal process was eliminated because emissions are negligible. Instead one rating "B" was used to describe the section.

Table 5.3-3 was revised to report methane and nonmethane VOC separately. Data were taken from Reference No. 1. Table 5.3-2 was modified to report the nonmethane VOC species under the headingnonmethane.

A table for the VOC Species Manual was prepared for carbon black manufacture. The data for this table was taken from Table 5.3-2 of the section. The VOC emission factors were found to be in agreement with the information contained in the references.

References 6 and 7 (new additional references) were added to the section's reference list.

The author's name was deleted from the first page of the section.

A footnote was added stating that the organic sulfur compounds which are emitted, shown in Table 5.3-2, are not included in the non-methane VOC emission factor reported in Table 5.3-3.

The fact that the emission factors are expressed as weight of emissions per unit weight of carbon black produced was added to the table. See footnote a on both Table 5.3-2 and 5.3-3.

Dryer vent emissions described in the text (Section 5.3.2.1, third paragraph) were explained in terms of bag filter exhaust, main process vent gas and combustion of natural gas to heat the dryer. Also, the emissions from the thermal process (Section 5.3.2.2) were described in terms of offgas recylcing.

The "C" emission factor rating for the thermal process was eliminated because emissions are negligible. Instead one rating "B" was used to describe the section.

A footnote was added to the thermal process in Table 5.3-3 explaining that emissions from the furnaces are negligible, but the emissions from all other parts of the process are similar to the Oil furnace process.

Footnote a (previously footnote d) was corrected to indicate that most plants use bag filters but some may use scrubbers at least on one process train.

Footnote d (previously footnote e) was changed to agree with footnote a. The work uncontrolled was deleted.

In footnote e (previously footnote f) reference to Monsanto Research Corporation was omitted.

Footnote 1 was added to the table.

"Emissions are mostly aromatic oils" was added to footnote i.

The emission factor table (previously Table 5.3-2) was renumbered 5.3-3.

Emission factors for dryer vent, uncotrolled were deleted from the emission factor table because they were based on only a few test results. These results do not make sense compared to the results for dryer vents controlled by a scrubber. There are more test results for the later and therefore the factors are considered to be more accurate. It is also not reasonable that the controlled emissions should be greater than the uncontrolled emissions. Also, most dryer vents are controlled, so an uncontrolled emission factor has limited application. For these reasons, the uncontrolled dryer vent factors were deleted.

ROUTING AND TRANSMITTAL SLIP

TO (Name, office symbol or location)		ACTION
1 Audrey McKeith	INITIALS	CIRCULATE
	DATE	COORDINATION
2	INITIALS	FILE
	DATE	INFORMATION
3	INITIALS	NOTE AND RETURN
	DATE	PER CONVERSATION
4	INITIALS	SEE ME
	DATE	SIGNATURE

REMARKS

attached are my comments on carbon black AP42 section. Aside from questions #1/#2 attached, & a couple typos in the text this looks to be in excellent shape. You may need to go back to Monsanto to resolve problems, if necessary.

Do NOT use this form as a RECORD of approvals, concurrences, disapprovals, clearances, and similar actions.

FROM (Name, office symbol or location)	DATE
Chuck Mann	1/26
	PHONE

OPTIONAL FORM 41
AUGUST 1967
GSA FPMR (41CFR) 100-11.206

GPO 043—16—81418-1 419-016

5041-101

1) p.1 - Info that gas furnace process ~~was~~ was phased out in 1960's conflicts with USBM production info (attached). Where did Monsanto get this information?

2) Table 5.3.2 - Why are particulate emissions for main process vent after a flare higher than uncontrolled emissions? I do not see how particulate emissions could be increased by flaring. Perhaps uncontrolled value is incorrect?

It may also be desirable to indicate that "uncontrolled" main process vent emissions relate to bag filter exhaust.

Exactly what NEDS data was used to estimate solid waste incinerator emission factors? Also, what sort of solid waste are we talking about?

3) Table 5.3.3 - Any info on the sort of trace elements that are emitted? What specific species, if any, have been identified

McBeth

5.3 CARBON BLACK

5.3.1 Process Description

Carbon black is produced by the reaction of a hydrocarbon fuel, such as oil or gas, with a limited supply of combustion air at temperatures of 2,400 to 2,800°F (1,320 to 1,540°C). The unburned carbon is collected as an extremely fine (10 to 500 nm diameter), black, fluffy particle. The principal uses of carbon black are as a reinforcing agent in rubber compounds (especially tires) and as a black pigment in printing inks, surface coatings, paper, and plastics. Two major processes are presently used in the United States to manufacture carbon black: the oil furnace process and the thermal process. The oil furnace process accounts for approximately 90% of production and the thermal process approximately 10%.

Two other processes, the lamp process for the production of lampblack and the cracking of acetylene to produce acetylene black, are each used at one plant in the United States. However, these are small volume, specialty black operations which constitute less than 1% of total U.S. carbon black production. Two additional processes, the channel process and the gas furnace process, were formerly operated ? in the country. The gas furnace process was phased out in the 1960's and the last channel black plant was closed in 1976.

5.3.1.1 Oil Furnace Process--

In the oil furnace process (Figure 5.3.1 and Table 5.3.1) an aromatic liquid hydrocarbon feedstock is preheated and injected continuously into the combustion zone of a natural gas fired furnace where

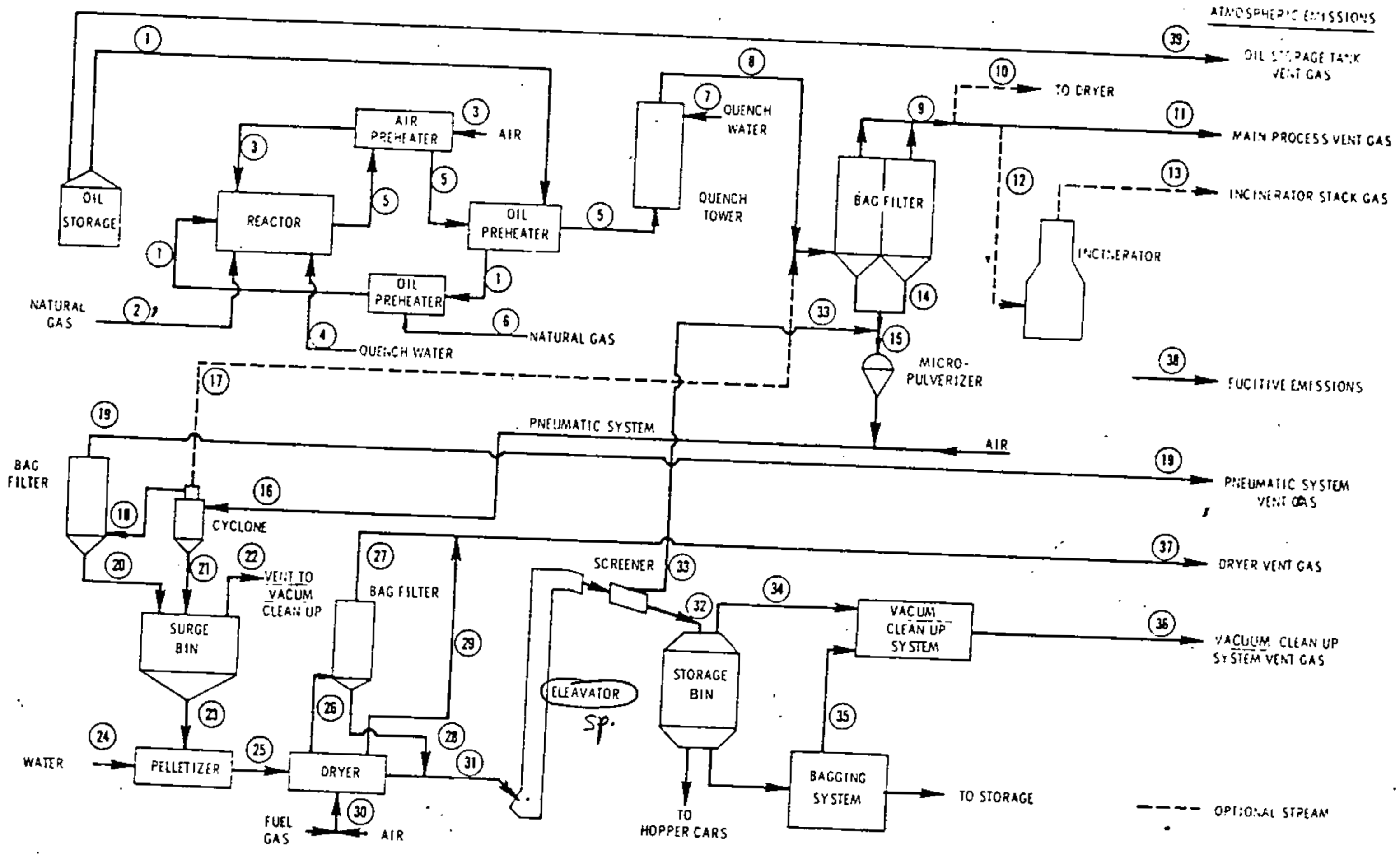


Figure 5.3.1. Flow diagram for the oil furnace carbon black process.[1]

TABLE 5.3.1 STREAM CODE FOR THE OIL FURNACE PROCESS ILLUSTRATED IN FIGURE 5.3.1[1]

Stream	Identification
1	Oil feed
2	Natural gas feed
3	Air to reactor
4	Quench water
5	Reactor effluent
6	Gas to oil preheater
7	Water to quench tower
8	Quench tower effluent
9	Bag filter effluent
10	Vent gas purge for dryer fuel
11	Main process vent gas
12	Vent gas to incinerator
13	Incinerator stack gas
14	Recovered carbon black
15	Carbon black to micropulverizer
16	Pneumatic conveyor system
17	Cyclone vent gas recycle
18	Cyclone vent gas
19	Pneumatic system vent gas
20	Carbon black from bag filter
21	Carbon black from cyclone
22	Surge bin vent
23	Carbon black to pelletizer
24	Water to pelletizer
25	Pelletizer effluent
26	Dryer direct heat source vent
27	Dryer bag filter vent
28	Carbon black from dryer bag filter
29	Dryer indirect heat source vent
30	Hot gases to dryer
31	Dried carbon black
32	Screened carbon black
33	Carbon black recycle
34	Storage bin vent gas
35	Bagging system vent gas
36	Vacuum cleanup system vent gas
37	Dryer vent gas
38	Fugitive emissions
39	Oil storage tank vent gas

it is decomposed to form carbon black. The exhaust gases from the furnace which contain the entrained carbon particles are cooled to about 450°F (230°C) by passage through heat exchangers and direct water sprays. The carbon black is then separated from the gas stream, usually by a fabric filter. A cyclone for primary collection and particle agglomeration may precede the filter. A single collection system often serves a number of furnaces that are manifolded together.

The recovered carbon black is finished to a marketable product by pulverizing and wet pelletizing to increase bulk density. Water from the wet pelletizer is driven off in a gas-fired rotary dryer. From 35% to 70% of the dryer combustion gas is charged directly to the interior of the dryer; the remainder acts as an indirect heat source for the dryer. The dried pellets are then conveyed to bulk storage. Process yields range from 35% to 65%, depending on the feed composition and grade of black produced. Furnace designs and operating conditions determine the particle size the other physical and chemical properties of the carbon black. Generally, yields are highest for large particle size blacks and lowest for small particle size blacks.

