



State of Florida
DEPARTMENT OF ENVIRONMENTAL REGULATION

For Routing To Other Than The Addressee	
To _____	Location _____
To _____	Location _____
To _____	Location _____
From: _____	Date _____

Interoffice Memorandum

TO: John Brown
FROM: W.C. Thomas *[Signature]*
DATE: November 28, 1989
SUBJECT: Start-Up Procedures for Sulfuric Acid Plants

RECEIVED

DEC 04 1989

DER-BAQM

Attached is the "Memorandum of Understanding", signed by Gary L. Dahms for the Royster Company, which covers both their Mulberry plant and their plant at Piney Point.

The Southwest District now has copies of all of the "Memorandums" signed by the sulfuric acid plant operators in central Florida with the exception of U.S. Agri-Chemicals.

WCT/js

Attachment

cc: Raul Alonso
Mirza Baig
Rick Garrity
Harry Kerns
C.S. Lee
Viet Ta

The parties jointly agree: for the purposes of Rule 17-2.250, the foregoing practices constitute "best operational practices" for the start-up of sulfuric acid plants.

The Department will not seek to incorporate these practices into permits for existing facilities during the first 18 months after implementation. After the expiration of this 18-month period, which is a typical catalyst cycle, the Department may seek to modify the permits, in accordance with Rule 17-4.080 and other applicable laws, to incorporate appropriate site-specific start-up procedures as enforceable permit conditions.

These Sulfuric Acid Plant Best Operation Start-Up Practices will be made available in the control room at all times.

Since these specific procedures are undergoing evaluation, the Department will not consider these practices to be the only means of demonstrating best operating procedures. If a company chooses to use another method, it will be its responsibility to demonstrate that it constitutes best operational practices in accordance with 17-2.250, F.A.C.

Best Available Copy

D. E. R.

NOV 28 1989

SOUTHWEST DISTRICT
TAMPA

MEMORANDUM OF UNDERSTANDING
REGARDING BEST OPERATIONAL START-UP PRACTICES.
FOR SULFURIC ACID PLANTS

These temperatures are the desired temperatures at the time the use of auxiliary fuel is terminated.

(2) The gas stream entering the converter shall contain SO_2 at a level less than normal, and sufficiently low to promote catalytic conversion to SO_3 .

b. Absorbing Towers.

The concentration, temperature and flow of circulating acid shall be as near to normal conditions as reasonably can be achieved. In no event shall the concentration be less than 96 percent H_2SO_4 .

5. Warm Restart.

a. Converter.

The inlet and outlet temperatures of the first two catalyst masses should be sufficiently high to ensure conversion. One of the following three conditions must be met:

(1) The first two catalyst masses inlet and outlet temperatures must be at a minimum of 700°F ; or

(2) Two of the four inlet and outlet temperatures must be greater than or equal to 800°F ; or

(3) The inlet temperature of the first catalyst must be greater than or equal to 600°F and the outlet temperature greater than or equal to 800°F . Also, the inlet and outlet temperatures of the second catalyst must be greater than or equal to 700°F .

Failure to meet one of the above conditions, requires use of cold start-up procedures.

To allow for technological improvements or individual plant conditions, alternative conditions will be considered by the Department in appropriate cases.

b. Absorbing Towers.

The concentration, temperature and flow of circulating acid shall be as near to normal conditions as reasonably can be achieved. In no event shall the concentration be less than 96 percent H_2SO_4 .

BEST OPERATIONAL START-UP PRACTICES
FOR SULFURIC ACID PLANTS

1. Only one sulfuric acid plant at a facility should be started up and burning sulfur at a time. There are times when it will be acceptable for more than one sulfuric acid plant to be in the start-up mode at the same time, provided the following condition is met. It is not acceptable to initiate sulfur burning at one sulfuric acid plant when another plant at the same facility is emitting SO₂ at a rate in excess of the emission limits imposed by the permit or rule, as determined by the CEMS emission rates for the immediately preceding 20 minutes.

