A-79-55

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AMMONIUM NITRATE
AP-42 Section 6.8
Reference Number
5

# EMISSION TESTS FOR PARTICULATES

COMINCO AMERICAN
BEATRICE, NEBRASKA

K. P. BROCKMAN

1974

Commonwealth American

MEMORANDUM

To Manager, Homestead Operations (GLC)
General Superintendent (LEW) Date February 27, 1974

From Plant Chemist (KPB) File No.

Subject: Particulates - Granulation Stack Page 2 Ref.

RUN #1

After preliminary testing of equipment, the first run was started at 10:45AM on January 30, 1974. The test was completed at 2:17PM.

Summary of the data taken:

| | | | |
|---|---|---|---|
| 1) | Ambient temperature | | 51°F. |
| 2) | Barometric pressure | | 28.44 inch of Hg |
| 3) | Assumed moisture | | 8% |
| 4) | Traverse points | | 44 points |
| 5) | Sampling time each point | | 3 minutes |
| 6) | Static pressure Ps | | 0.40 inches $H_2O$ |
| 7) | Stack temperature | | 115.5°F. |
| 8) | Velocity $\triangle$Ps | | 0.42 inches $H_2O$ |
| 9) | Pressure differential across orifice meter $\triangle$H | | 1.78 inch $H_2O$ ave. |
| 10) | Gas sampled volume (meter conditions) | | 96.6 $ft.^3$ |
| 11) | Gas temperature at dry gas meter (inlet) | | 102.2°F. |
| 12) | Gas temperature at dry gas meter (outlet) | | 81.5°F. |
| 13) | Gas temperature at dry gas meter (average) | | 91.8°F. |
| 14) | Sample box temperature (approximate average) | | 230°F. |
| 15) | Mls $H_2O$ collected (impingers) | Data sheet #1 | 202.4 mls |
| 16) | Acetone washings (oven dried) | Data sheet #2 | 270.3 milgms |
| 17) | Filter papers (5) (oven dried) | Data sheet #2 | 87.2 milgms |
| 18) | 83% feed to unit (calculated) | | 34.38 TPH |

Results from calculation sheet #1 are:

| | | | | |
|---|---|---|---|---|
| 1) | Volume of dry gas (standard condition) | $Vm_{std}$ | = | 88.5 $ft.^3$ |
| 2) | Volume of water vapor | $V_{1_{gas}}$ | = | 9.6 $ft.^3$ |
| 3) | % moisture in stack gas | Bo | = | 9.77% |
| 4) | Mole fraction of dry gas | Ndg | = | 0.9023 |
| 5) | Molecular weight of stack gas | Mg | = | 27.90 $\frac{lb}{lb\text{-mole}}$ |
| 6) | Stack gas velocity | Vw | = | 2345 FPM |
| 7) | Stack gas volume | $O_2$ | = | 117,780 SCFM |
| 8) | % Isokinetic | I | = | 106.5% |
| 9) | Concentration milgrams/SCF | $C_{std}$ | = | 4.035 $\frac{milgms}{SCF}$ |
| 10) | Particulate (P) | lbs/hr | = | 62.8 lbs |
| 11) | Process rate tons/hour | TPH | = | 34.38 Tons |

Signed

Continued . . . .

Commonwealth

MEMORANDUM

To Manager, Homestead Operations (GLC)
General Superintendent (LEW) Date February 27, 1974

From Plant Chemist (KPB) File No.

Subject: Particulates - Granulation Stack Page 3 Ref.

RUN #2

The second run was made on January 31, 1974. Data obtained from the first analyses was used to set up the equipment for the second test. This test was started at 9:49AM and completed at 1:12PM.