5.3.1.2 Thermal Process--

The thermal process is a cyclic operation in which natural gas is thermally decomposed to carbon particles, hydrogen, methane, and a mixture of other organics. To start the cycle, a stoichiometric mixture of air and fuel gas is burned to heat a brick checkerwork in the process furnace to about 2,400°F (1,300°C). The air and fuel supply is then cut off, the furnace stack is closed, and natural gas is introduced into the furnace. The natural gas is decomposed by the heat from the hot bricks. When the bricks become cool, the natural gas flow is shut off. The effluent gases containing the thermal black particles are flushed out of the furnace and cooled by water sprays to about 250°F (125°C) before passing through cyclonic collectors and fabric filters which recover the thermal black.

The effluent gases, consisting of about 90 percent hydrogen, 6 percent methane, and 4 percent higher hydrocarbons, are cooled, compressed, and used as a fuel to reheat the furnaces. Normally, more than enough hydrogen is produced to make the thermal-black process self-sustaining, and the surplus hydrogen is used to fire boilers that supply process steam and electric power.

The collected thermal black is pulverized and pelletized to a final product in much the same manner as furnace black. Thermal process yields are generally high (35% to 60%), but the relatively coarse particles produced (180 to 470 nm diameter) do not have the strong reinforcing properties required for rubber products.

5.3.2 Emissions and Controls

5.3.2.1 Oil Furnace Process--

Emissions from carbon black manufacture include particulate matter, carbon monoxide, organics, nitrogen oxides, sulfur compounds, polycyclic organic matter (POM), and trace elements.

The principal source of emissions in the oil furnace process is the main process vent. The vent stream consists of the reactor effluent quench water vapor vented from the carbon black recovery system. Gaseous emissions may vary considerably according to the grade of carbon black being produced. Organic emissions tend to be higher for small particle black production, corresponding to the lower yields obtained for these blacks. Sulfur compound emissions are actually a function of the feed sulfur content. Tables 5.3.2 and 5.3.3 show the normal emission ranges to be expected in addition to typical average values.

Particulate matter, sulfur oxides, and nitrogen oxides are also emitted from the dryer vent. The oil feedstock storage tanks are a source of organic emissions. Carbon black emissions also occur from the pneumatic transport system vent, the plant-wide vacuum cleanup system vent, and from cleaning, spills, and leaks (fugitive emissions).

Gaseous emissions from the main process vent may be controlled with CO boilers, incinerators, or flares. The pellet dryer combustion furnace, which is in essence a thermal incinerator, may also be employed in a control system. CO boilers, thermal incinerators, or combinations of these devices can achieve essentially complete oxidation of organics and can reduce sulfur compounds in the process flue gas. Combustion efficiencies of 99.6 percent for hydrogen sulfide and 99.8 percent for carbon monoxide have been measured for a CO boiler in a carbon black plant. A combustion efficiency in excess of 99.9 percent for carbon monoxide has been measured for a flare on a carbon black plant, but emissions are generally greater when this control option is used. Particulate emissions may also be reduced by combustion of some of the carbon black particles; however, emissions of sulfur dioxide and nitrogen oxides are increased by combustion devices.

5.3.2.2 Thermal Process-

A comparison of the thermal and oil furnace processes indicates that emissions from the former are generally less severe. Nitrogen oxides,

TABLE 5.3.2 EMISSION FACTORS FOR CARBON BLACK MANUFACTURE

EMISSION FACTOR RATING: B(OIL FURNACE PROCESS)

C(THERMAL PROCESS)

Process	Particulate[i]		Carbon Monoxide		Hydrocarbons[j]		Nitrogen Oxides		Sulfur Oxides		Hydrogen Sulfide	
	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT
Oil Furnace Process[a] Main Process Vent												
Uncontrolled[b]	0.22 ± 70% (0.2-10)	0.11 ± 70% (0.1-5)	2,800 ± 19% (1,400-4,400)	1,400 ± 19% (700-2,200)	100 ± 48% (20-300)	50 ± 48% (10-159)	0.56 ± 15% (2-5.6)	0.28 ± 15% (1-2.8)	0 (0-24)	0[l] (0-12)	60 ± 82%	30 ± 82%
Flare[c]	2.70 (2.4-3)	1.35 (1.2-1.5)	245 (216-274)	122 (108-137)	3.7 (3.4-4)	1.85 (1.7-2)	NA	NA[k]	50 (44-56)	25 (21.9-28)	2	1
Dryer Vent												
Uncontrolled[c]	0.45 (0.10-0.80)	0.23 (0.05-0.40)							0.10	0.05		
Bag Filter[d,e]	0.24 ± 89% (0.02-0.80)	0.12 ± 89% (0.01-0.40)					0.73 (0.24-1.22)	0.36 (0.12-0.61)	0.52 (0.06-1.08)	0.26 (0.03-0.54)		
Scrubber[c]	0.71 (0.02-1.40)	0.36 (0.01-0.70)					2.20	1.10	0.40	0.20		
Pneumatic System Vent[c,e]												
Bag Filter	0.58 ± 93% (0.12-1.40)	0.29 ± 93% (0.06-0.70)										
Oil Storage Tank Vent[f] Uncontrolled					1.44	0.72						
Vacuum Cleanup System Vent[c,e]												
Bag Filter	0.06 ± 58% (0.02-0.10)	0.03 ± 58% (0.01-0.05)										
Fugitive Emissions[c]	0.20	0.10										
Solid Waste Incinerator[g]	0.24	0.12	0.02	0.01	0.02	0.01	0.08	0.04	0.02	0.01		
Thermal Process[h]	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg

[a]Blanks indicate no emissions.

[b]Average values are based on results of six sampling runs conducted by Monsanto Research Corporation at a representative plant with the industry mean production rate of 5.1 x 10^4 MT/yr (5.6 x 10^4 ton/yr). The corresponding error bounds represent 95% confidence limits. The ranges of values are based on a survey of fifteen plants in Reference 4. All plants use bag filters for product recovery.

[c]Average values and the corresponding ranges of values are based on a survey of plants in Reference 4.

[d]Average values and corresponding ranges are based on the survey in Reference 4 and the public files of Louisiana Air Control Commission.

[e]Error bounds represent 95% confidence limits for corresponding mean values.

[f]Emission factor caluclated using empirical correlations for petrochemi[cal] losses from storage tanks (vapor pressure = 0.7 kPa).

[g]Based on emission rates obtained from the National Emission Data System.

[h]Emissions data are not available, but all emissions are believed to be negligible.

[i]The particulate matter is carbon black.

[j]Total non-methane hydrocarbons. Individual organic species are included in Table 5.3.3.

[k]Not available.

[l]Not detected at detection limit of 1 ppm.

TABLE 5.3.3 EMISSION FACTORS FOR CHEMICAL SUBSTANCES FOR OIL FURNACE CARBON BLACK MANUFACTURE

Chemical Substance	Main Process Vent Gas[a] lb/ton	kg/MT
Hydrogen	240 ± 39% (100-360)	120 ± 39% (50-180)
Carbon Disulfide	60 ± 76%	30 ± 76%
Carbonyl Sulfide	20 ± 99%	10 ± 99%
Methane	50 ± 47% (20-120)	25 ± 47% (10-60)
Acetylene	90 ± 48% (10-260)	45 ± 48% (5-130)
Ethane	0[b]	0[b]
Ethylene	3.2 ± 85%	1.6 ± 85%
Propylene	0[b]	0[b]
Propane	0.46 + 109% - 100%	0.23 + 109% - 100%
Isobutane	0.20 ± 80%	0.10 ± 80%
n-Butane	0.54 ± 57%	0.27 ± 57%
n-Pentane	0[b]	0[b]
POM	0.004 ± 52%	0.002 ± 52%
Trace Elements	<0.50 ± 43%	<0.25 ± 43%

Such as?

[a]These chemical substances are emitted only from the main process vent. Average values are based on six sampling runs made at a representative plant given in Reference 1. The corresponding error bounds represent 95% conficence limits for the mean values. The ranges given in parentheses are based on results of a survey of operating plants given in Reference 4.

sp.

[b]Not detected at detection limit of 1 ppm.

carbon monoxide, and particulate matter are emitted from the furnace during the heating part of the process when furnace stacks are open. During the production portion of the cycle, the process operates as a closed system and no emissions occur except possibly through leaks. Nitrogen oxides may be formed since high temperatures are reached in the furnaces. Carbon monoxide emissions result from oxidation. Particulate matter is emitted when loose carbon black deposited on the checkerbrick is released to the atmosphere in the form of puffs which occur at five minute intervals as the furnace is switched from carbon black production to heating.

Emissions from the dryer vent, the pneumatic transport system vent, the vacuum cleanup system vent, and fugitive sources are similar to those for the oil furnace process since the operations which give rise to these emissions are similar in the two processes. There is no emission point in the thermal process which corresponds to the oil storage tank vents in the oil furnace process. Sulfur compounds, POM, trace element, and organic compound emissions are minimal for the thermal process in comparison to the oil furnace process because low sulfur content natural gas feedstock is used and the process off-gas is burned as fuel.

REFERENCES FOR SECTION 5.3

1. Serth, R. W. and T. W. Hughes. Source Assessment: Carbon Black Manufacture. Monsanto Research Corporation. Publication Number EPA-600/2-77-107k. October 1977.

2. Air Pollutant Emission Factors. Final Report. Resources Research, Inc. Reston, Virginia. Prepared for National Air Pollution Control Administration, Durham, North Carolina, under Contract Number CPA-22-69-119. April 1970.

3. Drogin, I. Carbon Black. J. Air Pol. Control Association. 18:216-228, April 1968.

4. Engineering and Cost Study of Air Pollution Control for the Petrochemical Industry, Volume 1: Carbon Black Manufacture by the Furnace Process. Houdry Division, Air Products and Chemicals, Inc. Publication Number EPA-450/3-73-006a. June 1974.

5. Hustvedt, Kent C., Leslie B. Evans, and William M. Vatavuk. Standards Support and Environmental Impact Statement, An Investigation of the Best Systems of Emission Reduction for Furnace Process Carbon Black Plants in the Carbon Black Industry. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. April 1976.

6. Source Testing of a Waste Heat Boiler. George D. Clayton Associates. Publication Number EPA-75-CBK-3. 1975.

ROUTING AND TRANSMITTAL SLIP

TO (Name, office symbol or location)	INITIALS / DATE	ACTION
1 Audrey	INITIALS	CIRCULATE
	DATE	COORDINATION
2	INITIALS	FILE
	DATE	INFORMATION
3	INITIALS	NOTE AND RETURN
	DATE	PER CONVERSATION
4	INITIALS	SEE ME
	DATE	SIGNATURE

REMARKS

It's looking good. However, please go up and [illegible] with C. Mann ([illegible] NADB) (particularly about the S factors). and talk to Monsanto about any changes or questions. When satisfied that every number and change is defensible, please ~~[illegible]~~ route memo (on route slip) through R. Welch ESED for his [illegible] also. If you can find anyone in Welch's Branch who is assigned carbon black [illegible] you should probably give them opportunity to review now, also.

Do NOT use this form as a RECORD of approvals, concurrences, disapprovals, clearances, and similar actions.