2. A plant start-up must be at the lowest practicable operating rate, not to exceed 70 percent of the designated operating rate, until the SO₂ monitor indicates compliance. Because production rate is difficult to measure during start-up, if a more appropriate indicator (such as blower pressure, furnace temperature, gas strength, blower speed, number of sulfur guns operating, etc.) can be documented, tested and validated, the Department will accept this in lieu of directly documenting the operating rate. Implementation requires the development of a suitable list of surrogate parameters to demonstrate and document the reduced operating rate on a plant-by-plant basis. Documentation that the plant is conducting start-up at the reduced rate is the responsibility of the owner or operator.

3. Sulfuric acid plants are authorized to emit excess emissions from start-up for a period of three consecutive hours provided best operational practices, in accordance with this agreement, to minimize emissions are followed. No plant shall be operated (with sulfur as fuel) out of compliance for more than three consecutive hours. Thereafter, the plant shall be shut down. The plant shall be shut down (cease burning sulfur) if, as indicated by the continuous emission monitoring system, the plant is not in compliance within three hours of start-up. Restart may occur as soon as practicable following any needed repairs or adjustments, provided the corrective action is taken and properly documented.

4. Cold Start-Up Procedures.

a. Converter.

(1) The inlet and outlet temperature at the first two masses of catalyst shall be sufficiently high to provide immediate ignition when SO₂ enters the masses. In no event shall the inlet temperature to the first mass be less than 800°F or the outlet temperature to the first two masses be less than 700°F.

Steve Smallwood 11-11-89

Steve Smallwood, P.E., Date
Director, Division of Air
Resources Management
Department of Environmental
Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Boyer Bohme

Boyer Company

11/21/89

Date

MEDIA HOT SHEET

Reporter: Jocir Labelle

Date: 12-15-89

At (Newspaper, T.V., Radio, etc.): Tampa Tribune

JHP
From: Teresa Heron
Division: Air Resource mgmt
Bureau/Sect.: Air Regulation
Phone: 488-1344

Topic of Call: Royster Phosphates permit application

Questions asked: 1. what are the proposed SO₂, acid mist and
2. NO_x emissions for the project (sulfuric
3. acid plant) ?

Deadline: _____

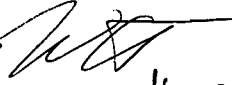
Summary of Conversation (use remainder of sheet, and back, if necessary):

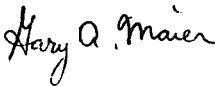
I told him what the application ^{that} proposed emission rates were. Also, we are in the preliminary review and that a BACT and modeling is needed which may change the proposed limits.

DER Employee Interviewed Teresa M. Heron

INTER-OFFICE MEMORANDUM

TO: Teresa M. Heron, DER Air BAQM, Tallahassee

THRU: W. C. Thomas, P.E. 

FROM: Gary A. Maier, DER Tampa 

DATE: December 21, 1989

SUBJECT: Permit Application No.: AC41-173305
County: Manatee
Project: New Sulfuric Acid Plant
Royster Phosphates, Inc.

The Southwest District office has reviewed the above referenced application. We have the following comments.

(1) The application does not contain a process flow diagram for the proposed facility. The process flow diagram in Figure 3-1 is described as "typical"; however, Figure 3-1 and the plant layout shown in Figure 3-2 do not agree with each other. (For example, Figure 3-1 places a Dryer upstream of the Furnace, but Figure 3-2 does not show a Dryer.) A process flow diagram for the proposed facility should be requested.

(2) The lack of a Dryer upstream of the Furnace raises a concern as to whether the acid mist emission limits will be met. The application does not contain design information, calculations, or historical operating experience for the Fiber Mist Eliminators. Design calculations and the design information listed below should be requested.

- (a) What is the controlling mechanism for mist collection, Inertial Impaction or Brownian Diffusion?
- (b) What is the design Superficial Velocity?
- (c) What is the Mist Loading of gases leaving the absorber and entering the mist eliminators (mg./SCF)?
- (d) What is the Mist Loading of gases leaving the mist eliminators (mg./SCF)?
- (e) What are the particle-size distributions of the mists entering and leaving the fiber mist eliminators?
- (f) What is the Volumetric Flow Rate through the mist eliminators?
- (g) What are the design pressure drop and filtering area?
- (h) What is the effect of "turn-down" on collection efficiency?

