AP42 Section: 6.5 Phthalic Anhydride

Title: Correspondence dated 1992 from Aristech Chemical Corporation to D. Beauregard

ARISTECH

Aristech Chemical Corporation
600 Grant Street
Pittsburgh, PA 15230-0250

ENVIRONMENTAL AFFAIRS
OCCUPATIONAL HEALTH AND SAFETY

FAX: (412) 433-7753

DATE: 4-3-92

PLEASE DELIVER THE FOLLOWING

TO: COLIN CAMPBELL

FROM: RICH HARRIS

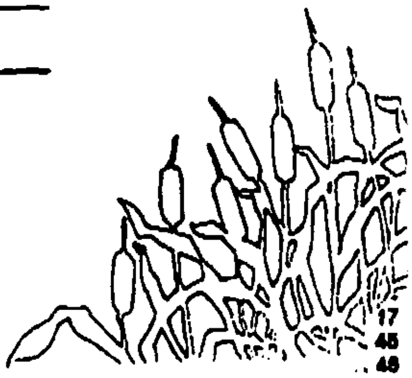
ATTACHED ARE 3 PAGES (EXCLUDING THIS PAGE)

IF YOU HAVE ANY QUESTIONS REGARDING THIS TRANSMITTAL:

CONTACT ME

AT 412 433 7730

MESSAGE:



17
45
48
6

Allied has a pilot 134a plant at Buffalo, N.Y., but Du Pont and ICI are already *making commercial* quantities at Corpus Christi, Tex., and Rocksavage, Indeed, current demand for 134a is said to be small and below producers' capacity. The source says Du

Continued on Page 13

Chemical Marketing Reporter

VOLUME 241
Number 13

MARCH 30, 1992

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modern facilities such as Greenville, Ohio.

As to the structural materials business, BASF has concluded after a strategic review, that BASF Structural *Materials*, Inc., which has approximately 550 employees, will not be a core activity in the long term.

Non-aerospace markets did not develop as the company had hoped, nor did the expected synergies emerge within BASF's overall plastics business. Finally, heavy Department of Defense spending cuts have hurt most, if not all, US companies in the business.

Dr. J. Dieter Stein, president and chief executive *officer of* BASF Corporation, told a press briefing in New York that 1991 was admittedly a disappointing year and said he sees no more than faint signs of an upturn on the horizon.

The company's $4.96 billion in sales in '91 were down 7.8 percent, although when adjusted for businesses divested during the year the decline was about 1.4 percent.

Earnings before taxes dropped from $133.5 million in *1990* to a negative $20.3 million. Poor performance of the automotive and construction industries, key businesses for the company, impacted sales and earnings and a charge of over $100 million in connection with the company's *long term* restructuring program was responsible for pushing earnings into the minus column.

Dr. Stein declined additional comment on the plan to purchase Mobil Chemical Company's *polystyrene resin business* (CMR, 1/20/92, pg.3), noting that the deal has entered

Continued on Page 26

Exiting PPS Keeps 'Ryton'

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ers in the US market: Phillips, Hoechst Celanese Corporation and GE Plastics. Only Phillips has production capabilities in the US.

Speculation *among industry analysts* indicates that Bayer was either looking to strengthen its position in the PPS market or get out of it altogether. In fact, until Bayer

Continued on Page 40

PA Reinvestment Rests on Price Hikes

Following earlier capacity rationalization, the phthalic anhydride industry is now stressing the importance of getting profitability back up to reinvestment levels. At stake, according to producers, is the *industry's ability* to be a steady supplier following an eventual rebound in demand or an unforeseen production outage.

Currently, production is characterized as "comfortably snug." However, the recovery of end markets following an uptick in the *economy is expected to* stretch the industry's production capacity. Industry projections show the need for new capacity by 1994-95.

Although offset somewhat by the recession, BASF Corporation's closing of its Kearny, N.J., and Cornwall, Ontario, phthalic facilities last year tightened the market.

"Production reliability is certainly an issue," says producer, adding that a string of *maintenance* turnarounds last year also tightened availability and forced production to near capacity.

"In the long term, there will be a *need for* more capacity," he says.

Plans for new capacity do exist, however. BASF, for example, expects to move two reactors at its Kearny location to Sterling Chemicals Inc.'s Texas City, Tex., *location*. Other producers with less specific plans report that when demand picks up, the need for increased capacity could be covered in the *short term* by debottlenecking.

The industry is supplied by Aristech Chemical Corporation, Exxon Chemical Company, Koppers Industries Inc., Stepan Company, as well as BASF and Sterling.

Downtime in the PA industry last year did, however, keep production rates firm.

According to Nelson Ockerbloom of Philadelphia-based PCI/Ockerbloom & Co., toward the end of last year production was *pushed to* nearly 90 percent of capacity, or beyond what is considered a comfortable operating margin.

"One more plant shutdown and there would have been a shortage," he says. "It can be argued that last fall an availability crisis almost developed."

But most agree that an increase in capacity could only *follow a strengthening of* margins.

"Margin improvement is a must if the industry is to get closer to reinvestment economics," says a producer, adding that even with a successful *increase, adequate returns* will still be "a way's away."

In a move to increase PA profitability, BASF announced a 2-cent-per-pound price increase effective April 1. Other producers, because of *contract restraints*, are expected to follow the move May 1.

"The goal is to get a little more profitability in the business," says a producer. "A mar-

Continued on Page 12

Chemical Marketing Cues

CITRIC ACID: Two producers hike capacity as demand grows sharply. .... Page 7

FLUOBORATES: Environmental compliance is contributing to rising prices. .... Page 25

CALCIUM HYPOCHLORITE: Recession has slowed

INSIDE CMR

AROMATIC ORGANICS

PA Reinvestment

Continued from Page 3

gin increase is needed to keep production in the black." A drop in feedstock ortho-xylene pricing will also help phthalic producers regain profitability. According to one ortho producer, April contracts are now being negotiated between 18 and 18½ cents per pound, down from a current 19¼ cents.

Price negotiations have followed a general decline in spot ortho pricing. In Europe for example, spot prices are now reported at 18 cents per pound after cresting around 19 cents.

For several months, however, ortho-xylene pricing had been on an upward trend. After having been at 18¼ cents per pound for November and December, the January ortho contract was settled at 19 cents. February and March, in an unusual move, were settled together at 19¼ cents.

Considered a "one-time deal," the two-month settlement came as a compromise after supplier and consumers couldn't come to terms for the February contract. According to an ortho producer, the delay came as PA producers refused to totally meet the proposed increase in ortho-xylene pricing.

Ortho-xylene producers, who were looking for a higher price, okayed a slight concession on the price increase in return for phthalic producers agreeing to a two-month price settlement.

"The terms of the arrangement dictated that the price would be effective for February and March," says an ortho-xylene producer, adding that such a two-month price settlement will not become standard operating procedure. "Ortho producers hope its not a trend," he says.

STEADY PRICING APPRECIATED

Phthalic producers, on the other hand, seem pleased with the two-month feedstock price settlement. "It certainly makes it easier on all of us," says one producer. "Even if its only administratively."

One reason that phthalic producers are in favor of a two-month price settlement is that typical delays in settling the contract price make it difficult for PA producers to be "responsive" to the market. One phthalic producer reports that he is going to push for a two-month settlement for April and May.

"It clarifies the market," he says. "Feedstock cost relief aside, we could use some regularity in pricing." Typically, ortho-xylene contracts are settled on a monthly basis, although para-xylene pricing is set quarterly.

The two-month settlement also enabled producers to better illustrate actual PA economics, which most agree are thin. According to Mr. Ockerbloom, phthalic producer's claims for cost relief are valid.

"Phthalic producers can only maintain cash costs for a certain length of time," he says. "But while an increase in margins is needed, market strength will determine the success of the latest price move."

million pounds, down 11 percent from 1990's total 1,221 million pounds. From 1989 to 1990, consumption dropped 7 percent.