FROM (Name, office symbol or location)

Note – I made a couple of changes
Also call Lima and get copy of report to send (or [illegible]) [signature]

DATE	
PHONE	

OPTIONAL FORM 41
AUGUST 1967
GSA FPMR (41CFR) 100-11.206

GPO : 913—16—81418-1 419-015

5041-101

from SSEIS document

Main Process Vent
CO Boiler and
Incinerator

Table C-3

Particulate = $\frac{[illegible] + 1.68 + 2.26}{3}$ = 1.83 (0.92)

$HC = \frac{3.7 + 1.1 + 1.8 + 1.3}{4}$ = 1.98 (0.99)

$SO_2 = \frac{43 + 30 + 36 + 30 + 37}{5}$ = 35.2 (17.6)

$NO_x = \frac{6.5 + 5.5 [illegible] 6 + 4.7 + 5.6}{5}$ = [illegible].3 (4.65)

Table C-9

Particulate = $\frac{1.8 + 1.82 + 3.34}{3}$ = 2.32 (1.16)

$CO = \frac{0.86 + 2.0 + 2.4}{3}$ = 1.75 (0.88)

$H_2S = \frac{0.31 + 0.49 + 0.06 + 0.0[illegible]}{4}$ = 0.22 (0.11)

Table C-3

[illegible] $(5.4 + 3.2 + 11)/3$ = 6.53 (3.27) pp 58

Main Process Vent Gas

hydrogen
carbon dioxide
carbon monoxide
hydrogen sulfide — sulfur content
sulfur oxides — "
methane
nitrogen + argon
carbon black
water
oxygen
nitrogen
acetylene
methane
~~acetylene~~ argon
carbon disulfide — [illegible]
carbonyl sulfide
ethylene
ethane
propylene
propane
iso-butane
POM
trace elements

Dryer Vent
carbon black
sulfur oxides
nitrogen oxides

bag filters, scrubbers

Pneumatic System Vent
carbon black

bag filter, cyclone

Oil Storage Tank Vents
hydrocarbons

none

Vacuum Cleanup System Vent
carbon black

cyclone, bag filter

Monsanto Research Corporation
[illegible] Road
Dayton, Ohio (513) [illegible] 3911
[illegible] 774-2700
Environmental [illegible] Monitoring

Run	1-TM	3-TM	4-TM	POM 1	POM2	POM3
Particulate	0.09	0.14	0.083	–	–	–
SOx	–	–	–	–	–	–
NOx	0.27	0.27	0.27	0.25	0.35	0.25
HC	55	37	35	37	79	–
CO	1,470	1,270	1,560	1,020	1,785	1,385

Emissions from Main Process Vent Gas at one plant, six tests conducted by Monsanto

---

Tables to Review: 3A U.S. plants
5 CO Boiler
6 Thermal Incinerator
7 CO + Thermal
8 Thermal Inc + Waste Heat Boiler
9 Catalytic Incinerator

convert $\frac{\text{tons}}{\text{ton}}$ to $\frac{g}{kg}$

$$\frac{\cancel{ton}}{\cancel{ton}} \times \frac{2.205\,\cancel{lb}}{kg} \times \frac{\cancel{ton}}{\cancel{2000}\,lb} \times \frac{1000\,g}{\cancel{kg}} \times \frac{\cancel{2.205}\,kg}{2.205\,\cancel{lb}} \times \frac{\cancel{2000\,lb}}{\cancel{ton}}$$

$$\frac{2205\,g}{2.205\,kg} = 1000$$

$$\frac{ton}{ton} \times 1000 \Rightarrow \frac{g}{kg}$$

All main process vent gas data (p. 67 of source assessment document are for units w/bag filter collection devices and no control devices.

Combustion Devices

CO Boilers 50-26 (steam generators)

Flares 50-7

0.3 particulate

CO_2

CO

H_2S

SO_x

H_2

CH_4

N + Ar

ref. [illegible]

Main Process Vent w/Controls

Flare 50-7

carbon black	(0.0002 + 0.0004 + 0.0002 + [illegible]) × 1000	= 1.2
CO_2	(0.45[illegible] + 0.664 + 0.406 + 0.695) × 1000	= 2220
CO	(0.022 + 0.037 + 0.020 + 0.[illegible]) × 1000	= 108
H_2S	(0.0002 + 0.0003 + 0.000[illegible] + 0.000[illegible]) × 1000	= 0.9
SO_x	(0.0045 + 0.0066 + 0.0[illegible]0 + 0.0[illegible]60) × 1000	= 21.9
H	(0.002 × 4) × 1000	= 8
CH_4	(0.0003 + 0.000[illegible] + 0.000[illegible] + 0.0006) × 1000	= 1.7
N + Ar	(1.255 + 1.831 + 1.121 + 1.917) × 1000	= 6124

Flare 50-8

carbon black	1.5
CO_2	2818
CO	137
H_2S	1
SO_x	28
H	10
CH_4	2
N + Ar	7772

CO Boilers + Incinerator 50-26

SO_x	8

$$kg \times MW \times f = ppm$$

$$f = \frac{ppm}{MW \times kg} = \frac{0.914}{1.07}$$

$$\frac{g}{\cancel{kg}} \times \frac{\cancel{kg}}{1000\,\cancel{g}} \times \frac{kg}{2.205\,\cancel{lb}} \times \frac{1.1\ \cancel{ton}}{MT} \times \frac{2000\,\cancel{lb}}{\cancel{ton}} = 0.998\,\frac{kg}{MT}$$

$$\frac{g}{kg} = 0.998\,\frac{kg}{MT}$$

$$1.002\,\frac{g}{kg} = \frac{kg}{MT}$$

$$\frac{\cancel{kg}}{\cancel{MT}} \times \frac{2.205\,lb}{\cancel{kg}} \times \frac{\cancel{MT}}{1.1\,ton} = 2.005\ \frac{lb}{ton}$$

TABLE 5.3.3 EMISSION FACTORS FOR CHEMICAL SUBSTANCES FOR OIL FURNACE CARBON BLACK MANUFACTURE

Chemical Substance	Main Process Vent Gas[a] lb/ton	kg/MT
Hydrogen	240 ± 39% (100 - 360)	120 ± 39% (50 - 180)
Carbon Disulfide	60 ± 76%	30 ± 76%
Carbonyl Sulfide	20 ± 99%	10 ± 99%
Methane	50 ± 47% (20 - 120)	25 ± 47% (10 - 60)
Acetylene	90 ± 48% (10 - 260)	45 ± 48% (5 - 130)
Ethane	0[b]	0[b]
Ethylene	3.2 ± 85%	1.6 ± 85%
Propylene	0[b]	0[b]
Propane	0.46 +109% -100%	0.23 +109% -100%
Isobutane	0.20 ± 80%	0.10 ± 80%
n-Butane	0.54 ± 57%	0.27 ± 57%
n-Pentane	0[b]	0[b]
POM	0.004 ± 52%	0.002 ± 52%
Trace Elements	<0.50 ± 43%	<0.25 ± 43%

[a] ~~All chemical substances in this table are emitted in the main process vent gas~~

[b] Not detected at detection limit of 1 ppm.

[a] These chemical substance are emitted only from the main process vent. Average values are based on six sampling runs made at a representative plant given in reference 1. The corresponding error bounds represent 95% confidence limits for the mean values. The ranges given in parentheses are based on results of a survey of operating plants given in reference 1.

Carbon Black

- topics not discussed in most recent revision in AP-42 (which are discussed in industrial process profiles, chapter 4)

- emission factors given in chapter 4 do not specify controls used but are generally in the range

- emission table in appendix is based on a larger plant and this may be the reason for any variances

- conclusion: no further changes need be made to this section

88 [illegible]
[illegible] 11

Monsanto

p. 1 - gas furnace process fased out in 1960's
U.S. Bureau of Mines thru 1974

p. 112 - exact source of NEDS emission rates for
solid waste incineration

p. 67 - discrepancies in emission factors

	MRC		Houdry
NO_x	0.28	g/kg	1-3
carbon black	0.110		0.1-5
H_2S	30		0-22 (used S factors on table)

particulate emissions vary w/product size and fabric filter efficiency

SSEIS document p. 3-15 ⇒ average emissions = 1.5 $\frac{kg}{MT}$

range of values 1 $\frac{kg}{MT}$ to 5 $\frac{kg}{MT}$

Source Assessment: 0.11 from Monsanto tests pp 178-190

Run 1-TM	0.09 g/kg particulate
3-TM	0.14
4-TM	0.083
POM-1	not determined
POM-2	" "
POM-3	" "

0.313/3 = 0.104 g/kg

all runs conducted at same plant

per Bill Harnett 8-31-78

Carbon Black
NSPS being developed
scheduled [illegible]
standard by 3-79

5.3.2.2 Thermal Process--

A comparison of the thermal and oil furnace processes indicates that emissions from the former are generally less severe. Nitrogen oxides, carbon monoxide, and particulate matter are emitted from the furnace during the heating part of the process when furnace stacks are open. During the production portion of the cycle, the process operates as a closed system and no emissions occur except possibly through leaks. Nitrogen oxides may be formed since high temperatures are reached in the furnaces. Carbon monoxide emissions result from oxidation. Particulate matter is emitted when loose carbon black deposited on the checkerbrick is released to the atmosphere in the form of puffs which occur at five minute intervals, as the furnace is switched from carbon black production to heating.

Emissions from the dryer vent, the pneumatic transport system vent, the vacuum cleanup system vent, and fugitive sources are similar to those for the oil furnace process since the operations which give rise to these emissions are similar in the two processes. There is no emission point in the thermal process which corresponds to the oil storage tank vents in the oil furnace process.

(same P)

Sulfur compounds, ~~organic compounds~~, POM, ~~and~~ trace element, and organic compound emissions are ~~lower than for the thermal~~ minimal for the thermal process ~~as compared~~ in comparison to the oil furnace process because low sulfur content natural gas ~~is~~ feedstock is used and the process off-gas is burned as fuel.

[a] Blanks indicate no emissions.

[b] Average values are based on results of six sampling runs conducted by Monsanto Research Corporation at a representative plant with the industry mean production rate of 5.1×10^4 MT/yr (5.6×10^4 ton/yr). The corresponding error bounds represent 95% confidence limits. The ranges of values are ~~from~~ based on a survey of fifteen plants in reference 4. All plants use bag filters for product recovery.

[c] Average values and the corresponding ranges of values are based on a survey of plants in reference 4.

[d] Average values and corresponding ranges are based on the survey in reference 4 and the public files of Louisiana Air Control Commission.

[e] Error bounds represent 95% confidence limits for corresponding mean values.

[f] Emission factor calculated using empirical correlations for petrochemical losses from storage tanks (vapor pressure = 0.7 kPa).

[g] Based on emission rates obtained from the National Emission Data System.

[h] Emissions data are not available, but ~~no significant~~ all emissions are believed to be negligible.

[i] The particulate matter is carbon black.

[j] Total non-methane hydrocarbons. Individual organic species are included in TABLE 5.3.3.

[k] Not available

[l] Not detected at detection limit of 1 ppm.