In addition to the above, historical operating data for identical mist eliminators on sulfuric acid plants without a dryer upstream of the furnace should be requested.

(3) The application does not contain design information, calculations, or historical operating experience for the proposed absorbers. Information such as size, packing type, liquid rate, pressure drop, efficiency as a function of gas rate, inlet/outlet compositions, superficial gas velocity, flood and load points, etc., should be requested.

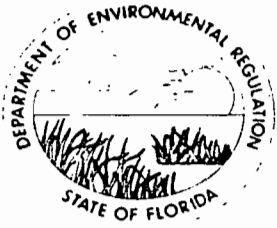
(4) The application does not contain design information, calculations, or historical operating experience for the proposed converters. Engineering estimates for SO₂ emissions are not possible based upon the information submitted by the applicant. Information such as size, number of passes, efficiency, flow rates, reaction rates, vendor guarantees, maintenance plans, etc., should be requested.

(5) The applicant has misinterpreted Rule 17-2.270 regarding "Good Engineering Practice Stack Height" (see page 38 of the application). The rule defines a minimum stack height. The applicant has interpreted the rule as defining a maximum stack height and has proposed a stack height that does not comply with the minimum requirements of the rule. The applicant should be requested to change the stack height proposal.

(6) All of the Air Quality Modeling submitted by the applicant was based on a stack height that does not comply with Rule 17-2.270. Air Quality Modeling should be re-done based upon an appropriate stack height.

If you have any questions regarding these comments, please call me at Suncom 552-7612 ext 360.

copy to: J. Harry Kerns



Florida Department of Environmental Regulation

Twin Towers Office Bldg. • 2600 Blair Stone Road • Tallahassee, Florida 32399-2400

Bob Martinez, Governor

Dale Twachmann, Secretary

John Shearer, Assistant Secretary

December 28, 1989

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. Gary L. Dahns
Vice President and General Manager
Royster Phosphates, Inc.
P. O. Box 1329
Palmetto, Florida 34220

Dear Mr. Dahns:

Re: Completeness Review for Proposed Sulfuric Acid Plant

The Department has reviewed your application for a permit to construct a double absorption sulfuric acid plant at Royster Phosphates, Inc.'s chemical complex in Palmetto, Manatee County, Florida. The Department needs additional information before we can process this application. In addition to the questions raised in the enclosed December 21, 1989, and December 22, 1989 memos from Mr. Gary Maier and Mr. Rob Baum, respectively, please provide the required air quality modeling for this project.

We will resume processing your application upon receipt of the requested information. If you have any questions on this matter, please contact Gary Maier at (813) 623-5561, Rob Baum at (813) 542-1408, Cleve Holladay at (904) 488-1344 or write to me at the Department's Tallahassee address.

Sincerely,

C. H. Fancy, P.E.

Chief

Bureau of Air Regulation

CHF/TH/plm

Attachments:

Gary Maier's memo dated December 21, 1989

Rob Baum's memo dated December 22, 1989

c: Bill Thomas, SW District
Rob Baum, Manatee County
John Koogler, P.E.

INTER-OFFICE MEMORANDUM

TO: Teresa M. Heron, DER Air BAQM, Tallahassee

THRU: W. C. Thomas, P.E. *WCT*

FROM: Gary A. Maier, DER Tampa *Gary A. Maier*

DATE: December 21, 1989

SUBJECT: Permit Application No.: AC41-173305
County: Manatee
Project: New Sulfuric Acid Plant
Royster Phosphates, Inc.

The Southwest District office has reviewed the above referenced application. We have the following comments.

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(3) The application does not contain design information, calculations, or historical operating experience for the proposed absorbers. Information such as size, packing type, liquid rate, pressure drop, efficiency as a function of gas rate, inlet/outlet compositions, superficial gas velocity, flood and load points, etc., should be requested.

(4) The application does not contain design information, calculations, or historical operating experience for the proposed converters. Engineering estimates for SO₂ emissions are not possible based upon the information submitted by the applicant. Information such as size, number of passes, efficiency, flow rates, reaction rates, vendor guarantees, maintenance plans, etc., should be requested.