Summary of the data taken:

| | | |
|---|---|---|
| 1) | Ambient temperature | 15°F. |
| 2) | Barometric pressure | 28.95 inch of Hg |
| 3) | Assumed moisture | 9% |
| 4) | Traverse points | 44 points |
| 5) | Sampling time (each point) | 3 minutes |
| 6) | Static pressure Ps | 0.37 inch of $H_2O$ |
| 7) | Stack temperature | 110°F. |
| 8) | Velocity $\triangle$ Ps | 0.43 inch of $H_2O$ |
| 9) | Pressure differential across orifice meter | 1.72 inches of $H_2O$ |
| 10) | Gas sampled volume (metered conditions) | 96.605 ft.$^3$ |
| 11) | Gas temperature at dry gas meter (inlet) | 107.27°F. |
| 12) | Gas temperature at dry gas meter (outlet) | 84.21°F. |
| 13) | Gas temperature at dry gas meter (average) | 95.73°F. |
| 14) | Sample box temperature (approximate average) | 250°F. |
| 15) | Mls $H_2O$ collected (impingers) Data sheet #1 | 188.5 mls |
| 16) | Acetone washings (oven dried) Data sheet #2 | 189.6 milgms |
| 17) | Filter papers (4) (oven dried) Data sheet #2 | 40.8 milgms |
| 18) | 83% feed to unit (calculated) | 35.76 TPH |

Results from calculation sheet #2 are:

| | | | |
|---|---|---|---|
| 1) | Volume of dry gas (standard conditions) | $Vm_{std}$ | = 89.43 ft.$^3$ |
| 2) | Volume of water vapor | $V_{1\,gas}$ | = 8.93 ft.$^3$ |
| 3) | % moisture in stack gas | Bo | = 9.08% |
| 4) | Mole fraction of dry gas | Ndg | = 0.9092 |
| 5) | Molecular weight of stack gas | Mg | = 27.97 $\frac{lb}{lb\text{-}mole}$ |
| 6) | Stack gas velocity | Vw | = 2225 FPM |
| 7) | Stack gas volume | $O_2w$ | = 115,683 SCFM |
| 8) | % Isokinetic | I | = 109.0% |
| 9) | Concentration milgrams/SCF | $C_{std}$ | = 2.576 $\frac{milgms}{SCF}$ |
| 10) | Particulate (P) | lbs/hr | = 39.42 lbs |
| 11) | Process rate tons/hour | TPH | = 35.76 Tons |

Signed Continued . . . .

Cominco American

MEMORANDUM

To Manager, Homestead Operations (GLC)
General Superintendent (LEW) Date February 27, 1974

From Plant Chemist (KPB) File No.

Subject: Particulates - Granulation Stack Page 4 Ref.

RUN #3

The third run started as soon as possible after the second run was completed. It was necessary to complete this test in a minimum length of time due tothe natural gas curtailment which makes it necessary to shut down granulation. The run was started at 3:04PM and completed at 5:45PM.

Summary of the data taken:

| | | |
|---|---|---|
| 1) | Ambient temperature | 21°F. |
| 2) | Barometric pressure | 28.95 inch of Hg |
| 3) | Assumed moisture | 9% |
| 4) | Traverse points | 44 points |
| 5) | Sampling time (each point) | 3 minutes |
| 6) | Static pressure Ps | 0.37 in. of $H_2O$ |
| 7) | Stack temperature | 110°F. |
| 8) | Velocity $\Delta$Ps | 0.45 inch of $H_2O$ |
| 9) | Pressure differential | 1.74 inches of $H_2O$ |
| 10) | Gas sampled volume (metered conditions) | 97.995 $ft.^3$ |
| 11) | Gas temperature at dry gas meter (inlet) | 110.58°F. |
| 12) | Gas temperature at dry gas meter (outlet) | 88.04°F. |
| 13) | Gas temperature at dry gas meter (average) | 93.30°F. |
| 14) | Sample box temperature (approximate average) | 275°F. |
| 15) | Mls $H_2O$ collected (impingers) Data sheet #1 | 182.3 mls |
| 16) | Acetone washings (oven dried) Data sheet #3 | 40.5 milgms |
| 17) | Filter papers (5) (oven dried) Data sheet #3 | 122.1 milgms |
| 18) | 83% feed to unit (calculated) | 35.96 |