TABLE 5.?2 EMISSION FACTORS FOR CARBON BLACK MANUFACTURE
EMISSION FACTOR RATING: B (OIL FURNACE PROCESS)
C (THERMAL PROCESS)

	Process	Particulate[i]		Carbon Monoxide		Hydrocarbons[j]		Nitrogen Oxides		Sulfur Oxides		Hydrogen Sulfide	
		lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT
	Oil Furnace Process[a]												
	Main Process Vent												
	Uncontrolled[b]	0.22 ± 70% (0.2 - 10)	0.11 ± 70% (0.1 - 5)	2,800 ± 19% (1,400 - 4,400)	1,400 ± 19% (700 - 2,200)	100 ± 48% (20 - 300)	50 ± 48% (10 - 150)	0.56 ± 15% (2 - 5.6)	0.28 ± 15% (1 - 2.8)	0 (0 - 24)	0[l] (0 - 12)	60 ± 82% (105 - 265)	30 ± 82% (55 - 135)
	Flare[c]	2.70 (2.4 - 3)	1.35 (1.2 - 1.5)	245 (216 - 274)	122 (108 - 137)	3.7 (3.4 - 4)	1.85 (1.7 - 2)	NA	NA[k]	50 (44 - 56)	25 (21.9 - 28)	2	1
76	Dryer Vent												
	Uncontrolled[c]	0.45 (0.10 - 0.80)	0.23 (0.05 - 0.40)							0.10	0.05		
	Bag Filter[d,e]	0.24 ± 89% (0.02 - 0.80)	0.12 ± 89% (0.01 - 0.40)					0.73 (0.24 - 1.22)	0.36 (0.12 - 0.61)	0.52 (0.06 - 1.08)	0.26 (0.03 - 0.54)		
	Scrubber[c]	0.71 (0.02 - 1.40)	0.36 (0.01 - 0.70)					2.20	1.10	0.40	0.20		
77	Pneumatic System Vent[c,e]												
	Bag Filter	0.58 ± 93% (0.12 - 1.40)	0.29 ± 93% (0.06 - 0.70)										
78	Oil Storage Tank Vent[f]												
	Uncontrolled					1.44	0.72						
79	Vacuum Cleanup System Vent[c,e]												
	Bag Filter	0.06 ± 58% (0.02 - 0.10)	0.03 ± 58% (0.01 - 0.05)										
	Fugitive Emissions[c]	0.20	0.10										
112	Solid Waste Incineration[g]	0.24	0.12	0.02	0.01	0.02	0.01	0.08	0.04	0.02	0.01		
	Thermal Process[h]	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg

9.19

Pete Porter (918) 661-6721
Phillips Petroleum Bartlesville OK

supp #9 preview ~~plan~~ edition

? NOx / uncontrolled / looks like a misprint

? how to figure "oil storage tank vent" HC losses

call after 2:00 here
before 3:00

0.7 KPa = .1450 = 0.1 psi

Mr. M.L. Porter
Phillips Petroleum Company
10 ~~D4~~ Phillips Building
Bartlesville Oklahoma 74004

---

sent him pages of Source Assessment for question #2 - he will call back if necessary

6/10/76
CSM

Sec. 5.3-1 - Emission Factor Backup Document

- References contained herein: 2, 3, 4, 5, 6, 7.

- References found "on the shelf": 1, ~~5~~
(Most of information from reference 5 is incorporated into reference 6).

A. - Emission factors for furnace black - gas process, channel process

1. Example calculations are contained in Reference 1. No changes were made for the updated AP-42 section. These processes are already or becoming obsolete.

B. - Emission factors for furnace black - oil process

1. Uncontrolled factors:
Particulates - Ref. 5, Table CB-4, computes to 4.6 lb/Ton, Ref. 6, p. 3-15 gives 3 lb/Ton. Inlet of Plant A, Ref. 6 gives 11.2 lb/Ton.

$$Avg = \frac{4.6 + 3 + 11.2}{3} = 6.2 \cong 6 \text{ lb/Ton.}$$

Since emissions seem to vary somewhat (depends on filter efficiency), a value of 6 which corresponds both to average of values quoted above and a filter collection efficiency of 99.7% (midway between 99.5 & 99.9% - figures quoted in Ref. 1) was chosen.

CO - Ref. 5, Table CB-4 computes to 2740 lb/Ton. Ref. 6 Test reports for Plants A, B, C - give 2380, 1805, 2900 lb/Ton. Ref. 6, p 3-13 gives 3200 lb/ton average.

$$Avg = \frac{2380 + 1805 + 2900 + 3200}{} = 2571 \cong 2600$$

HC – Ref. 6, p. 3-15, Avg = 200, Ref. 6 Source tests, Plants A, B, C = 140, 222, 188. So 200 is reasonable average.

NOX – Ref. 6, p. 3-17. NO_x = 0.4 lb/ton – Same data as Ref. 6 source test, Plant A = 0.37 lb/ton, so 0.4 used. Ref. 5 shows higher value ≈ 3.5 lb/ton. This not based on test data so used 0.4 as being more reasonable.

H_2S – Ref. 6. p. 3-17, H_2S = 205 lb/Ton – Compares w/ test data given.

SO_2 – Assume essentially complete oxidation of H_2S by control device, negligible SOx in inlet exhaust gas. Therefore, inlet SO_2 = Nil, outlet ≅ 2 lb SO_2/lb H_2S = 405.

2. Controlled factors:

Part: Ref. 6 reports 50-75% reduction in part. in CO boiler outlet, ∴ EF = 6 × 0.5 = 3 lb/Ton

CO: Ref. 6, pp 7-4, 7-5 ratio of controlled to uncontrolled emission for model plant used to formulate E.F. Equivalent to 99+% control for CO boiler. For flares, assumed 95% control of uncontrolled value (Ref. 6, p. 4-15).

HC: NO_x, SO_x Similar to CO – Used Tables 7-1, 7-2 of Ref. 6. For HC, ratio applied to total HC which includes CH_4. Values in Tables 7-1, 7-2 are for C_2H_2 only. Assumed same extent of control would apply for CH_4 as C_2H_2.

Precision Values for SIEFA:

1. Furnace Black - Oil Process Uncontrolled:

$$P_{Part} = \frac{\left(\frac{11.2 - 3.0}{1.693}\right)}{(3)^{1/2}(6)} = \underline{0.466}$$

$$P_{CO} = \frac{\left(\frac{3200 - 1805}{2.059}\right)}{(4)^{1/2}(2600)} = \underline{0.13}$$

$$P_{HC} = \frac{\left(\frac{222 - 140}{2.059}\right)}{(4)^{1/2}(200)} = \underline{0.1}$$

P_{NOx} = $\underline{0.7}$ for one observation of 0.4

P_{H_2S} = ? - Adequate data not available, Source test data for does not specify S content. Avg. value quoted in Ref. 6, p. 3-17 is only one observation. Use SO2 R value for n<1? If so, $P_{H_2S} = 0.254$.

P_{SO_2} = ~~See H~~ Based on H_2S - ∴ $P_{SO_2} \overset{?}{=} 0.254$.

2. Furnace Black - Gas Process - No change from old factors in PEDCo report

3. Channel Black - No change from old factors in PEDCo report.

Plant A

Part. - Inlet - 10.4 + 7.5 + 15.8 lb/Ton = 11.2

- Outlet' - 3.3 + 2.6 + 3.6 lb Ton = 3.2

CO - Inlet - 1734 + 3036 lb/Ton = 2380

Outlet' - N.D. (120 ppm vs. 13% CO inlet)

HC - Inlet - 152 + 129 lb/Ton = 140

Outlet' - 3.7 + 1.1 + 1.55 lb/Ton = 2.1

H_2S Inlet - 25 + 14.5 + 15.5 lb/Ton = 18

SO_2 Outlet' - 43 + 33 + 33.5 lb/Ton = 36

NH_3 Inlet - 0.3 + 0.4 + 0.37 lb/T = 0.36

Outlet' - 6.5 + 5.5 + 5.15 lb/Ton = 5.7

Plant B

CO - Inlet - 1637 + 1484 + 1895 + 1876 + 2133 = 1805

HC - Inlet - 211 + 222 + 234 = 222

H_2S - 11.8 + 13.9 + 11.1 = 12.3

Plant C

Part - Outlet' - 2.7 + 3.06 + 4.56 = 3.4

CO - Inlet - 2900 = 2900

Outlet' - 0.86 + 2 + 2.4 = 1.75

HC - Inlet - 188 = 188

H_2S - Inlet - 16.7 + 18.9 = 18

Outlet - 0.31 + 0.47 + 0.06 + 0.003 = 0.2

CO Boiler

Highway Vehicle Emissions, 10^3 Tons/yr

	Urban	Rural	Total
Passenger Cars			
Light Duty Trucks			
Heavy Duty Trucks			
Gasoline			
Diesel			

	Urban	Rural	Total
Passenger Cars			
Light Duty Trucks			
Heavy Duty Trucks			
Gasoline			
Diesel			

	Urban	Rural	Total
Passenger Cars			
Light Duty Trucks			
Heavy Duty Trucks			
Gasoline			
Diesel			

$\frac{\cancel{kg}}{\cancel{kg}} \times \frac{\cancel{2.2046 lb}}{\cancel{kg}} \times \frac{?}{\cancel{2.2046 lb}} \times \frac{2000 lb}{Ton}$ $\boxed{2000}$

Furnace Oil Main Vent

Uncontrolled: (lb/ton)

Part[3]: 6 (2 - 16) (t, dry) (<2 μ liquid particles)

TRS[2]: 205 (105 - 265) (...) (...)

NOx: 0.4 ...

HC[1]: 200 (60 - 520) (...)

CO: 2600 (1500 - 6000) (t, dry) 5300 (4200 - 6400)

Gas

Furnace gas: 10-35 (20) % eff. - 40-80 (60) nm particles

Oil - 35-65 (50) % eff. ... (35) ...

HC, CO -

Part -

...?

...

Dryer purge gas: Part - 0.08 lb/Ton (fabric filter) = ...

Vent w/ CO boiler[4]

Part - Reduce (50-, 72% (0.0189 gr/dscf) ~~(...)~~ (3)

TRS - H_2S < 1 ppm to 10 ppm (0.6) ~~(...)~~ (0.25) - Complete conversion to SO_2 ~~(...)~~ (40 s)

NOx - 70 ppm (6)

HC - 1 (... C_2H_2, 99.5% control) = 3 incl. CH_4 at 99.5%) (3)

CO - ~~...~~ 10 (99+ % control)

Vent w/ Flare; ~95% oxidation of gaseous pollutants

HC: 10

CO: ~~...~~ 130

Incinerator. 99% efficiency expected → CO = 25, HC ≅ 5

[1] 50-75% C_2H_2, rest CH_4

[2] as H_2S, % S may be 1-2% given increasing ... scarcity of low sulfur feedstocks.

... fabric filter efficiencies of 99.5 to 99.9%

... model plant

1. Title of Project: Enhancement of National Emissions Data System (NEDS) Program Reporting Capabilities

2. Period of Performance: Eight months from date of award

3. Project Officer: Charles O. Mann
National Air Data Branch
Monitoring and Data Analysis Division (MD-14)
Office of Air Quality Planning and Standards
Environmental Protection Agency
Phone: 919-688-8146, ext. 395

4. Background:

The National Emissions Data System (NEDS) provides for storage and retrieval of air pollutant source and emissions data in a standardized format for the entire nation. It has been determined through meetings with and surveys of the NEDS user community and the National Air Data Branch's internal evaluations that a number of system enhancements could substantially increase the value of NEDS to its users.