For UPR production, SPI reports that between 1991 and 1990 production fell 12 percent to 1,074 million pounds from 1,221 million pounds.

"Producers are so far disappointed about demand," says Mr. Ockerbloom.

PRICE TRENDLINES

WEEK ENDING MAR. 27, 1992

CHANGES/UP
None

CHANGES/DOWN
None

AROMATICS INDEX

The Aromatic Organics Index reflects the prices of 14 representative materials in this sector and the quantity of each produced in 1991.

Mar. 27, 1992	178.80
Mar. 20, 1992	178.90
Feb. 27, 1992	190.88
Mar. 29, 1991	241.01

Chemical Prices Start on Page 30

On the pricing front, little real change has occurred in quite some time. Currently, for large phthalic anhydride accounts, ranging between 30 million and 80 million pounds, molten, are reported between 34 and 35 cents per pound. Medium to smaller accounts for molten material can pay 43 cents per pound and up.

For flake shipments, large accounts reportedly pay between 36 and 37 cents per pound. Smaller accounts can pay 46 cents per pound and up.

For flake material, cheap imports may adversely effect pricing. According to one observer, there is a "big differential" between local selling price and what importers are advertising.

In several cases, an exporter have posted flake material at prices "well below the US cost of production," according to domestic producers.

"Imported flake material is a concern to US producers," says Mr. Ockerbloom. "It wouldn't be surprising if an inquiry resulted in an investigation of the possibility of dumping underpriced material."

DOUGLAS LOFFREDO

BETA-NAPHTHOL — Last week's article on beta-naphthol (CMR, 3/23/92, pg. 12) incorrectly reported Enichem America Inc.'s price for the chemical. The price quoted should have been $1.30 per pound for truckloads, and higher for less-than-truckload quantities.

BTX — According to a source, April benzene contracts have been settled at $1.15 per

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AROMATICS

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Thai Drug Po

Continued from Page 9

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Continued strong sales in the plasticizer market has been a plus for the phthalic producers. While linked to the recession-hit automobile and construction industries, plasticizers sold into the vinyl market have remained strong.

"Producers in the vinyls industry are running flat out," says a market observer. "As the largest end market for phthalic anhydride, it bodes well for the industry." Overall, the plasticizer market constitutes nearly half the phthalic market.

Other phthalic end markets are not faring as well. The unsaturated polyester resin market, for example, consumes the second largest amount of phthalic, but its markets continue to remain depressed. Hopes are pinned to an increase in consumption in the second and third quarters — traditionally strong periods for phthalic consumption — to balance the losses previously suffered.

Society of Plastics Industry Inc. reports that for the second year in a row, unsaturated polyester resin consumption rates are down. In 1991, UPR sales and captive use was 1,078

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BTX — According to a source, April benzene contracts have been settled at $1.15 per gallon. Production problems in the industry have tightened supply and have driven up prices. But overall, producers surveyed say that markets are quiet, with little trader activity reported.

Benzene spot prices are between $1.16 and $1.17 per gallon, unchanged from the previous week. A trader reports that buyers are, however, looking for material for April below projected contract levels.

But because of currently limited benzene supply, sentiment in the market is that the April nomination at $1.15 per gallon "should stick."

"There's not enough supply in the market," says a producer. "April contracts appear secure."

In toluene markets, producers also report slow going. Commercial grade toluene has been sold at 90c. per gallon, and nitration grade toluene is reported several cents above that. According to one trader, a commercial toluene deal was done at 90¼c. per gallon for blending.

In the mixed-xylene market, spot prices

capacity. To accomplish this
nol producers will have to in
something that hasn't yet bee

The last time phenol pro
raise prices was in January,
move fell through, however,
nificant drop in feedstock be

STYRENE — Styrene pro
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March 1 styrene price incre
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Thai Drug Pol

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Thailand, and (the regulatio
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to satisfy the 'working' req
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The US Trade Represent
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designated Thailand as a "
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PMA says Thailand offers
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are only $12 million because
"egregious acts and prac
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"The Thai government
patent piracy has allowed
produce low-quality a
medicines that threaten the
being of a large portion of
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people who may use th
medicines outside of Thaila

Allied Steps

Continued from Page 3

Pont recently lowered its
percent as part of its plan t
production costs go down. H
cost around $8 per pound i
$12 in the resale market.

Allied-Signal has had a fe
the way to its latest announ
it stated plans to make 141b
but then shelved the project,
to make it at El Segundo, wh
infrastructure was more su

At one time it also annou
grassroots 134a plant at G
scrapped that too, opting in
vantage of existing CFC
Baton Rouge. Both El Seg
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CFC's and are well suited
tives as well, the company s

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ARISTECH

April 10, 1992

Mr.Colin Campbell
Pacific Environmental Services
3708 Mayfair St., Suite 202
Durham, N.C. 27707

Dear Mr. Campbell:

Enclosed are results of testing performed on Aristech Chemical Corporation - Pasadena Plant's phthalic anhydride scrubber stacks. The plant has two fixed-bed tubular reactors with each having associated switch condensers and thermal incinerator/scrubber systems. This unit has an annual nameplate production capacity of 210 million pounds of phthalic anhydride. Start-up of the unit occurred in mid - 1983.

The Texas Air Control Board Operating Permits required that the scrubber stacks be tested to insure compliance with VOC and CO emissions rates listed in the permit. There were no requirements to test for sulfur dioxide emissions since it has never been introduced into the process. The permit listed all organic compounds as VOC's rather than particulates as indicated in AP-42 Table 5.12-1. Method 25-A for VOC detection was used in all the enclosed test results except for the testing done on October 1, 1987. During this test, a modified sampling and analysis method was used for VOC detection. This was a freeze/trap method which resembles the EPA method for particulate determination. Particulate testing was included in the March 26, 1987 and October 1, 1987 sampling per EPA methodology.

Testing to date, includes sampling of both scrubber stacks for VOC and CO on April 30 and May 1, 1985. Results of this test showed VOC levels above permitted limits. Sampling on November 11 and 12, 1985 was for VOC only and results were well within the permit limits. Adjustments had been made to the operation of the incinerator/scrubber system prior to the November sampling. The sampling done on March 1, 1987 was only done on one scrubber stack. The purpose was to test emissions from the incinerator, only. For this test the liquid level in the scrubber was kept below the inlet line from the incinerator and it was basically used as a stack. Because a significant increase in stack temperature occurred, the October 1 test utilized a freeze/trap sampling procedure to test for VOC levels. Again, only one scrubber stack was sampled. During the first test run, the incinerator tripped and the scrubber was quickly placed back in service. This explains the decrease in stack emissions from runs 2 through 4. Run 1 was not reported because one of the tubes collecting the samples was broken during sampling. Analysis from this test shows that the main constituent being emitted is maleic acid. Operation of the incinerator without the scrubber has not been pursued. The TACB Operating Permit currently requires scrubber operation at all times that the incinerator is in operation.

The enclosed package lists physical conditions from each test as well as results and methodologies utilized.