Results from calculation sheet #3 are:

| | | | |
|---|---|---|---|
| 1) | Volume of dry gas (standard conditions) | Vm | = 90.18 $ft.^3$ |
| 2) | Volume of water vapor | $V_{1\,gas}$ | = 8.64 $ft.^3$ |
| 3) | % moisture in stack gas | Bo | = 8.74% |
| 4) | Mole fraction of dry gas | Ndg | = 0.9126 |
| 5) | Molecular weight of dry gas | Mg | = 28.01 $\frac{lb}{lb\text{-}mole}$ |
| 6) | Stack gas velocity | Vw | = 2223 FPM |
| 7) | Stack gas volume | $O_2w$ | = 116,009 SCFM |
| 8) | % Isokinetic | I | = 110% |
| 9) | Concentration (milgram/SCF) | $C_{std}$ | = 1.803 $\frac{milgm}{SCF}$ |
| 10) | Particulate (P) | lbs/hr | = 27.66 $\frac{lbs}{hour}$ |
| 11) | Process rate tons/hour | TPH | = 35.96 Tons |

Signed Continued . . . .

Dominion American

MEMORANDUM

To Manager, Homestead Operations (GLC)
General Superintendent (LEW) Date February 27, 1974

From Plant Chemist File No.

Subject: Particulates - Granulation Stack Page 5 Ref.

Results

Test #1 January 30, 1974

At a process rate of 34.38 TPH; the allowable emission rate is 41.35 pounds per hour and the tests indicate a particulate emission of 62.86 lbs/hour.

Test #2 January 31, 1974

The process rate during this test run was 35.76 TPH and the allowable emission rate is 41.51 pounds per hour. The tests indicate a particulate emission of 39.42 pounds/hour.

Test #3 January 31, 1974

The process rate during the third test was 35.96 TPH and the allowable emission rate is 41.57 pounds per hour. The tests indicate a particulate emission of 27.66 pounds/hour.

Emission rates were calculated by the following formula from the Federal Register, Paragraph 52.1432 Control Strategy.

$$E = 55.0 \times P^{0.11} - 40 \qquad P > 30 \text{ tons/hour}$$

Mr. Giar and Mr. Kelly contributed much in helping us develop a good sampling technique. The second and third test runs were made under better and much more reliable testing conditions. For the above reason, this writer feels that the results of the first test run may indicate a higher than actual particulate emission from the stack.

The sampling point and the rails appeared to be very satisfactory for the testing procedure.

Enclosures - 1) 3 Data Sheets
2) 3 Calculation Sheets
3) 6 Raw Data Sheets
4) 2 Feed Rate Data Sheets

KPB:jh

Signed Kenneth P. Brockman
Kenneth P. Brockman

Cominco American Incorporated
Homestead Plant

## List of Symbols

An = nozzle area, sq. in.

As = stack area, sq. in.

Bo = moisture in stack gas, % by volume

$C_{std}$ = particulate total @ std. cond., milgrams/SCF

Cp = Pitot tube coefficient

$\Delta H$ = orifice pressure drop, in. $H_2O$

Mn = total particulate, mg

$Mdg_w$ = ave. molecular wt. of dry stack gas, lb/lb-mole

Mg = molecular weight of stack gas, lb/lb-mole

Ndg = mole fraction dry gas

$\Delta P$ = velocity head of stack gas during test, in. $H_2O$

$P_{bar}$ = barometric pressure druing test, in. Hg absolute

$P_{s_w}$ = stack pressure, in. Hg absolute

$\Delta P_w$ = velocity head of stack gas, in. $H_2O$

$\theta$ = net time of test, min.