Development of a new procedure for calculating area source emissions using county-specific emission factors for selected categories is desirable. To attain this goal, NADB must have the capability to easily calculate on an annual basis area source emission factors for highway vehicles which take into account altitude, vehicle mix by model year, and applicable emission regulations for each of the approximately 3,100 counties in the U. S. Changes to the NEDS area source file structure to accommodate county-specific emission factors have been completed. However, a system to calculate the emission factors for highway mobile sources and load into the emission factor file emission factors for any area source category must be developed.

The NEDS point source input file should be modified to allow input of facility coordinates either as Universal Transverse Mercator (UTM) coordinates or latitude-longitude coordinates. Presently only UTM coordinates can be used. This results in difficult problems of manual conversion of data for cases in which UTM coordinates cannot be obtained. Development of a program to automatically convert latitude-longitude coordinates to UTM coordinates for input to NEDS is required.

It is also necessary to complete the development of and make minor revisions to the data tables contained in the existing Source Inventory and Emission Factor Analysis (SIEFA) program. Loading of SIEFA "typical tables" values for process throughputs, control device efficiencies, and fuel parameters is required. Also, revision

5.3 CARBON BLACK

Carbon black is produced by the reaction of hydrocarbon fuel such as oil or gas, or both, with a limited supply of air at temperatures of 2500 to 3000°F (1370 to 1650°C). Part of the fuel is burned to CO_2, CO, and water, thus generating heat for the combustion of fresh feed. The unburned carbon is collected as a black fluffy particle. The three basic processes for producing this compound are the furnace process, accounting for about 83 percent of production; the older channel process, which accounts for about 6 percent of production; and the thermal process.

5.3.1 Channel Black Process[1]

In the channel black process, natural gas is burned with a limited air supply in long, low buildings. The flame from this burning impinges on long steel channel sections that swing continuously over the flame. Carbon black is deposited on the channels, is scraped off, and falls into collecting hoppers. The combustion gases containing the solid carbon that is not collected on the channels, in addition to carbon monoxide and other combustion products, are then vented directly from the building. Approximately 1 to 1.5 pounds of carbon black is produced from the 32 pounds of carbon available in 1000 cubic feet of natural gas (16 to 24 kilograms carbon black from the 513 kilograms in 1000 cubic meters).[2-4] The balance is lost as CO, CO_2, hydrocarbons, and particulates.

5.3.2 Furnace Process[1]

The furnace process is subdivided into either the gas or oil process depending on the primary fuel used to produce the carbon black. In either case, the fuel–gas in the gas process or gas and oil in the oil process–is injected into a reactor with a limited supply of combustion air. The combustion gases containing the hot carbon are then rapidly cooled to a temperature of about 500°F (260°C) by water sprays and by radiant cooling.

The largest and most important portion of the furnace process consists of the particulate or carbon black removal equipment. While many combinations of control equipment exist, an electrostatic precipitator, a cyclone, and a fabric filter system in series are most commonly used to collect the carbon black. Gaseous emissions of carbon monoxide and hydrocarbons are not controlled in the United States.

5.3.3 Thermal Black Process[1]

In thermal black plants, natural gas is decomposed by heat in the absence of air or flame. In this cyclic operation, methane is pyrolyzed or decomposed by passing it over a heated brick checkerwork at a temperature of about 3000°F (1650°C). The decomposed gas is then cooled and the carbon black removed by a series of cyclones and fabric filters. The exit gas, consisting largely of hydrogen (85 percent), methane (5 percent), and nitrogen, is then either recycled to the process burners or used to generate steam in a boiler. Because of the recycling of the effluent gases, there are essentially no atmospheric emissions from this process, other than from product handling.

Table 5.3-1 presents the emission factors from the various carbon black processes. Nitrogen oxide emissions are not included but are believed to be low because of the lack of available oxygen in the reaction.

Table 5.3-1. EMISSION FACTORS FOR CARBON BLACK MANUFACTURING[a]
EMISSION FACTOR RATING: C

Type of process	Particulate		Carbon monoxide		Hydrogen sulfide		Hydrocarbons[b]	
	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT
Channel	2,300	1,150	33,500	16,750	–	–	11,500	5,750
Thermal	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg
Furnace								
Gas	c	c	5,300	2,650	–	–	1,800	900
Oil	c	c	4,500	2,250	38S[d]	19S[d]	400	200
Gas or oil	220[e]	110[e]						
	60[f]	30[f]						
	10[g]	5[g]						

[a]Based on data in References 2, 3, 5, and 6.
[b]As methane.
[c]Particulate emissions cannot be separated by type of furnace and are listed for either gas or oil furnaces.
[d]S is the weight percent sulfur in feed.
[e]Overall collection efficiency was 90 percent with no collection after cyclone.
[f]Overall collection efficiency was 97 percent with cyclones followed by scrubber.
[g]Overall collection efficiency was 99.5 percent with fabric filter system.

References for Section 5.3

1. Air Pollutant Emission Factors. Final Report. Resources Research, Incorporated. Reston, Virginia. Prepared for National Air Pollution Control Administration, Durham, N.C., under Contract Number CPA-22-69-119. April 1970.

2. Drogin, I. Carbon Black. J. Air Pol. Control Assoc. *18*:216-228, April 1968.

3. Cox, J.T. High Quality, High Yield Carbon Black. Chem. Eng. *57*:116-117, June 1950.

4. Shreve, R.N. Chemical Process Industries, 3rd Ed. New York, McGraw-Hill Book Company. 1967. p. 124-130.

5. Reinke, R.A. and T.A. Ruble. Oil Black. Ind. Eng. Chem. *44*:685-694, April 1952.

6. Allan, D. L. The Prevention of Atmospheric Pollution in the Carbon Black Industry. Chem. Ind. p. 1320-1324, October 15, 1955

Emission Factor 2300 LB/TON

Process (SCC) CARBON BLACK

Pollutant PARTICULATE FROM CHANNEL PROCESS

AP-42 Pg. No. 5.3-2

Observed values are:

☐ Test Data

☐ Engineering Analysis

☐ Material Balance

Observations

Observed Value,

Observation	AP-42 Ref. No.	Observed Value
	2[b]	none
	3	Inadquate data
	5	none
	6	none

a) This reference is not available from ☐ PEDCo ☐ Public Library ☐ EPA

b) Yield of carbon black. 2.5/1000 ft³ of gas burned.

Emission Factor NEGLIGIBLE

Process (SCC) CARBON BLACK

Pollutant PARTICULATE FROM THERMAL PROCESS

AP-42 Pg. No. 5.3-2

Observed values are:

☐ Test Data

☐ Engineering Analysis

☐ Material Balance

Observations

Observed Value,

Observation	AP-42 Ref. No.	Observed Value
	2[b]	none
	3	None
	5	none
	6	none

a) This reference is not available from ☐ PEDCo ☐ Public Library ☐ EPA

b) Carbon formation is 31.82 lb/ft³ of [illegible]

Emission Factor 2000 LB/TON

Process (SCC) CARBON BLACK

Pollutant PARTICULATE FROM GAS FURNACE

AP-42 Pg. No. 5.3-2

Observed values are:

☐ Test Data

☐ Engineering Analysis

☐ Material Balance

Observations

Observed Value,

Observation	AP-42 Ref. No.	Observed Value
	2	Inadequate date
	3	None
	5	none
	6	none

a) This reference is not available from ☐ PEDCo ☐ Public Library ☐ EPA

Emission Factor 2000 LB/TON

Process (SCC) CARBON BLACK

Pollutant PARTICULATE FROM OIL FURNACE

AP-42 Pg. No. 5.3-2

Observed values are:

☐ Test Data

☐ Engineering Analysis

☐ Material Balance

Observations

Observed Value,

Observation	AP-42 Ref. No.	Observed Value
	2	None
	3	None
	5	None
	6	none

a) This reference is not available from ☐ PEDCo ☐ Public Library ☐ EPA

PRIORITY

Observed values are:

☐ Test Data

☐ Engineering Analysis

☐ Material Balance

Emission Factor 11,500 lb/ton
As Methane

Process (SCC) ______

Pollutant HC ~~from~~ channel Process
carbon black

AP-42 Pg. No. 5.3-2

Observations

Observed Value,

Observation	AP-42 Ref. No.	Observed Value
	2	Inadequate data
	3	Inadequate data
	5	none
	6	none

a) This reference is not available from ☐ PEDCo ☐ Public Library ☐ EPA

Emission Factor NEGLIGIBLE

Observed values are:

☐ Test Data

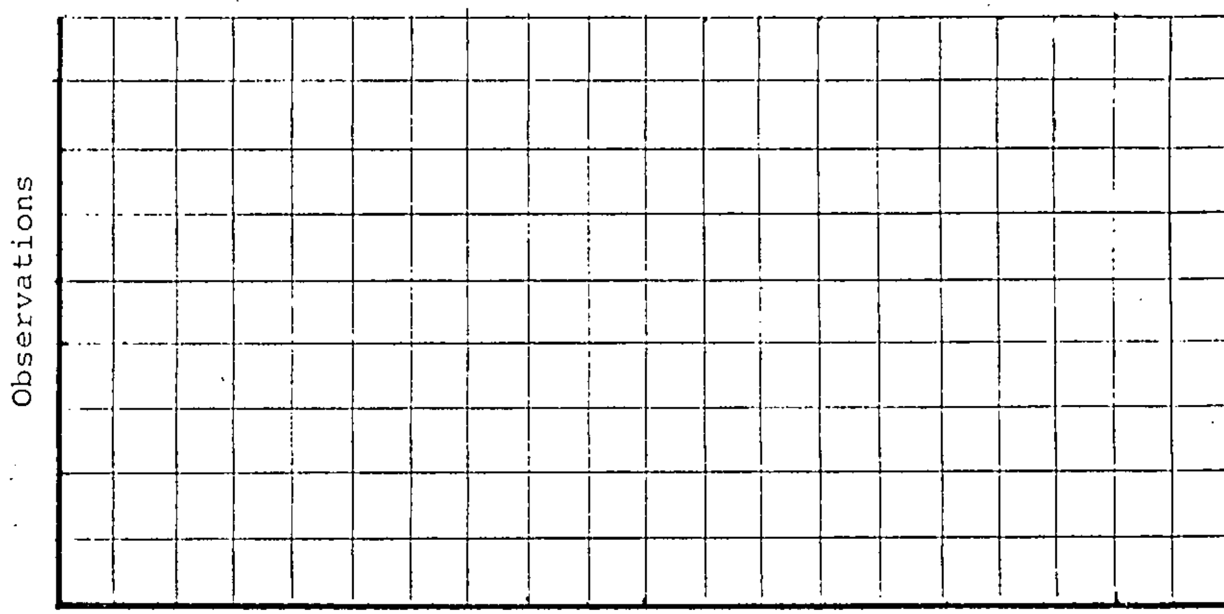
☐ Engineering Analysis

☐ Material Balance

Process (SCC) CARBON BLACK

Pollutant HC FROM THERMAL PROCESS

AP-42 Pg. No. 5.3-2



Observed Value,

Observation	AP-42 Ref. No.	Observed Value
	2	negligible
	3	none
	5	none
	6	none

a) This reference is not available from ☐ PEDCo ☐ Public Library ☐ EPA

Emission Factor 1800 LB/TON

Process (SCC) ____

Pollutant CARBON BLACK HC FROM GAS FURNACE

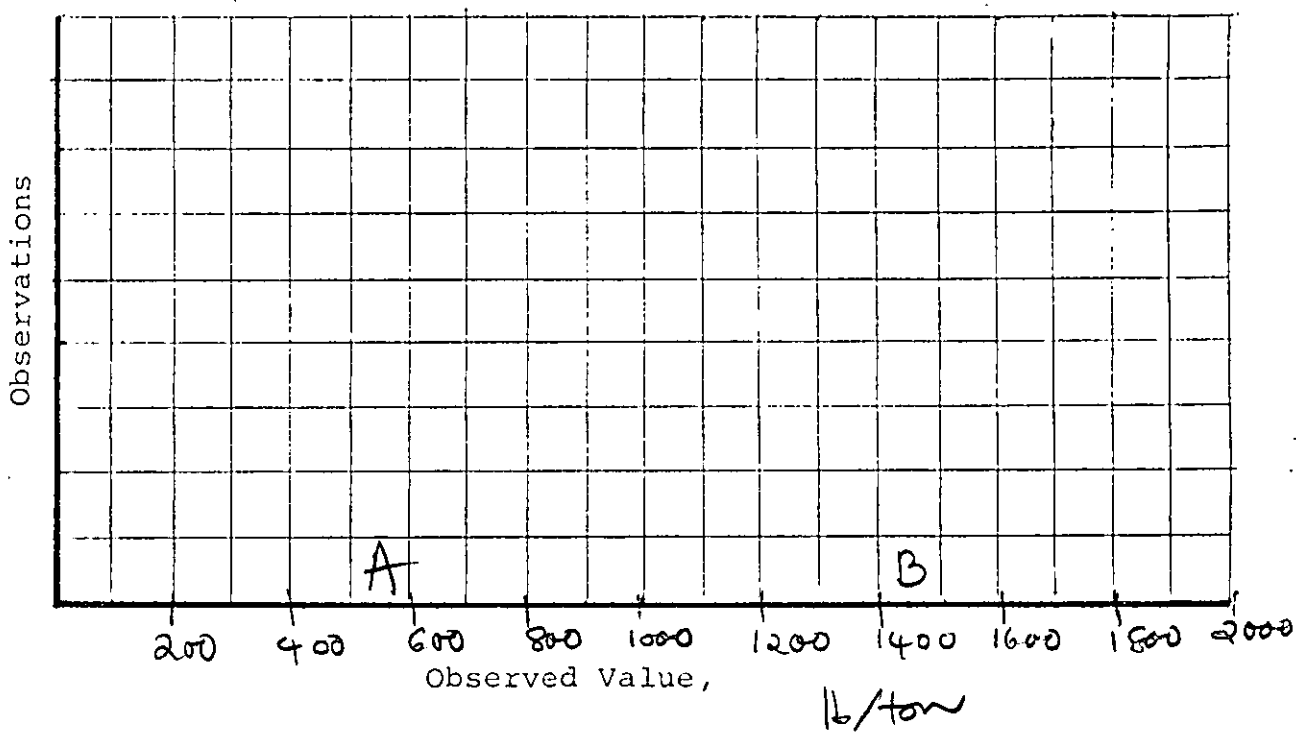
AP-42 Pg. No. 5.3-2

Observed values are:

☐ Test Data

☐ Engineering Analysis

☐ Material Balance



Observation	AP-42 Ref. No.	Observed Value
A	2 [b1]	542.21 lb/ton
	3	none
	5	none
	6	none
B	2 [b2]	1433.47 lb/ton

$\bar{x} = (542.21 + 1433.47)/2 = 987.84$ lb/ton

$\text{STD. DEV} = (\text{max} - \text{min})/d_2$

$= (1433.47 - 542.21)/1.13$

$= 788.72$

a) This reference is not available from ☐ PEDCo ☐ Public Library ☐ EPA

b_1 & b_2: see the attached yellow sheets artg. calculation of 'CO' from gas furnace.

Emission Factor 400 LB/TON

Process (SCC)

Pollutant HC FROM CARBON BLACK OIL FURNACE

AP-42 Pg. No. 5.3-2

Observed values are:

☐ Test Data

☐ Engineering Analysis

☐ Material Balance

Observations

Observed Value,

Observation	AP-42 Ref. No.	Observed Value
	2	In adquate data is given
	3	none
	5	none
	6	none

a) This reference is not available from ☐ PEDCo ☐ Public Library ☐ EPA

PRIORITY

Emission Factor 33500 LB/TON

Observed values are:

Process (SCC) ____________

☐ Test Data

Pollutant CO FROM CHANNEL PROCESS FOR CARBON BLACK PRODUCTION

☐ Engineering Analysis

AP-42 Pg. No. 5.3-1

☐ Material Balance

Observations

Observed Value,

Observation	AP-42 Ref. No.	Observed Value
	2	Inadquate data
	3	Inadquate data
	5	none
	6	none

a) This reference is not available from ☐ PEDCo ☐ Public Library ☐ EPA

Emission Factor NEGLIGIBLE

Process (SCC) CARBON BLACK

Pollutant CO FROM THERMAL PROCESS

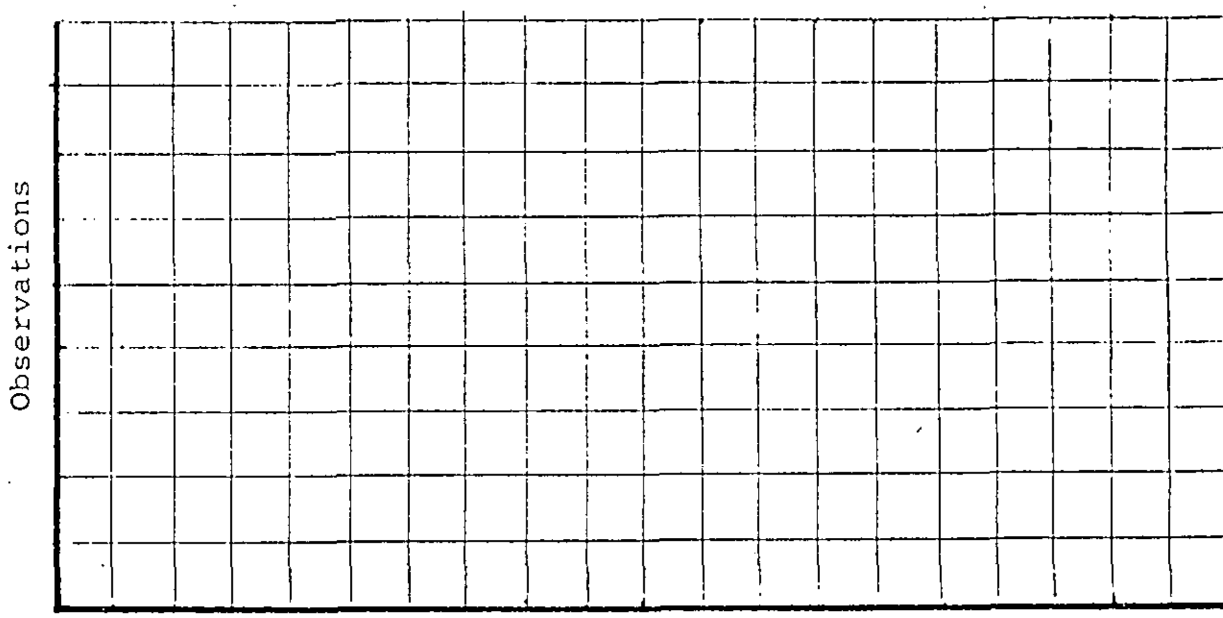
AP-42 Pg. No. 5.2-3

Observed values are:

☐ Test Data

☐ Engineering Analysis

☐ Material Balance



Observed Value,

Observation	AP-42 Ref. No.	Observed Value
	2	negligible
	3	None
	5	none
	6	none

a) This reference is not available from ☐ PEDCo ☐ Public Library ☐ EPA

PRIORITY

Emission Factor 5300 LB/TON

Process (SCC) ______

Pollutant CO FROM CARBON BLACK GAS FURNACE

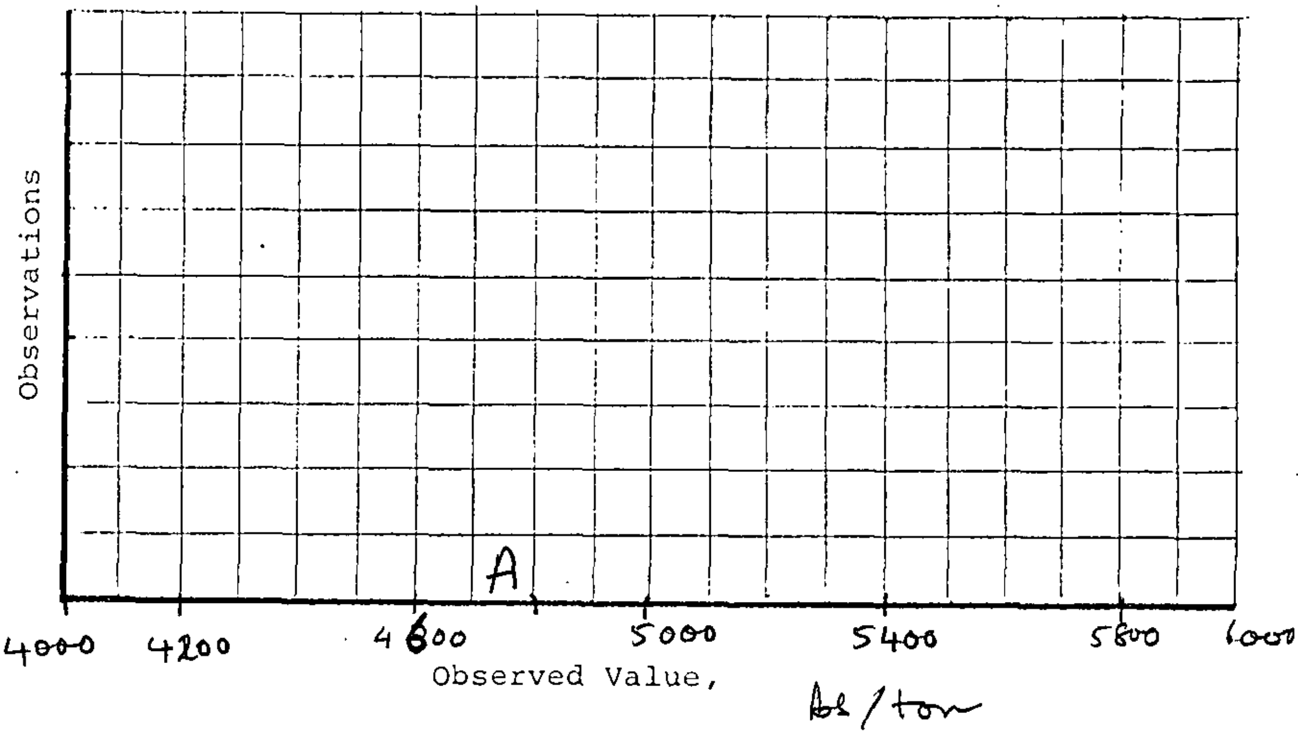
AP-42 Pg. No. 5.3-2

Observed values are:

☐ Test Data

☐ Engineering Analysis

☐ Material Balance



Observation	AP-42 Ref. No.	Observed Value
A	2[b1]	4744.33 lb/ton
	3	None
	5	none
	6	none
B	2[b2]	12542.88

$\bar{x}$ = 8643.61 lb/ton

STD-DEV = (MAX - MIN) / d_2

= (12542.88 - 4744.33) / 1.13

= 6900

a) This reference is not available from ☐ PEDCo ☐ Public Library ☐ EPA

b1) for producing larger particle size carbon black.

b2) for producing small particle size carbon black

b1, b2 : see attached [illegible]

①

Reference 2

· Gas furnace.