Sincerely,

Rex A. Shuff
Rex A. Shuff,REM
Environmental Coordinator

RAS:pr
Enclosure

32-92

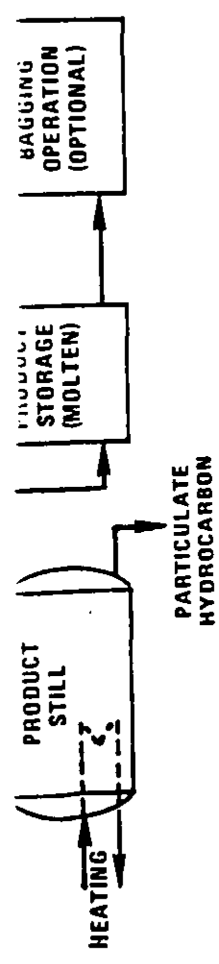

Figure 5.12-2. Flow diagram for phthalic anhydride using naphthalene as basic feedstock.1

Table 5.12-1. EMISSION FACTORS FOR PHTHALIC ANHYDRIDE[1,a]
EMISSION FACTOR RATING: B

Process	Particulate lb/ton	Particulate kg/MT	SO_x lb/ton	SO_x kg/MT	HC lb/ton	HC kg/MT	CO lb/ton	CO kg/MT
Oxidation of o-xylene[b]								
Main process stream[c]								
Uncontrolled	138[d]	69[d]	9.4[e]	4.7[e]	0	0	301	151
W/scrubber and thermal incinerator	6	3	9.4	4.7	0	0	12	6
W/thermal incinerator	7	4	9.4	4.7	0	0	15	8
W/incinerator with steam generator	7	4	9.4	4.7	0	0	15	8
Pretreatment								
Uncontrolled	13[f]	6.4[f]	0	0	0	0	0	0
W/scrubber and thermal incinerator	0.5	0.3	0	0	0	0	0	0
W/thermal incinerator	0.7	0.4	0	0	0	0	0	0
Distillation								
Uncontrolled	89[d]	45[d]	0	0	2.4	1.2	0	0
W/scrubber and thermal incinerator	4	2	0	0	<0.1	<0.1	0	0
W/thermal incinerator	4	2	0	0	0.1	<0.1	0	0
Oxidation of naphthalene[b]								
Main process stream[c]								
Uncontrolled	569[i]	289[i]	0	0	0	0	100	50
W/thermal incinerator	11	6	0	0	0	0	20	10
W/scrubber	0.6	0.3	0	0	0	0	100	50
Pretreatment								
Uncontrolled	5[h]	2.5[h]	0	0	0	0	0	0
W/thermal incinerator	1	0.5	0	0	0	0	0	0
W/scrubber	<0.1	<0.1	0	0	0	0	0	0
Distillation								
Uncontrolled	389	199	0	0	10	5	0	0
W/thermal incinerator	8	4	0	0	2	1	0	0
W/scrubber	0.4	0.2	0	0	0.1	<0.1	0	0

[a] Emission factors are in units of pounds of pollutant per ton (kilogram of pollutant per metric ton) of phthalic anhydride produced.

[b] Control devices listed are those currently being used by phthalic anhydride plants.

[c] Main process stream includes the reactor and multiple switch condensers as vented through the condenser unit.

[d] Particulate consists of phthalic anhydride, maleic anhydride, and benzoic acid.

[e] Emissions change with catalyst age. Value shown corresponds to relatively fresh catalyst. Can be 19 to 25 lb/ton (9.5 to 13 kg/MT) for aged catalyst.

[f] Particulate consists of phthalic anhydride and maleic anhydride.

[g] Particulate consists of phthalic anhydride, maleic anhydride, and naphthaquinone.

[h] Particulate is phthalic anhydride.

[i] Particulate does not include catalyst dust which is controlled by cyclones with an efficiency of 90 to 98 percent.

Reference for Section 5.12

1. Engineering and Cost Study of Air Pollution Control for the Petrochemical Industry. Vol 7: Phthalic Anhydride Manufacture from Ortho-Xylene. Houdry Division, Air Products and Chemicals, Inc., Marcus Hook, Pa. Prepared for Environmental Protection Agency, Research Triangle Park, N.C. Publication No. EPA-450/3-73-006-g. July 1975.

Permit compliance testing

4/29/85 Train 1 feedrate $54.0 g / 4.0 m^3$

$= \text{(approx.)}\ 13{,}000 \frac{lb}{hr}$ of PA produced

$13{,}000 \frac{lb}{hr} = 6.5 \frac{ton}{hr}$

VOC: $\frac{5.7\ lb}{6.5\ ton} = \frac{0.88\ lb}{ton}$

CO: $\frac{2.8\ lb}{6.5\ ton} = \frac{0.43\ lb}{ton}$

Train 2 feedrate $54.0 g / 3.3\ m^3$

$= \text{(approx)}\ 10{,}500 \frac{lb}{hr}$ of PA produced

$10{,}500 \frac{lb}{hr} = 5.25\ ton/hr$

VOC: $\frac{6.2\ lb}{5.25\ ton} = \frac{1.18\ lb}{ton}$

CO: $\frac{3.2\ lb}{5.25\ ton} = \frac{0.61\ lb}{ton}$

11/12/85 Re-test for VOC only

Train 1 feedrate $62.0 g / 3.0\ m^3$

$= \text{(approx)}\ 11{,}000 \frac{lb}{hr}$ of PA produced $= 5.5$ ton

VOC: $\frac{1.4\ lb}{5.5\ ton} = \frac{0.25\ lb}{ton}$

Train 2 feedrate • $61.5 g / 3.5 m^3$

$= \text{(approx)}\ 12{,}900 \frac{lb}{hr}$ of PA produced $= 6.45$ ton

VOC : $\frac{1.5\ lb}{6.45\ ton} = \frac{0.23\ lb}{ton}$

3/26/87

Train 2 (Train 1 not tested) 63.0g / 3.4 m^3

= (approx.) 13,000 $\frac{lb}{hr}$ of PA produced = 6.6 tons

Particulate : (Avg.) $\frac{1.94\ lb}{6.6\ tons} = \frac{0.29\ lb}{ton}$

VOC : (Avg.) $\frac{1.3\ lb}{6.6\ tons} = \frac{0.20\ lb}{ton}$

CO (Avg.) $\frac{4.0\ lb}{6.6\ tons} = \frac{0.61\ lb}{ton}$

10/1/87

Train 1 (Train 2 not tested) 70.0 g / 4.0 m^3

= (approx) 17,000 $\frac{lb}{hr}$ of PA produced = 8.5 tons

Particulate : $\frac{2.52\ lb}{8.5\ ton} = \frac{0.3\ lb}{ton}$

VOC : $\frac{5.03\ lb}{8.5\ ton} = \frac{0.59\ lb}{ton}$ *

CO : $\frac{9.7\ lb}{8.5\ ton} = \frac{1.14\ lb}{ton}$

* Permit limit exceeded on run 2 & 3 because of incinerator trip

uncontrolled emissions (from heat recouperator inlet results)

Run #1 – prior to incinerator trip

VOC : $\frac{1092\ lb}{8.5\ ton} = \frac{128\ lb}{ton}$ (good agreement w/ table on particulate emissions.

Avg of 3 runs

VOC : $\frac{2322\ lb}{8.5\ ton} = \frac{273\ lb}{ton}$

TABLE 2.2

PHTHALIC ANHYDRIDE PLANT SCRUBBER NO. 1

PHYSICAL DATA SUMMARY

Parameter	Unit	RUN 1	2	3
Date		4-30-85	4-30-85	4-30-85
Time		1017-1117	1200-1300	1327-1427
Sampling time	minutes	60	60	60
Net sample volume	cu ft	34.822	34.533	35.050
Meter temperature	°F	89	90	93
Condensate collected	gm	100.5	109.2	111.1
Moisture content	Vol %	12.4	13.4	13.5
Molecular weight (Actual)	gm/gm mole	27.608	27.505	27.515
Stack temperature	°F	126	130	130
Stack pressure	in Hg	29.94	29.94	29.94
Pitot tube correction factor	---	0.843	0.843	0.843
Dry gas meter correction factor	---	1.000	1.000	1.000
Stack diameter	in	74	74	74
Average stack velocity	ft/sec	39.9	39.5	39.9
Volumetric stack gas flow rate	ACFM	71,502	70,785	71,502
Volumetric stack gas flow rate	SCFM	64,618	63,562	64,031
Volumetric dry stack gas flow rate	DSCFM	56,606	55,045	55,386