$T_m$ = average meter temperature, $^oF.$

$T_s$ = average stack temp. during test, $^oF.$

$T_{s_w}$ = stack temperature, $^oF.$

$V_1$ = total $H_2O$ collected, ml

$V_{1_{gas}}$ = volume of water vapor collected @ std. cond., SCF

$V_m$ = dry gas sample volume @ meter conditions, CF

$V_{m_{std}}$ = dry gas sample volume @ std. cond., SCF

$V_w$ = stack gas velocity, FPM

KPB:jh

Analytical Data Sheet
#1

Run #1

| Impingers | #1 | #2 | #3 | #4 |
|---|---|---|---|---|
| Final wt. | 738.8 | 596.6 | 477.0 | 695.2 |
| Tare wt. | 570.5 | 581.4 | 474.0 | 679.2 |
| Grams $H_2O$ Collected | 168.3 | 15.2 | 3.0 | 15.9 |

Total mls $H_2O$ collected = 202.4 mls

Run #2

| Impingers | #1 | #2 | #3 | #4 |
|---|---|---|---|---|
| Final wt. | 714.4 | 600.7 | 477.9 | 700.7 |
| Tare wt. | 570.5 | 581.4 | 474.0 | 679.3 |
| Grams $H_2O$ Collected | 143.9 | 19.3 | 3.9 | 21.4 |

Total mls $H_2O$ collected = 188.5 mls

Run #3

| Impingers | #1 | #2* | #3 | #4 |
|---|---|---|---|---|
| Final wt. | 761.8 | 551.3 | 480.0 | 698.8 |
| Tare wt. | 575.9 | 580.6 | 473.9 | 679.2 |
| Grams $H_2O$ Collected | 185.9 | -29.3 | 6.1 | 19.6 |

Total mls $H_2O$ collected = 182.3 mls

*Some of the initial water in impinger #2 was siphoned into impinger #1 during the 'leak check' of the equipment before any sampling started.

KPB:jh

Analytical Data Sheet
#2

Run #1

Filter Paper

| Filter paper | #1 | #2 | #3 | #4 | #5 |
|---|---|---|---|---|---|
| Final wt. | 0.2717 | 0.2485 | 0.2750 | 0.2662 | 0.2296 |
| Tare wt. | 0.2458 | 0.2307 | 0.2509 | 0.2479 | 0.2285 |
| Gain | 0.0259 | 0.0178 | 0.0241 | 0.0183 | 0.0011 |

Total milligrams collected = 87.2

Acetone Washing

| | Washings | Blank |
|---|---|---|
| Final weight | 77.4950 gms | 77.9659 gms |
| Tare weight | 77.2227 gms | 77.9630 gms |
| Gain | 0.2723 gms | 0.0020 gms |

Acetone washings = 0.2723 - 0.0020 = 0.2703 grams

Run #2

Filter Paper

| Filter Paper | #1 | #2 | #3 | #4 |
|---|---|---|---|---|
| Final wt. | 0.2333 | 0.2726 | 0.2668 | 0.2340 |
| Tare wt. | 0.2322 | 0.2496 | 0.2513 | 0.2328 |
| Gain | 0.0011 | 0.0230 | 0.0155 | 0.0012 |

Total milligrams collected = 40.8

Acetone Washing

| | Washings | Blank |
|---|---|---|
| Final weight | 156.6961 grams | 158.7504 grams |
| Tare weight | 156.5042 grams | 158.7481 grams |
| Gain | 0.1919 grams | 0.0023 grams |

Acetone washings = 0.1919 - 0.0023 = 0.1896 grams

KPB:jh

Analytical Data Sheet
#3

Run #3

Filter Paper

| Filter Paper | #1 | #2 | #3 | #4 | #5 |
|---|---|---|---|---|---|
| Final wt. gms | 0.2766 | 0.2732 | 0.2638 | 0.2560 | 0.2620 |
| Tare wt. gms | 0.2499 | 0.2468 | 0.2310 | 0.2340 | 0.2478 |
| Gain gms | 0.0267 | 0.0264 | 0.0328 | 0.0220 | 0.0142 |

Total milligrams collected = 122.1

Acetone Washing

| | Washings | Blank |
|---|---|---|
| Final weight | 163.6561 grams | 158.7504 grams |
| Tare weight | 163.6133 grams | 158.7481 grams |
| Gain | 0.0428 grams | 0.0023 grams |

Acetone washings = 0.0428 - 0.0023 = 0.0405 grams

KPB:jh

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Calculations #1

1. Volume of dry gas sampled @ standard conditions

$V_m$ = 96.6 ft.$^3$

$P_{bar}$ = 28.43 in. Hg

$\Delta H$ = 1.79 in. $H_2O$

$T_m$ = 91.8 °F.