· Gas input = 560 ft³/min

Carbon content of natural 97% (assumed)

∴ Carbon entering

$$= 560 \frac{\cancel{ft^3}}{\cancel{min}} \times 0.97 \times \frac{12 \text{ lbs}}{383 \cancel{ft^3}} \times \frac{60 \text{ min}}{hr}$$

$$= \frac{560 \times .97 \times 12 \times 60}{383} = 1013.22 \frac{lbs}{hr}$$

yield = 25 to 30% (for longer particle size - furnace blow)

exit gas composition.

CO_2 = 5%

CO = 5%

H_2 = 17-18%

CH_4 = 1%

C_2H_2 = 1%

∴ Carbon content of exit gas

= 1013.22 (1 - 0.275)

= 734.59 lbs/hr.

$[(0.05 + 0.05 + 0.01) 12 + (0.01) 24] (x) / 387$

where x → exit gas rate ft³/hr

$$x = \frac{734.59 \times 387}{1.32 + .24} = 182,234.83 \; ft^3/hr$$

$$= \frac{182234.83}{1013.22 - 734.59} \frac{ft^3}{lbs\ prod} = 654.04 \frac{ft^3}{lbs\ prod}$$

$654.04 \times 2000 = 1308080 \ ft^3/\text{ton of prod}$

'CO' present in [illegible] gas

$$= \frac{0.05 \times 1308080 \times 28}{386} \ \frac{lbs}{ton}$$

$$= \underline{4744.33 \ lbs/ton}$$

'CH_4' present

$$= \frac{0.01 \times 1308080 \times 16}{386} = \underline{\underline{542.21}} \ lbs/ton$$

yield = 10 – 15% (for the smaller particle-size carbon black)

ave = 12.5 %

∴ carbon content of exit gas

$= 1013.22\,(1-0.125) = 886.38\ \frac{lbs}{hr.}$

i.e. the product = 126.84 lbs/hr.

∴ rate of exit gas

$= \frac{886.38 \times 386}{1.324.24}$

$= 219322.23\ ft^3/hr$

$= \frac{219322.23}{126.84} = 1729.13\ \frac{ft^3}{lb\ \text{pound}}$

$= 1729.13 \times 2000 = 3458250.24\ \frac{ft^3}{ton}$

∴ CO content $= \frac{0.05 \times 3458250.24 \times 28}{386}$

$= \underline{12542.88}$ lb/ton

CH_4 content $\frac{0.01 \times 3458250.24 \times 16}{386} = \underline{\underline{1433.47}}$ lb

PRIORITY

Emission Factor 4500 LB/TON

Observed values are:

☐ Test Data

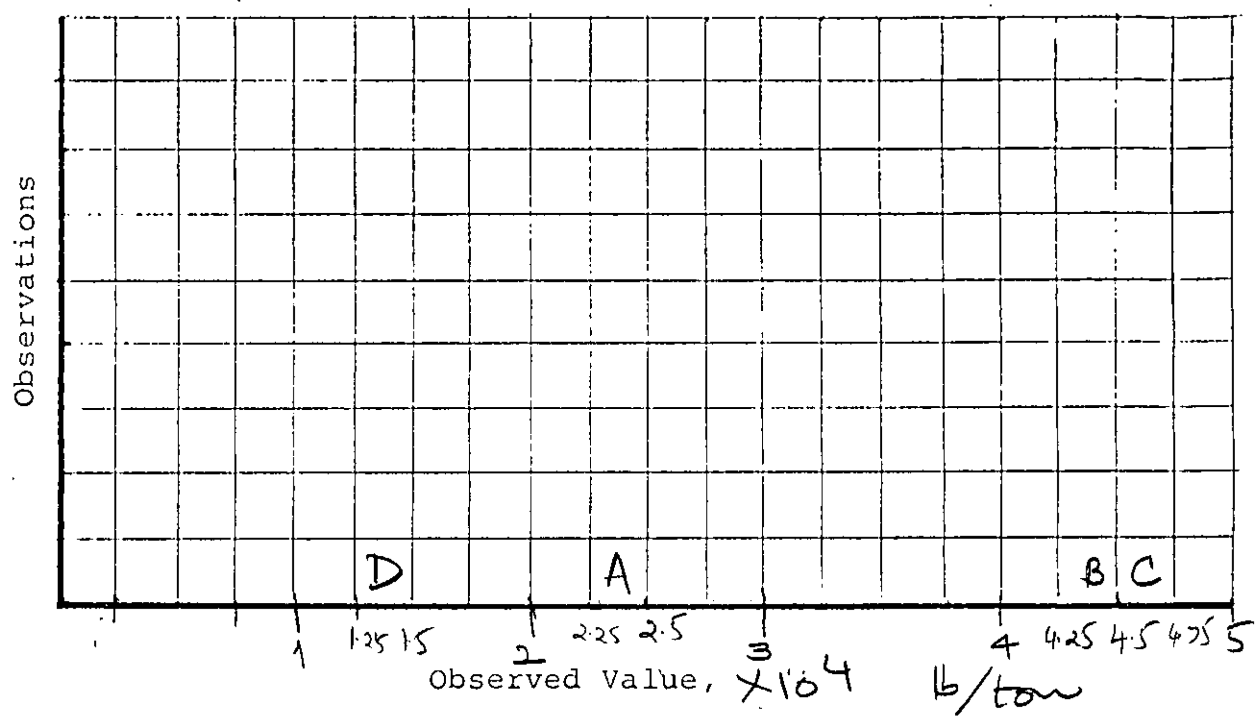
☐ Engineering Analysis

☐ Material Balance

Process (SCC) CARBON BLACK

Pollutant CO FROM OIL FURNACE

AP-42 Pg. No. 5.3-2



Observation	AP-42 Ref. No.	Observed Value
A	2	2.2700×10^4 lb/ton
	3	None
	5	none
	6	none
B	2	4.49×10^4 lbs/ton
C	2	4.7×10^4
D	2	1.317×10^4

$\bar{X} = 31942.5$ lb/ton

STD. DEV = (MAX − MIN)/d_2

$= (4.7 - 1.317) \times 10^4 / 2.06$

$= 1.64 \times 10^4$

a) This reference is not available from ☐ PEDCo ☐ Public Library ☐ EPA

Reference :-

<u>oil furnace</u>

1) oil input = 240 gl/hr

density = 7.1 $\frac{lb}{gal}$

$\therefore$ Input = $240 \frac{\cancel{gal}}{hr} \times 7.1 \frac{lb}{\cancel{gal}}$

= 1700 lbs/hr

Carbon Content of oil = 90%

i e 1700×0.9 = ~~15300~~ 1530 lbs C/hr entering

Conversion of carbon to carbon black is 55%

$\therefore$ Carbon black produced

= 1530 × 0.55 = 841.5 lbs/hr.

Rate of exhaust gas = 50,000 to 110,000 ft³/min

ave = $80,000 \frac{ft^3}{min} \times \frac{60\ min}{hr}$

$= 48 \times 10^5 \frac{ft^3}{hr}$

Composition of exhaust in %

CO_2	5
CO	5
H_2	17.~~5~~ 18
CH_4	1
C_2H_2	1
N_2	70 - 71

∴ 'CO' content of exhaust

$$0.05 \frac{\text{lb.}\cancel{\text{mole}}\text{ of CO}}{\text{lb.mole of exhaust}} \times \frac{28 \text{ lb of CO}}{\cancel{\text{lb.mole}}\text{ of CO}}$$

$$= 1.4 \text{ lb of CO/lb.mole of exhaust}$$

$$= 1.4 \frac{\text{lbs of CO}}{\cancel{\text{lb.mole of exhaust}}} \times \frac{1 \cancel{\text{lb.mole}}}{387 \cancel{ft^3}} \times \frac{48\times10^5 \cancel{ft^3}}{hr}$$

$$= \frac{1.4\times4.8}{3.87}\times10^4 \frac{\text{lbs of CO}}{hr} \times \frac{hr}{841.5 \text{ lbs of prod}} \times \frac{2000 \text{ lbs}}{\text{ton}}$$

$$= \frac{1.4\times4.8\times2}{3.87\times8.42}\times10^5 \frac{\text{lbs of CO}}{\text{ton of carbon black}}$$

$$= 4.13\times10^4 \frac{\text{lbs of CO}}{\text{ton of carbon black}}$$

2) oil input = 220 gal/hr

= 220 × 7.1 = 1562 lbs/hr

carbon content = 1562 × 0.9 = 1406 lbs/hr

Carbon black produced = 1406 × 0.55 = 773.2 lbs/hr

∴ lbs of CO per ton of carbon black produced.

$$= \frac{0.05\times28\times48\times10^5}{387} \times \frac{2000}{773.2} = 4.49\times10^4 \frac{\text{lbs CO}}{\text{ton}}$$

3) oil input = 210 gal/hr

∴ carbon black production

$= 210 \times 7.1 \times 0.9 \times 0.55 = 738.1$ lbs/hr

∴ 'CO' of exhaust gas

$= \frac{0.05 \times 28 \times 48 \times 10^5}{387} \times \frac{2000}{738.1} = 4.7 \times 10^4 \frac{\text{lbs of CO}}{\text{ton of carbon black}}$

4) oil input = 750 gal/hr

∴ Carbon black produced

$= 750 \times 7.1 \times 0.9 \times 0.55 = 2636 \frac{\text{lbs}}{\text{hr}}$

'CO' of exhaust gas

$= \frac{0.05 \times 28 \times 48 \times 10^5}{387} \times \frac{2000}{2636} = 13.17 \times 10^3 \frac{\text{lbs of CO}}{\text{ton}}$

THE ENVIRONMENTAL HEALTH ASSOCIATION
OF THE CARBON BLACK INDUSTRY, INC.

J. M. Huber Corporation
P. O. Box 2831
Borger, Texas 79008-2831

Airborne Express Mail

May 15, 1992

Mr. Dennis Beauregard
United States Environmental Protection Agency
Office of Air Quality Planning and Standards
Emission Inventory Branch
Research Triangle Park, NC 27711

Dear Mr. Beauregard:

You recently requested information from all U.S. carbon black manufacturers regarding emissions and controls for the furnace black process. The information will be used to update and revise the publication Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, otherwise known as AP-42. In accordance with our telephone conversation of April 1, 1992, this updated information would be provided by the Environmental Health Association of the Carbon Black Industry, a group composed of all U.S. carbon black manufacturers.

Attached is the subject information. It is a compilation of available data from all companies and is supplied in the same format as the existing AP-42 tables. The footnotes on the tables should provide all required information needed to understand the basis and derivation of the emission factors.