TABLE 2.3

PHTHALIC ANHYDRIDE PLANT SCRUBBER NO. 2

PHYSICAL DATA SUMMARY

Parameter	Unit	RUN 1	RUN 2	RUN 3
Date		5-1-85	5-1-85	5-1-85
Time		1003-1103	1125-1225	1237-1337
Sampling time	minutes	60	60	60
Net sample volume	cu ft	34.411	34.218	34.283
Meter temperature	^oF	92	101	96
Condensate collected	gm	114.5	111.5	108.1
Moisture content	Vol %	14.0	14.0	12.0
Molecular weight (Actual)	gm/gm mole	27.440	27.471	27.688
Stack temperature	^oF	129	129	121
Stack pressure	in Hg	29.92	29.92	29.92
Pitot tube correction factor	---	0.843	0.843	0.843
Dry gas meter correction factor	---	1.005	1.005	1.005
Stack diameter	in	74	74	74
Average stack velocity	ft/sec	52.4	52.6	52.2
Volumetric stack gas flow rate	ACFM	93,902	94,260	93,543
Volumetric stack gas flow rate	SCFM	84,177	84,498	85,010
Volumetric dry stack gas flow rate	DSCFM	72,392	72,668	74,809

TABLE 2.1

EMISSION RATE DATA SUMMARY

Source Name	Parameter	Emission Rate	[illegible]	TACB Maximum Allowable Emission Rate
PA Plant Scrubber No. 1	VOC	5.7 lbs/hr	[illegible]	4.6 lbs/hr
	CO	2.8 lbs/hr	[illegible]	93.3 lbs/hr
PA Plant Scrubber No. 2	VOC	6.2 lbs/hr	[illegible]	4.6 lbs/hr
	CO	3.2 lbs/hr	[illegible]	93.3 lbs/hr
2-EH Vacuum Vent	VOC	0.04 lbs/hr		4.2 lbs/hr
[redacted] Stripper Vent CO_2	VOC	0.307 lbs/hr		5.4 lbs/hr

4/29/85

SECTION 4.0 - Sampling and Analytical Procedures

Stack gas velocity and volumetric flow rate of the two scrubber stacks in the PA plant were determined by EPA Methods 1 and 2. EPA Method 1 - "Sample and Velocity Traverses for Stationary Sources" was followed in locating the sampling sites, and determining the number of sampling points. Sixteen sample points were used for the velocity traverse, and a point approximately one meter from the stack wall was used to extract samples for moisture, molecular weight, CO and VOC determinations. EPA Method 2 - "Determination of Stack Gas Velocity and Volumetric Flow Rate" was followed in determining the stack gas volumetric flow rate. An S-type pitot tube (ten feet in length) equipped with a type K thermocouple was used to monitor the velocity and flue gas temperature. Velocity head pressure was measured using the pitot tube and an inclined manometer having a full range of 0 to 5 inches of H_2O.

Actual volumetric flow rates for the vacuum and stripper vents in the 2-ethyl hexanol plant were supplied by TENN-USS Chemical.

For each site the molecular weight of the stack gas was determined using an Orsat analyzer according to the procedures given in EPA Reference Method 3, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight". Orsat samples were collected over a period of approximately one hour for the scrubber stack and ten minutes for each vent. Samples were drawn directly through a teflon lined diaphragm pump and into a 5-ply Calibrated Instruments sample bag using the single point, integrated sample procedure in EPA Method 3.

Upon completion of the Orsat analysis the Orsat bag was then analyzed for carbon monoxide using a Beckman infrared analyzer (Model No. 864-11 I.R. Analyzer; Serial No. RAPID 9935) according to CFR-40, EPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources".

At each site EPA Reference Method 4, "Determination of Moisture Content in Stack Gases" was followed in determining the amount of moisture in the stack gas. In this method, the volume of moisture condensed is measured to the nearest milliliter (ml). The increase in weight of the silica gel was determined by weighing the silica gel to the nearest 0.5 gram (g). The weight of the moisture found in the silica gel was then converted to ml by dividing the density of water (1 g/ml).

The impinger water and collected condensate from the vacuum and the stripper vents on the 2-EH plant were transferred to amber colored borosilicate glass sample bottles with teflon lined caps. The samples from each test run were then composited and analyzed for butanol, 2-ethyl hexanol, n-butyraldehyde, isobutyraldehyde, and ethyl propyl acrolein via liquid injection gas chromatography.

Leak checks were conducted in accordance with procedures described in EPA Methods 2, 3 and 4. The pitot tube, pitot lines, and Orsat lines were leak checked at four inches of H_2O, prior to and at the conclusion of each test. The Method 4 train was also leak checked prior to and at the conclusion of each test.

Volatile Organic Compounds

EPA Method 25A 40 CFR Part 60 - "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer" procedures were used as a guide in sampling for Volatile Organic Compound (VOC) emissions.

The gas sample was drawn through a heated teflon line by a teflon lined diaphragm pump located in a TECO Model 800 sample conditioner. From the sample conditioner, the sample flow was directed to an AID Model 511 GC/FID. Samples were analyzed for VOC (less methane) as n-heptane for the two scrubbers in the phthalic anhydride plant and the stripper vent in the 2-ethyl hexanol plant and as n-hexane in the vacuum vent of the 2-ethyl hexanol plant.

TABLE 2.2

PHTHALIC ANHYDRIDE PLANT SCRUBBER NO. 1

PHYSICAL DATA SUMMARY

Parameter	Unit	RUN 1	RUN 2	RUN 3
Date		11-12-85	11-12-85	11-12-85
Time		1256-1326	1405-1435	1533-1553
Sampling time	minutes	30	30	30
Net sample volume	cu ft	21.386	21.227	21.807
Meter temperature	°F	81.8	82.7	83.7
Condensate collected	gm	213.4	219.9	229.1
Moisture content	Vol %	14.5	14.5	14.5
Molecular weight (Actual)	gm/gm mole	27.426	27.474	27.429
Stack temperature	°F	128.6	128.6	128.8
Stack pressure	in Hg	30.16	30.16	30.16
Pitot tube correction factor	---	0.853	0.853	0.853
Dry gas meter correction factor	---	1.018	1.018	1.018
Stack diameter	in	74	74	74
Average stack velocity	ft/sec	36.0	37.1	38.4
Volumetric stack gas flow rate	ACFM	64511	66482	68812
Volumetric stack gas flow rate	SCFM	58333	60116	62201
Volumetric dry stack gas flow rate	DSCFM	49875	51399	53182

TABLE 2.3

PHTHALIC ANHYDRIDE PLANT SCRUBBER NO. 2

PHYSICAL DATA SUMMARY

Parameter	Unit	RUN 1	RUN 2	RUN 3
Date		11-13-85	11-13-85	11-13-85
Time		1020-1050	1131-1201	1242-1312
Sampling time	minutes	30	30	30
Net sample volume	cu ft	20.043	22.051	21.101
Meter temperature	°F	81.7	83.5	84.5
Condensate collected	gm	57.6	82.9	76.3
Moisture content	Vol %	11.9	14.5	14.6
Molecular weight (Actual)	gm/gm mole	27.712	27.436	27.418
Stack temperature	°F	128.8	128.7	128.8
Stack pressure	in Hg	30.20	30.20	30.20
Pitot tube correction factor	---	0.853	0.853	0.853
Dry gas meter correction factor	---	1.018	1.018	1.018
Stack diameter	in	74	74	74
Average stack velocity	ft/sec	39.3	39.2	39.2
Volumetric stack gas flow rate	ACFM	70425	70245	70245
Volumetric stack gas flow rate	SCFM	63744	63592	63581
Volumetric dry stack gas flow rate	DSCFM	56158	54371	54298

TABLE 2.1

VOC, AND ORSAT DATA SUMMARY

PA Plant Scrubber No. 1

Run	Date	Time	VOC (as hexane)		CO_2(Vol%)	O_2(Vol%)
			ppmv	lb/hr		
1	11-12-85	1300-1320	3	2.0	2.6	15.2
2	11-12-85	1410-1430	1	0.7	3.0	15.0
3	11-12-85	1530-1550	2	1.4	2.6	15.3
	AVG. EMISSION RATE			1.4*		