$V_1$ = 202.4 ml

$$V_{m_{std}} = \frac{17.7 \times V_m \left(P_{bar} + \frac{\Delta H}{13.6}\right)}{T_m + 460} = 88.5 \text{ SCF}$$

2. Volume of water vapor @ standard conditions

$$V_{1_{gas}} = .0474 \times V_1 = 9.6 \text{ CF}$$

3. % moisture in stack gas

$$Bo = \frac{100 \times V_{1_{gas}}}{V_{m_{std}} + V_{1_{gas}}} = 9.77 \%$$

4. Mole fraction of dry gas

$$Ndg = \frac{100 - Bo}{100} = 0.9023$$

5. Molecular weight of stack gas (includes moisture)

$Mdg_w$ = 28.97

$$Mg = Mdg_w \times Ndg + 18\ (1-Ndg) = 27.90 \text{ lb/lb-mole}$$

6. Stack gas velocity @ stack conditions

Cp = 0.85

$T_{s_w}$ = 115 °F.

$\Delta P_w$ = 0.40 in. $H_2O$

$$v_w = 5128. \times Cp \sqrt{\frac{(T_{s_w} + 460) \times (\Delta P_w)}{P_{s_w} \times Mg}} = 2345 \text{ FPM}$$

7. Stack gas volume @ standard conditions, dry

$P_{s_w}$ = 28.41 in. Hg

$A_s$ = 9160 in.$^2$

$$Q_w = \frac{.123 \times v_w \times As \times Ndg \times P_{s_w}}{T_{s_w} + 460} = 117,780 \text{ SCFM}$$

8. % Isokinetic

$$I = \frac{(T_s+460)\left(.00267 \times V_1 + \frac{V_m}{(T_m + 460)}\left(P_{bar} + \frac{\Delta H}{13.6}\right)\right)}{\theta \times v_w \times P_{s_w} \times An} \times 1.44 \times 10^4 = 106.5 \%$$

9. $C_{std} = \frac{Mn}{V_{m_{std}}} = 4.035$

Mn = 357.5 mil gms

10. lbs/hr = $C_{std} \times 2.2046 \times 10^{-6} \times Qw \times 60$ = 62.8

11. TPH = $\frac{\text{(Initial reading) - (final reading) x .005713 tons/count}}{\text{Hours}}$ = 34.38

KPB:jh

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## Calculations #2

1. Volume of dry gas sampled @ standard conditions

$$V_{m_{std}} = \frac{17.7 \times V_m \left(P_{bar} + \frac{\Delta H}{13.6}\right)}{T_m + 460} = \underline{89.43} \text{ SCF}$$

$V_m$ = 96.605 ft.$^3$
$P_{bar}$ = 28.95 in. Hg
$\Delta H$ = 1.7205 in. $H_2O$
$T_m$ = 95.73 °F.

2. Volume of water vapor @ standard conditions

$$V_{l_{gas}} = .0474 \times V_l = \underline{8.93} \text{ CF}$$

$V_l$ = 188.5 ml

3. % moisture in stack gas

$$Bo = \frac{100 \times V_{l_{gas}}}{V_{m_{std}} + V_{l_{gas}}} = \underline{9.08} \%$$

4. Mole fraction of dry gas

$$Ndg = \frac{100 - Bo}{100} = \underline{0.9092}$$

5. Molecular weight of stack gas (includes moisture)

$Mdg_w$ = 28.97

$$Mg = Mdg_w \times Ndg + 18\ (1-Ndg) = \underline{27.97} \text{ lb/lb-mole}$$

6. Stack gas velocity @ stack conditions

Cp = 0.85

$$v_w = 5128. \times Cp \sqrt{\frac{(T_{s_w} + 460) \times (\Delta P_w)}{P_{s_w} \times Mg}} = \underline{2225} \text{ FPM}$$