It should be noted that factors are supplied for three general categories of product grades. These are tread, carcass, and other (which includes all specialty grades). These categories cover essentially all the different types of furnace blacks manufactured. This approach provides a much better representation of actual emissions than combining all of these into a single table as they are currently portrayed.

As will be noted in Table 5.3-2, small quantities of benzene and cyanide (HCN) have been detected in the emissions of some of the manufacturers. These substances have never been listed before in the AP-42 tables. It should be noted, however, that these compounds have not been detected by all companies and the information supplied is based upon very limited data.

Additionally, the following corrections and modifications are offered for Section 5.3 of AP-42.

1) There is currently a typographical error on Figure 5.3-1 of AP-42. The oil storage tank vent gas stream is incorrectly labelled as stream 29. It should be corrected to read as stream 39, coincident with the description of this stream in Table 5.3-1.

2) Currently, Figures 5.3-1 illustrates a combined dryer vent gas, stream 37. However, in general, the industry does not combine their dryer vent gases. Rather, two separate emission points are typically used. These two emission points correspond to stream 27, dryer heat exhaust after bag filter, and stream 29, dryer indirect heat source vent. We suggest that Figure 5.3-1 be modified to more accurately reflect current industry practice by eliminating stream 37, and extending streams 27 and 29 independently as two emission points. Also, the third paragraph of text under Section 5.3.2.1, Oil Furnace Process, should be modified to read similar to the following:

> "The dryer heat exhaust after the bag filter (stream 27 in Figure 5.3-1) emits carbon black and other contaminants from the combustion of gases in the dryer. These contaminants include nitrogen oxides, sulfur oxides, and carbon monoxide. The dryer indirect heat source vent (stream 29 in Figure 5.3-1) emits contaminants from the combustion of the main process vent gas if the gas is used as supplementary fuel for the dryer, as well as contaminants from the combustion of impurities in the natural gas fuel. These contaminants include particulates, carbon monoxide, sulfur and nitrogen oxides, unburned organic compounds, and hydrogen sulfide..."

If you have any questions regarding this information, please contact me.

Sincerely,

Jimmy W. Boyd

Jimmy W. Boyd, P.E.
President of EHACBI

Company: All

13-May-92

10:58 AM

Table 5.3-2. EMISSION FACTORS FOR CHEMICAL SUBSTANCES FROM OIL FURNACE CARBON BLACK MANUFACTURE (a)

	Main Process Vent Gas					
	Carcass (b)		Tread (c)		Other (d)	
Chemical Substance	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton
Carbon disulfide	4.85 (0.13-15)	9.70 (0.25-30)	7.65 (1.2-21.64)	15.30 (2.4-43.28)	9.65 (4.88-18.39)	19.29 (9.75-36.77)
Carbonyl sulfide	1.45 (0.039-3.35)	2.91 (0.078-6.69)	2.39 (0.55-5.24)	4.79 (1.1-10.48)	2.56 (0.91-4.92)	5.11 (1.82-9.84)
Methane	30.13 (24.38-36.26)	60.26 (48.75-72.52)	21.75 (3.01-40)	43.50 (6.02-79)	18.94 (0.00-42.87)	37.88 (0.00-85.74)
Nonmethane VOC						
Acetylene	17.89 (0.62-59)	35.78 (1.23-117)	24.16 (0.20-109.92)	48.33 (0.39-219.94)	9.45 (0.00-104.37)	18.90 (0.00-208.73)
Ethane						
Ethylene	3.39 (2.62-4.15)	6.77 (5.24-8.29)	1.97 (0.19-3.11)	3.94 (0.37-6.22)		
Propylene						
Propane						
Isobutane						
n-Butane						
n-Pentane						
Benzene	0.019 (0.003-0.043)	0.038 (0.005-0.085)	0.032 (0.025-0.038)	0.063 (0.049-0.076)		
Cyanide (HCN)	1.88 (0.02-3.7)	3.77 (0.04-7.3)	1.79 (0.03-3.7)	3.58 (0.06-7.4)		
POM						
Trace Elements						

Footnotes:

a) Expressed in terms of weight of emissions per unit weight of carbon black produced. Shaded areas indicate no new information.

b) Average values based on a survey of a total of 22 sampling runs at 11 process trains throughout the carbon black industry from February, 1983 through January, 1991. Ranges incorporate the minimum through maximum values obtained during the sampling runs. All runs did not necessarily analyze for all species indicated.

c) Average values based on a survey of a total of 29 sampling runs at 13 process trains throughout the carbon black industry from March, 1984 through July, 1991. Ranges incorporate the minimum through maximum values obtained during the sampling runs. All runs did not necessarily analyze for all species indicated.

d) Average values based on a survey of a total of 16 sampling runs at 8 process trains throughout the carbon black industry from April, 1984 through August, 1991. Ranges incorporate the minimum through maximum values obtained during the sampling runs. All runs did not necessarily analyze for all species indicated.

COMPANY NUMBER: All

13-May-92

11:01 AM

Table 5.3-3. EMISSION FACTORS FOR CARBON BLACK MANUFACTURE (a)

EMISSION FACTOR RATING: C

Process	Particulate (b)		Carbon Monoxide		Nitrogen Oxides		Sulfur Oxides		Methane		Nonmethane VOC (c)		Hydrogen Sulfide (d)	
	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton
Oil Furnace Process – Carcass Main Process Vent (e) (11)	0.08 (0.015–0.13)	0.16 (0.03–0.25)	882 (93.8–1994)	1763 (197.5–3988)	0.32 (0.005–2.77)	0.64 (0.01–5.53)	0.89 (0.034–3.90)	1.78 (0.067–7.79)	30.13 (24.38–36.26)	60.26 (48.75–72.52)	18.45 (0.62–59)	36.91 (1.23–117)	13.15 (0.13–38) (0.06S–10.5S)	26.29 (0.25–76) (0.12S–20.9S)
Flare														
Boilers: (i) Cogen Vent	0.25	0.49	1.46	2.91	2.38	4.76	52.34	104.67	NA	NA	NA	NA	NA	NA
Dryer Heat Exhaust After Bag Filter (f) (27)	0.17	0.34	1.73	3.45	0.27	0.54	0.83	1.65	NA	NA	NA	NA	NA	NA
Dryer Indirect Heat Source Vent (g) (29)	0.27 (0.16–0.43)	0.53 (0.32–0.86)	5.42 (0.108–12.50)	10.85 (0.216–24.99)	0.84 (0.464–1.41)	1.68 (0.928–2.82)	14.46 (19.50–27.27)	28.92 (39.00–54.53)	NA	NA	0.05 (0.04–0.06)	0.10 (0.08–0.11)	0.08 (0.07–0.13)	0.15 (0.13–0.26)
Scrubber														
Pneumatic System Vent Bag Filter (19)														
Oil Storage Tank Vent Uncontrolled (39)														
Vacuum Cleanup System Vent Bag Filter (36)														
Fugitive Emissions (38)														
Solid Waste Incinerator														
Wt. % Sulfur in Feed	1.24–3.8 %													

COMPANY NUMBER: All
13-May-92
11:01 AM

Table 5.3-3. EMISSION FACTORS FOR CARBON BLACK MANUFACTURE (a)

EMISSION FACTOR RATING: C

Process	Particulate (b)		Carbon Monoxide		Nitrogen Oxides		Sulfur Oxides		Methane		Nonmethane VOC (c)		Hydrogen Sulfide (d)	
	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton
Oil Furnace Process – Tread Main Process Vent (h) (11)	3.49 (0.03–16.38)	6.98 (0.06–32.75)	855 (236.9–2586)	1710 (473.8–5171)	1.06 (0.0–5.62)	2.13 (0.0–11.23)	2.23 (0.0–18.86)	4.47 (0.0–37.71)	21.75 (3.01–40)	43.50 (6.02–79)	24.66 (0.20–109.92)	49.31 (0.39–219.94)	12.12 (0.25–56.47) (0.12S–25.0S)	24.23 (0.50–112.94) (0.24S–50.0S)
Flare														
Boilers: (i) Cogen Vent	0.97	1.94	5.51	11.01	1.91	3.81	27.54	55.07	0.34	0.67	ND	ND	1.96	3.92
Process Vent	0.17	0.33	NA	NA	0.35	0.70	3.91	7.81	NA	NA	NA	NA	0.11	0.22
Dryer Heat Exhaust After Bag Filter (j) (27)	1.66 (0.06–6.31)	3.32 (0.11–12.62)	1.86	3.72	0.24 (0.05–0.434)	0.48 (0.10–0.868)	1.08 (0.40–1.76)	2.16 (0.80–3.51)	NA	NA	NA	NA	ND	ND
Dryer Indirect Heat Source Vent (k) (29)	0.49 (0.19–1.10)	0.98 (0.38–2.19)	3.87 (ND–12.50)	7.74 (ND–24.99)	0.94 (0.39–1.45)	1.87 (0.77–2.90)	11.03 (4.00–27.27)	22.06 (7.99–54.53)	NA	NA	0.05 (0.04–0.06)	0.10 (0.08–0.11)	0.07 (0.01–0.16)	0.14 (0.02–0.31)
Scrubber														
Pneumatic System Vent Bag Filter (i) (19)	0.06	0.11	NA	NA	0.06	0.12	0.35	0.69	NA	NA	NA	NA	NA	NA
Oil Storage Tank Vent Uncontrolled (39)														
Vacuum Cleanup System Vent Bag Filter (36)														
Fugitive Emissions (38)														
Solid Waste Incinerator														
Wt. % Sulfur in Feed	0.7–3.8 %													

COMPANY NUMBER: All

13-May-92

11:01 AM

Table 5.3-3. EMISSION FACTORS FOR CARBON BLACK MANUFACTURE (a)

EMISSION FACTOR RATING: C

Process	Particulate (b)		Carbon Monoxide		Nitrogen Oxides		Sulfur Oxides		Methane		Nonmethane VOC (c)		Hydrogen Sulfide (d)	
	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton
Oil Furnace Process – Other														
Main Process Vent (l) (11)	0.24	0.47	2083 (239–19953)	4165 (477–39906)	1.91 (0.015–33.04)	3.83 (0.03–66.08)	8.56 (0.18–127.32)	17.12 (0.35–254.64)	18.94 (0.0–42.87)	37.88 (0.0–85.74)	9.45 (0.0–104.37)	18.90 (0.0–208.73)	18.64 (0.13–264.82) (0.045S–212S)	37.28 (0.26–529.64) (0.090S–424S)
Flare														
CO Boiler and Incinerator (13)														
Dryer Heat Exhaust After Bag Filter (27)														
Dryer Indirect Heat Source Vent (m) (29)	0.37 (0.31–0.43)	0.74 (0.61–0.86)	10.74 (8.98–12.50)	21.48 (17.96–24.99)	1.22 (1.02–1.41)	2.43 (2.03–2.82)	23.43 (19.60–27.27)	46.86 (39.19–54.53)	NA	NA	0.05 (0.04–0.06)	0.10 (0.08–0.11)	0.08 (0.047–0.09)	0.15 (0.13–0.17)
Scrubber														
Pneumatic System Vent Bag Filter (19)														
Oil Storage Tank Vent Uncontrolled (39)														
Vacuum Cleanup System Vent Bag Filter (36)														
Fugitive Emissions (38)														
Solid Waste Incinerator														
Wt. % Sulfur in Feed	1.97–2.9 %													