PA Plant Scrubber No. 2

Run	Date	Time	VOC (as hexane)		CO_2(Vol%)	O_2(Vol%)
			ppmv	lb/hr		
1	11-13-85	1030-1050	2	1.5	2.6	15.2
2	11-13-85	1140-1200	2	1.5	2.7	15.1
3	11-13-85	1250-1310	2	1.5	2.6	15.3
	AVG. EMISSION RATE			1.5*		

*TACB Maximum Allowable Emission Rate: 4.6 lb/hr

11/12/85

NUS CORPORATION

SECTION 4.0 - Sampling and Analytical Procedures

Stack gas velocity and volumetric flow rate of the two scrubber stacks in the PA plant were determined by EPA Methods 1 and 2. EPA Method 1 - "Sample and Velocity Traverses for Stationary Sources" was followed in locating the sampling sites, and determining the number of sampling points. Sixteen sample points were used for the velocity traverse, and a point approximately one meter from the stack wall was used to extract samples for moisture, molecular weight and VOC determinations. EPA Method 2 - "Determination of Stack Gas Velocity and Volumetric Flow Rate" was followed in determining the stack gas volumetric flow rate. An S-type pitot tube (ten feet in length) equipped with a type K thermocouple was used to monitor the velocity and flue gas temperature. Velocity head pressure was measured using the pitot tube and an inclined manometer having a full range of 0 to 5 inches of H_2O.

For each site the molecular weight of the stack gas was determined using an Orsat analyzer according to the procedures given in EPA Reference Method 3, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight". Orsat samples were collected over a period of approximately twenty minutes for the scrubber stacks. Samples were drawn directly through a teflon lined diaphragm pump and into a 5-ply Calibrated Instruments sample bag using the single point, integrated sample procedure in EPA Method 3.

At each site EPA Reference Method 4, "Determination of Moisture Content in Stack Gases" was followed in determining the amount of moisture in the stack gas. In this method, the volume of moisture condensed is measured to the nearest milliliter (ml). The increase in weight of the silica gel was determined by weighing the silica gel to the nearest 0.5 gram (g). The weight of the moisture found in the silica gel was then converted to ml by dividing the density of water (1 g/ml).

Leak checks were conducted in accordance with procedures described in EPA Methods 2, 3 and 4. The pitot tube, pitot lines, and Orsat lines were leak checked at four inches of H_2O, prior to and at the conclusion of each test. The Method 4 train was also leak checked prior to and at the conclusion of each test.

Volatile Organic Compounds

EPA Method 25A 40 CFR Part 60 - "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer" procedures were used as a guide in sampling for Volatile Organic Compound (VOC) emissions.

The gas sample was drawn through a Perma-Pure dryer by a diaphragm pump. The sample flow was directed to an AID Model 511 GC/FID. Samples were analyzed for VOC (less methane and ethane) as hexane for the two scrubbers in the phthalic anhydride plant.

TABLE 2-3
PHTHALIC ANHYDRIDE
UNIT #2
SOURCE TESTING PHYSICAL DATA SUMMARY

Parameter	Units	Run No.		
		One	Two	Three
Date		3-26-87	3-26-87	3-26-87
Begin Time		1036	1300	1508
End Time		1201	1418	1626
Sampling Time	minutes	72	72	72
Net Sample Volume	cu ft	46.369	45.290	44.300
Meter Pressure	in Hg	29.89	29.88	29.88
Meter Temperature	deg. F	73.1	74.5	80.2
Condensate Collected	gm	61.5	59.6	61.8
Moisture Content	vol %	6.0	5.9	6.3
Molecular Weight	gm/gm mole	28.340	28.367	28.308
Stack Pressure	in Hg	29.79	29.79	29.79
Stack Temperature	deg. F	321.8	331.5	329.8
Ptcf	----	0.839	0.839	0.839
Dgmcf	----	0.994	0.994	0.994
Nozzle Area	sq ft	3.12E-04	3.27E-04	327E-04
Stack Diameter	in	74.00	74.00	74.00
Avg. Stack Velocity	ft/sec	5.36E + 01	5.21E + 01	5.14E + 01
Vol. Stack Gas Rate	acfm	9.60E + 04	9.34E + 04	9.21E + 04
Vol. Stack Gas Rate	scfm	6.46E + 04	6.20E + 04	6.13E + 04
Isokinetic Variation	%	9.49E + 01	9.61E + 01	9.45E + 01

TABLE 2-1
SCRUBBER STACK EMISSIONS
PARTICULATE DATA SUMMARY

Date	Time	Run #	Total Emissions (lbs/hr)
3-26-87	1036 - 1202	1	1.76
3-26-87	1300 - 1418	2	2.36
3-26-87	1508 - 1626	3	1.71

3/26/87

TABLE 2-4
VOC DATA SUMMARY
(VOC AS PROPANE)

Date	Run #	Incinerator Inlet (lbs/hr)	Scrubber Inlet (lbs/hr)	Stack Emissions (lbs/hr)
3-26-87	1	47	1.0	1.1*
3-26-87	2	49	1.0	1.2*
3-26-87	3	45	1.0	1.6*

* It appears that retrainment of VOC's may be occuring beyond the scrubber inlet sample location. Emission rates at the scrubber stack are higher than VOC rates at the scrubber inlet.

TABLE 2-5
CARBON MONOXIDE
DATA SUMMARY

CO Concentrations (ppmv)

Date	Run #	Inlet to Incinerator (ppmv)	Scrubber Inlet (ppmv)	Stack Emissions (ppmv)
3-26-87	1	5060	8	14
3-26-87	2	5021	17	14
3-26-87	3	5031	20	19

CO Rates (lbs/hr)

Date	Run #	Inlet to Incinerator (lbs/hr)	Scrubber Inlet (lbs/hr)	Stack Emissions (lbs/hr)
3-26-87	1	1340	2.1	3.7
3-26-87	2	1280	4.3	3.6
3-26-87	3	1260	5.0	4.8

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Texas Air Control Board (TACB) "Compliance Sampling Manual", TACB 'Laboratory Methods for Determination of Air Pollutants, and Environmental Protection Agency (EPA) Regulations on Standards of Performance for New Stationary Sources, Title 40, Code of Federal Regulations, Part 60 (40 CFR 60) Appendix A - Reference Methods were adhered to for analytical procedures where applicable.

TACB procedures were followed in determining the volumetric flow rate of the source, i.e., sample location, sample points, stack gas velocity, dry molecular weight of the stack gas moisture content, and stack gas pressure. An S-type pitot tube (ten feet in length) equipped with a type K thermocouple was used to monitor the velocity and exhaust gas temperature. Velocity head pressure was measured using the pitot tube. The weight of moisture condensed and the increase in weight of the silica gel was measured to the nearest 0.1 gram.

The particulate/acid mist samples were collected using a modified TACB particulate sampling train. The stack gases were isokinetically withdrawn from the stack through a glass lined probe. The gases were then passed through a glass fiber filter to collect particulate matter and a series of four impingers to collect condensate and the water soluable acid gases

EPA Method 10 (modified), "Determination of Carbon Monoxide Emissions from Stationary Sources" was employed in the determination of CO concentrations. The Sample was drawn through a stainless Steel probe and Perma Pure dryer system by a teflon lined diaphram pump located in a TECO model 800 sample conditioner. From the sample conditioner, the sample flow was directed to a Beckman Model 864 Infrared Analyzer CO analyzer. The signal output went to a Esterline Angus dual channel recorder.

Excess oxygen and carbon dioxide levels were determined by the use of an Orsat analyzer as outlined in the TACB Sampling Procedures Manual, appendix F. Ambient air was used as a calibration gas to verify the effectiveness of the reagent solutions.