$T_{s_w}$ = 110 °F.
$\Delta P_w$ = 0.37 in. $H_2O$

7. Stack gas volume @ standard conditions, dry

$$Q_w = \frac{.123 \times v_w \times As \times Ndg \times P_{s_w}}{T_{s_w} + 460} = \underline{115,683} \text{ SCFM}$$

$P_{s_w}$ = 28.97 in. Hg
$A_s$ = 9160 in.$^2$

8. % Isokinetic

$$I = \frac{(T_s + 460)\left(.00267 \times V_l + \frac{V_m}{(T_m + 460)}\left(P_{bar} + \frac{\Delta H}{13.6}\right)\right)}{\theta \times v_w \times P_{s_w} \times An} \times 1.44 \times 10^4 = \underline{109} \%$$

9. $C_{std} = \frac{Mn}{V_{m_{std}}} = \underline{2.576}$

Mn = 23.04 mil gms

10. lbs/hr = $C_{std} \times 2.2046 \times 10^{-6} \times Qw \times 60$ = 39.42

11. TPH = $\frac{\text{(Initial reading) - (final reading) x .005713 tons/count}}{\text{Hours}}$ = 35.76

KPB:jh

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## Calculations #3

1. Volume of dry gas sampled @ standard conditions

$$V_{m_{std}} = \frac{17.7 \times V_m \left(P_{bar} + \frac{\Delta H}{13.6}\right)}{T_m + 460} = \underline{\quad 90.18 \quad} \text{ SCF}$$

$V_m$ = 97.995 ft.$^3$
$P_{bar}$ = 28.95 in. H
$\Delta H$ = 1.74 in. $H_2O$
$T_m$ = 99.3 $^oF$.

2. Volume of water vapor @ standard conditions

$$V_{1_{gas}} = .0474 \times V_1 = \underline{\quad 8.64 \quad} \text{ CF}$$

$V_1$ = 182.3 ml

3. % moisture in stack gas

$$Bo = \frac{100 \times V_{1_{gas}}}{V_{m_{std}} + V_{1_{gas}}} = \underline{\quad 8.74 \quad} \%$$

4. Mole fraction of dry gas

$$Ndg = \frac{100 - Bo}{100} = \underline{\quad 0.9126 \quad}$$

5. Molecular weight of stack gas (includes moisture)

$Mdg_w$ = 28.97

$$Mg = Mdg_w \times Ndg + 18\ (1-Ndg) = \underline{\quad 28.011 \quad} \text{ lb/lb-mole}$$

6. Stack gas velocity @ stack conditions

Cp = 0.85

$$v_w = 5128. \times Cp \sqrt{\frac{(T_{s_w} + 460) \times (\Delta P_w)}{P_{s_w} \times Mg}} = \underline{\quad 2223 \quad} \text{ FPM}$$

$T_{s_w}$ = 110 $^oF$.
$\Delta P_w$ = 0.37 in. $H_2O$
$P_{s_w}$ = 28.92 in. Hg

7. Stack gas volume @ standard conditions, dry

$$Q_w = \frac{.123 \times v_w \times As \times Ndg \times P_{s_w}}{T_{s_w} + 460} = \underline{\quad 116,009 \quad} \text{ SCFM}$$

$A_s$ = 9160 in.$^2$

8. % Isokinetic

$$I = \frac{(T_s + 460)\left(.00267 \times V_1 + \frac{V_m}{(T_m + 460)}\left(P_{bar} + \frac{\Delta H}{13.6}\right)\right)}{\theta \times v_w \times P_{s_w} \times An} \times 1.44 \times 10^4 = \underline{\quad 110 \quad} \%$$

9. $C_{std} = \frac{Mn}{V_{m_{std}}} = \underline{\quad 1.803 \quad}$

Mn = 162.6

10. lbs/hr = $C_{std} \times 2.2046 \times 10^{-6} \times Qw \times 60$ = 27.66

11. TPH = $\frac{\text{(Initial reading) - (final reading) x .005713 tons/count}}{\text{Hours}}$ = 35.96

KPB:jh