A modified version of EPA Method 20 was employed in the determination of nitrogen oxides. A stainless steel sample probe was used to extract the gas sample from the stack. The probe was attached to a 3-way calibration valve where zero and span gases were introduced. The gas sample was drawn through a Perma Pure dryer by a diaphram pump located in a Thermo Electron Model 800 sample conditioner. From the sample conditioner, the sample flow was directed Thermo Electron

Model 10 nitrogen oxides analyzer. The signal output went to a dual channel recorder. Calibration procedures were consistent with those specified in EPA Method 20. Certified calibration gases were used for the nitrogen oxides analyzer.

EPA Method 25A, "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer" procedures were followed for sampling for Volatile Organic Compound (VOC) emissions. The samples were analyzed on an AID 511 GC/FID for VOC as propane less methane. The signal output was recorded by a Spectra Physics SP Model 4270 Integrator.

Copies of the field and analytical data and calculations are in the appendices of this report.

TABLE 2-5

PHTHALIC ANHYDRIDE
UNIT #1
STACK TESTING PHYSICAL DATA SUMMARY

Parameter	Units	Run Number
		One
Date		10/1/87
Begin Time		1025
End Time		1501
Sampling Time	minutes	168
Net Sample Volume	cu ft	112.592
Meter Pressure	in Hg	30.20
Meter Temperature	deg. F	80.6
Condensate Collected	gm	232.5
Moisture Content	vol %	9.1
Molecular Weight	gm/gm mole	28.028
Stack Pressure	in Hg	30.08
Stack Temperature	deg. F	277.8
Ptcf	----	0.839
Dgmcf	----	0.991
Nozzle Area	sq ft	3.27E-04
Stack Diameter	in	74.00
Avg. Stack Velocity	ft/sec	51.95
Vol. Stack Gas Rate	acfm	9.31E + 04
Vol. Stack Gas Rate	scfm	6.70E + 04
Isokinetic Variation	%	97.7

TABLE 2-1

PHTHALIC ANHYDRIDE
UNIT #1
PARTICULATE EMISSIONS DATA SUMMARY

Date	Run No.	Time	Volumetric Flow Rate (dscfm)	Total Emissions (lbs/hr)
10-1-87	1	1025 1501	60882	2.52

Note: Sampling was interrupted between 1054 - 1233 because of a process unit upset condition. During this time, the probe was removed from the stack and no sampling was performed.

10/1/87

TABLE 2-3

PHTHALIC ANHYDRIDE UNIT #1
ORGANIC/ACID EMISSIONS DATA SUMMARY

Organic/ Acid Gas Compounds	Run No. 1 Emissions lb/hr		Run No. 2 Emissions lb/hr			Run No. 3 Emissions lb/hr			Run No. 4 Emissions lb/hr Stack
	Heat Recouperator Inlet	Scrubber Inlet	Heat Recouperator Inlet	Scrubber Inlet	Stack	Heat Recouperator Inlet	Scrubber Inlet	Stack	
Maleic Anhydride	211.70	--	247.41	--	--	520.92	--	--	--
Phthalic Anhydride	233.13	--	172.38	--	--	509.08	3.2	--	--
Maleic Acid	694.22	--	1699.57	8.34	5.78	2726.50	13.46	5.59	3.72
Phthalic Acid	--	--	--	--	--	--	--	--	--
Benzoic Acid	54.16	--	--	--	--	--	--	--	--
o-Toluic Acid	--	--	--	--	--	--	--	--	--
Citraconic Acid	--	--	--	--	--	--	--	--	--
Total Organics	1092.21	--	2119.36	8.34	5.78	3756.50	16.66	5.59	3.72

TABLE 2-2

PHTHALIC ANHYDRIDE
UNIT #1
MALEIC AND PHTHALIC ACID EMISSIONS
DATA SUMMARY

Date	Run No.	Time	Volumetric Flow Rate (dscfm)	Stack Gas Concentration	
				Maleic Acid (ppmv)	Phthalic Acid (ppmv)
10-1-87	1	1025 1501	60882	16.50	1.91

Note: Sampling was interrupted between 1054 - 1233 because of a process unit upset condition. During this time, the probe was removed from the stack and no sampling was performed.

TABLE 2-4

PHTHALIC ANHYDRIDE
UNIT #1
CARBON MONOXIDE EMISSIONS DATA SUMMARY

Date	Run No.	Time	Stack Gas Concentration (ppmv)	Stack Emissions (lbs/hr)
10-1-87	1	1029 1054	35.0	9.03
10-1-87	2	1231 1301	40.7	10.63
10-1-87	3	1340 1410	37.3	9.57

Note: Sampling was interrupted between 1054 - 1233 because of a process unit upset condition. During this time, the probe was removed from the stack and no sampling was performed.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Texas Air Control Board (TACB) "Compliance Sampling Manual", TACB 'Laboratory Methods for Determination of Air Pollutants, and Environmental Protection Agency (EPA) Regulations on Standards of Performance for New Stationary Sources, Title 40, Code of Federal Regulations, Part 60 (40 CFR 60) Appendix A - Reference Methods were adhered to for sampling and analytical procedures where applicable.

TACB procedures were followed in determining the volumetric flow rate of the source, i.e., sample location, sample points, stack gas velocity, dry molecular weight of the stack gas moisture content, and stack gas pressure. An S-type pitot tube (ten feet in length) equipped with a type K thermocouple was used to monitor the velocity and exhaust gas temperature. Velocity head pressure was measured using the pitot tube. The weight of moisture condensed and the increase in weight of the silica gel was measured to the nearest 0.1 gram.

The particulate/acid mist samples were collected using a modified TACB particulate sampling train. The stack gases were isokinetically withdrawn from the stack through a glass lined probe. The gases were then passed through a glass fiber filter to collect particulate matter and a series of four impingers to collect condensate and the water soluble acid gases.

EPA Method 10 (modified), "Determination of Carbon Monoxide Emissions from Stationary Sources" was employed in the determination of CO concentrations. Samples were drawn through a stainless steel probe whose tip was located at the centroid of the stack, using a teflon lined diaphram pump into Tedlar sample bags. The sample gases were later transported to NUS laboratory facility in Houston. There the stack gases were analyzed using a Beckman Model 864 Infrared Analyzer. The signal output went to a Esterline Angus dual channel recorder. The analyzer was calibrated using National Bureau of Standards (NBS) traceable calibration gases. Excess oxygen and carbon dioxide levels were determined by the use of an Orsat analyzer as outlined in the TACB Sampling Procedures Manual, Appendix F. Ambient air was used as a calibration gas to verify the effectiveness of the reagent solutions.

Organic/acid gas samples were collected simultaneously at three sample locations by the use of miniature impinger sampling trains. Triplicate samples were obtained at each location. The flue gases were drawn out of the centroid of the stack using stainless steel probes and heated sample line maintained at 350°F. At the Heat Recouperator Inlet and the Scrubber Inlet, flue gases were obtained from existing heat traced sampling connections.

Before sampling for organic/acid gases at the three sample locations, flue gases were purged through each of the sample lines for approximately 10 minutes. The purge gases were discharged into water baths to prevent dispersion of these gases into the ambient air. After purging, connections were made between the heated sample lines and the impinger trains and the connecting glassware was allowed to equilabrate to flue gas temperatures before commencement of sampling. The flue gases were then passed through a series of miniature impingers.

The first impinger contained a straight (non-tapered)tube to prevent ice formation and blockage of the sample train. The following three impingers were equipped with tapered tubes to optimize organic absorption in the acetone. The first impinger was dry (empty) and the remaining three were each charged with 15 ml of acetone. The entire impinger assembly was immersed in an acetone/dry ice bath and maintained at sub-zero temperatures. A calibrated Gilian sample pump equipped with a rotometer was utilized to draw the flue gases through the sample train. Rotometer readings were taken every five minutes to insure accurate flow data was obtained.

Sample runs were approximately 30 minutes in duration at sample rates of approximately 0.75 L/min. Impinger freezing occurred at the Heat Regrouper Inlet, which reduced the effective sampling time and consequent sample volume. The connecting tubing between the fourth impinger and the sample pump was sufficiently long to allow the gases exiting from the fourth impinger to equilibrate to ambient temperatures (approximately 80°F).

Upon completion of sampling, samples were carefully poured into designated 40 ml VOA sample bottles. The contents of Impinger #1 and #2 were combined into one VOA bottle and the contents of Impinger #3 and #4 were combined into a second VOA bottle for each sample run. Each impinger was also carefully rinsed with acetone and the rinseate added to the appropriate VOA bottle. Each VOA bottle was brought up to volume and the bottle was capped and stored on dry ice for transport to the laboratory. Prior to sampling each VOA bottle had been calibrated to determine its true volume. These true volumes were used in determining the mass of organic/acid gases caught. The VOA bottles containing the contents of Impingers #1 and #2 were analyzed separately from the VOA bottles containing the contents of Impingers #3 and #4 to determine if sample break through had occurred..

In the laboratory, samples were reduced in volume in the ratio 10:1 to produce a detection limit (DL) of 1 mg/L. Organic concentrations of maleic and phthalic anhydrides were determined by Gas Chromatography using a Flame Ionization Detector (GC/FID). Organic acid concentrations, (Maleic, Phthalic, Benzoic, o-Toluic and Citraconic Acids from the organic/acid flue gas sampling trains and Maleic and Phthalic Acid Mists from the particulate sampling train), were determined using High Pressure Liquid Chromatography (HPLC).

EPA-600/2-77-188
September 1977

Environmental Protection Technology Series

PHTHALIC ANHYDRIDE PLANT AIR POLLUTION CONTROL

Industrial Environmental Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

CONTENTS

CONTENTS (continued)

Appendices

Aristech Chemical Corporation
600 Grant Street
Pittsburgh, PA 15230-0250
412/433-2747
Telex: 6503608865
Answer Back: 6503608865MCI UW

ARISTECH

March 25, 1992

Mr. Dennis Beauregard
Emission Inventory Branch (MD-14)
Technical Support Division
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

Dear Mr. Beauregard:

I have been asked to respond to your letter to our Mr. Ron O'Toole dated February 19, 1992. Aristech Chemical Corporation would be pleased to participate in the current update of the AP-42 phthalic anhydride industry profile.

Your specific technical questions regarding our process may be addressed to: Mr. Rex Shuff, Environmental Coordinator
Aristech Chemical Pasadena Plant
P.O. Box 600
Pasadena, TX 77501

Your specific questions relating to commercial matters may be addressed to me 600 Grant Street, Pittsburgh, Pennsylvania 15219.

We look forward to your inquiries.

Sincerely,

Richard A. Harris
Senior Environmental
Systems Consultant

cc: R. O'Toole
R. Shuff

ARISTECH

Aristech Chemical Corporation
600 Grant Street
Pittsburgh, PA 15230-0250
412/433-2747
Telex: 6503608865
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April 10, 1992

Mr. Dennis Beauregard
Emission Inventory Branch (MD-14)
Technical Support Division
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

Dear Mr. Beauregard:

In further response to your letter dated February 19, 1992, Aristech Chemical Corporation is pleased to provide the enclosed commercial information on the phthalic anhydride industry for your update of AP-42.

We believe future growth in phthalic production will mirror GNP growth and will be orthoxylene based, as naphthalene is difficult to handle and generally produces more environmental emissions.

Though we have studied maleic recovery, we believe it to be prohibitively costly, and the recovered material would be of substandard quality.

The four attached graphs address the other questions posed in your letter. The technical data requested is being sent directly to Mr. Colin Campbell under separate cover.

Thank you for the opportunity to be of service. Do not hesitate to contact me should you desire clarification.

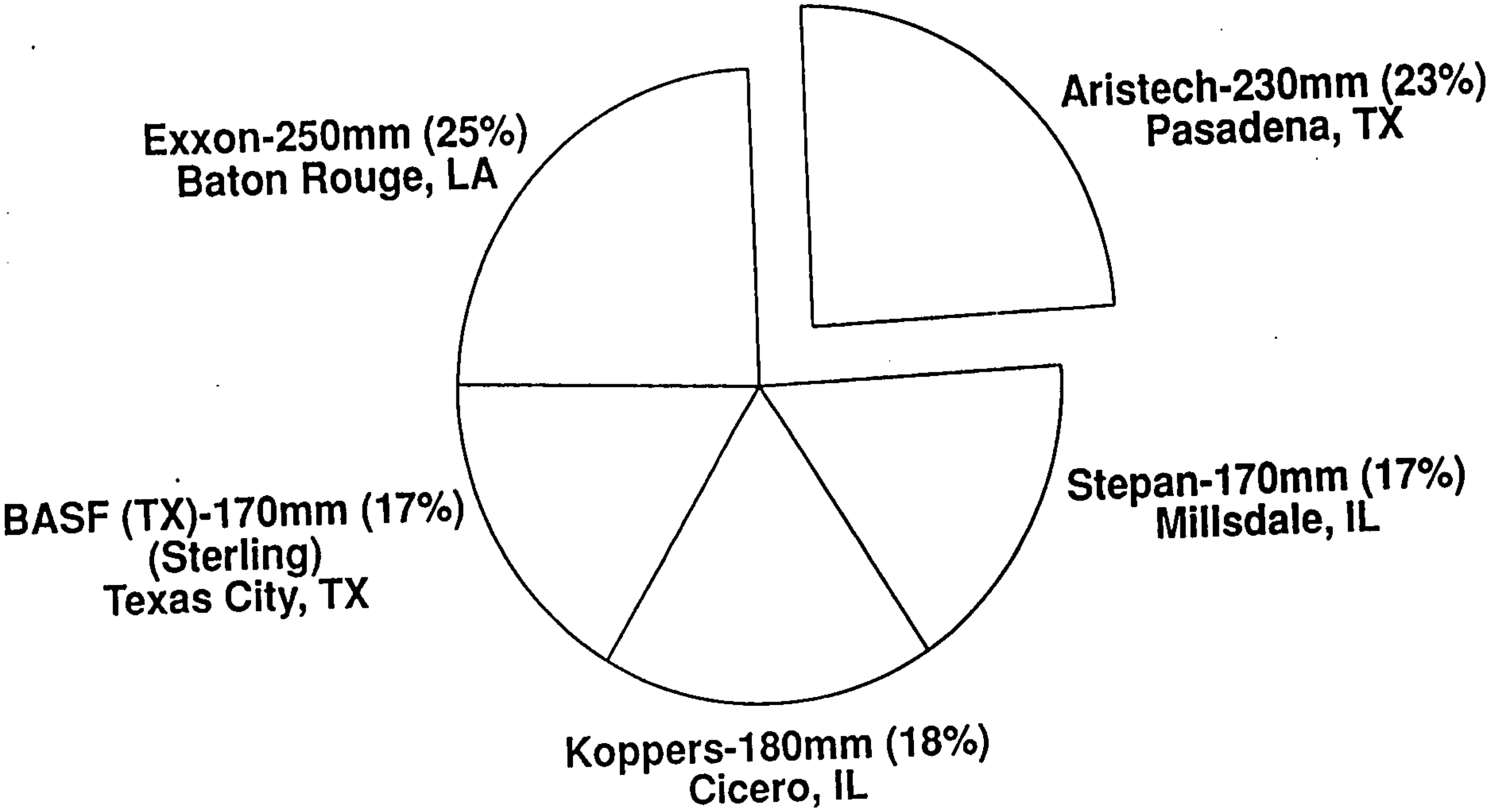
Sincerely,

Richard A. Harris
Senior Environmental
Systems Consultant

enclosures(4)

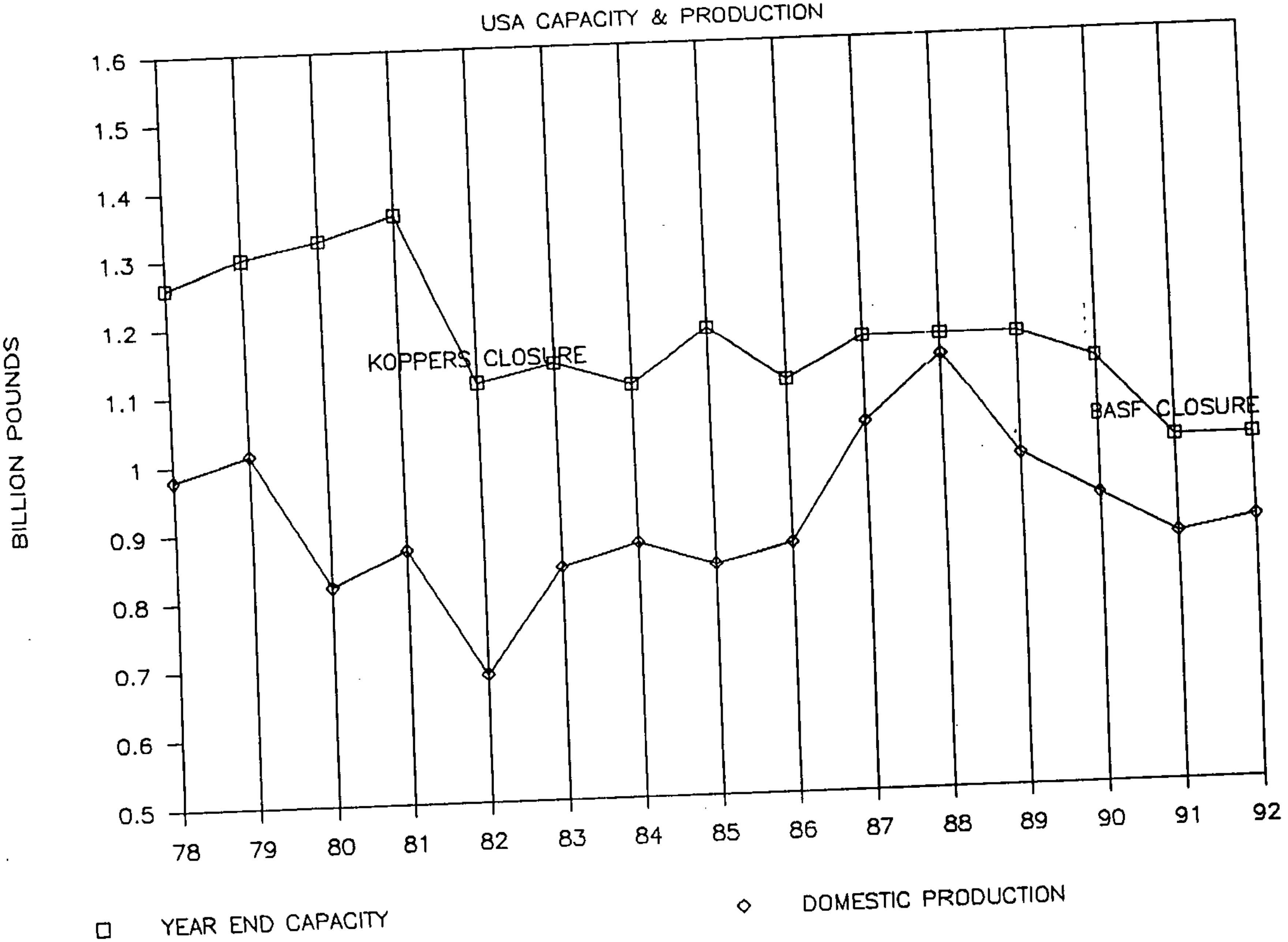
cc: R. Shuff

PHTHALIC DOMESTIC CAPACITY
Total Capacity 1,000mm/lbs



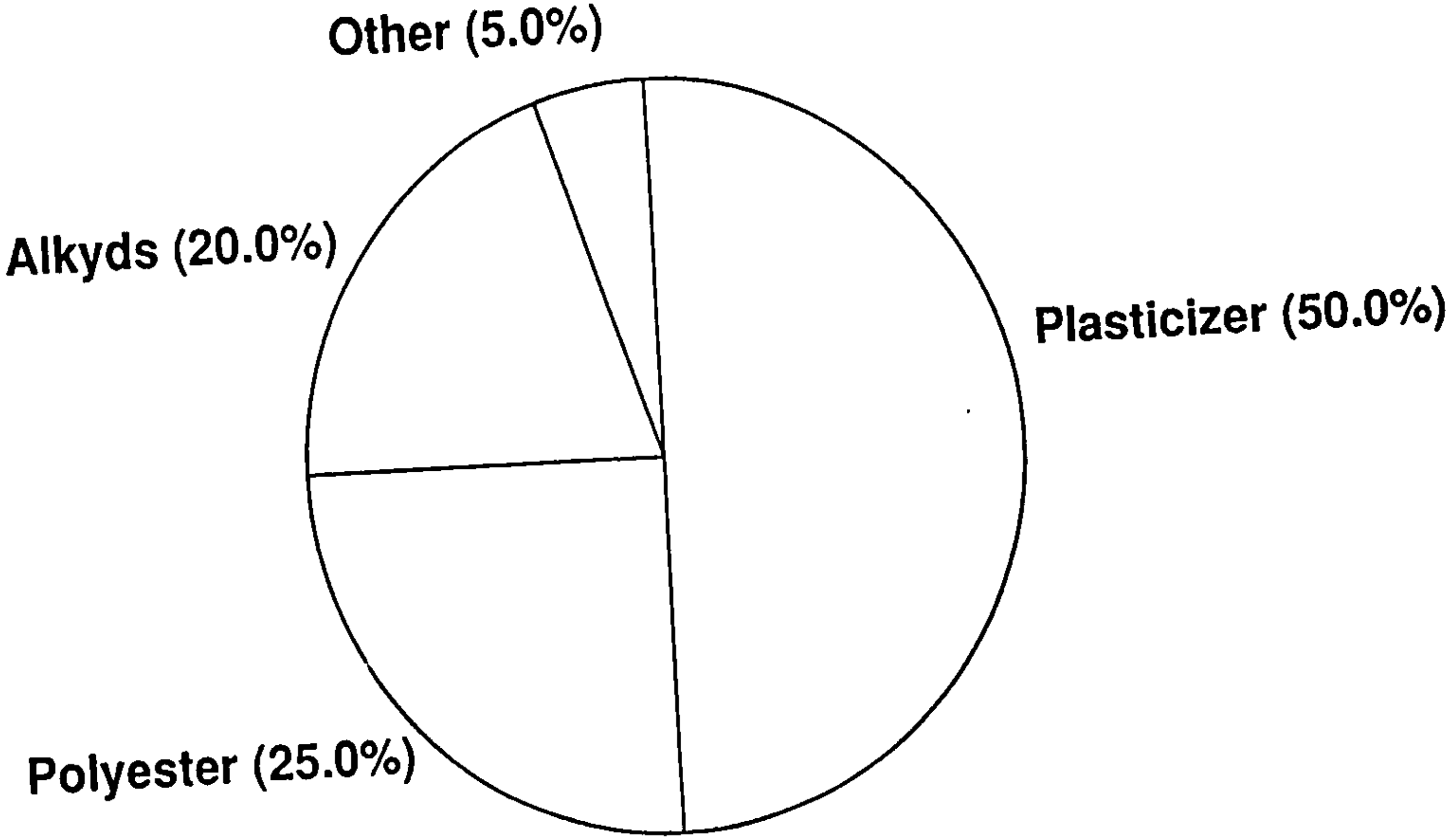
PHTHALIC ANHYDRIDE

USA CAPACITY & PRODUCTION



PHTHALIC ANHYDRIDE

Domestic Market By End Use



PHTHALIC ANHYDRIDE INDUSTRY

SPREADS OVER ORTHOXYLENE