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If you have any questions regarding these comments, please call me at Suncom 552-7612 ext 360.

copy to: J. Harry Kerns



STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATION SERVICES

December 22, 1989

DEC 26 1989

Teresa Heron, Air Permitting Engineer
Department of Environment Regulation
2600 Blair Stone Rd
Tallahassee, Florida 32399-2400

DER-BAQM

RE: Manatee County Public Health Unit (MCPHU) Review of Royster Phosphates new Sulfuric Acid Plant

Dear Teresa:

Enclosed is Manatee County Pollution Control questions in response to the Air Permit Application submitted by Royster Phosphates for a new Sulfuric Acid Plant. This completes the initial review of subject source . In order to complete our review addition information is required of the applicant.

Questions to Applicant:

1. Will any additional sulfuric acid storage tank be required for the new plant ?
2. If no new storage tanks are required how much new plumbing will be required to hook up to the old tanks. Please provide a sketch showing the new piping and old piping connection locations and placements.
3. Submit information showing that the new plant will comply with the recently adopted DER policy for the start up of sulfuric acid plants?
4. Based on the fact that the old plant maintained an emission rate of 3.37 lbs per ton what is the actual projected emission rate for the new plant?
5. Identify any industrial wastewater that the new plant will discharge and submit a water balance for the plant.
6. Provide detail description of the in-plant spill containment measures that the new plant will have?
7. Provide manufacture name and specification of continuous stack monitoring instruments provided on the new plant?

DISTRICT SIX
HRS MANATEE COUNTY PUBLIC HEALTH UNIT
410 SIXTH AVENUE EAST, BRADENTON, FLORIDA 34208 1986

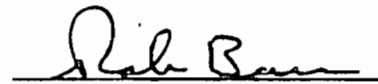
(813) 7484444

Page #2

8. Submit an analysis of fuel that will be used to bring the plant up during cold start up ?
9. What will be the gross electric power produced by co-generation process ?
10. What is the planned schedule for catalyst changes?
11. What planned catalyst manufacture and type will be used in the converter?
12. Will there be a imported electric power usage reduction at the Royster facility due to the use of the co-generation sulfuric acid plant?
13. If there is electrical power change due to this co-generation acid plant what will be the power requirement change in Mega watts at the Royster facility and what increase or decrease in pollutants is expected due to this electrical power requirement change?
14. Submit addition information regarding type and rational of computer air analysis performed , the actual computer output sheet and assumption made in the analysis.

If there are any question or comments on this letter please don't hesitate to call me at Suncom 542-1408. Please advise if any meeting on this subject as this office would like to participate.

Very Truly Yours



Rob Baum P.E.

RAB/rab

xc: R. Alonso
B. Priesmeyer
J. Bruens
Bill Thomas , DER Tampa
File

Best Available Copy

MEMORANDUM

TO: Teresa M. Heron, DER BAR, Tallahassee
THRU: *W.C.* C. Thomas, P.E. and J. Harry Kerns, P.E. *JK*
FROM: Gary A. Maier, DER Tampa *Gary A. Maier*
DATE: August 9, 1990
SUBJECT: Permit Application No. AC41-173305
County: Manatee
Project: Sulfuric Acid Plant
Applicant: Royster Phosphates, Inc.

During the May 21, 1990 meeting between FDER, Royster, Manatee County, and Monsanto, the FDER agreed to waive the detailed technical questions in items #2, #3, and #4 of my December 21, 1989 memo if Royster would provide satisfactory sulfur dioxide and acid mist stack test emission data from an operating plant that is similar to the proposed project. Roysters' response, dated July 6, 1990, does not provide such data.

Questions #2, #3, and #4 of my December 21, 1989 memo to you still stand, until and unless Royster provides the stack test data that they agreed to provide during the May 21, 1990 meeting.

RECEIVED

AUG 13 1990

DER: DER:m

INTER-OFFICE MEMORANDUM

TO: Teresa M. Heron, DER Air BAQM, Tallahassee
THRU: W. C. Thomas, P.E. *WCT*
FROM: Gary A. Maier, DER Tampa *Gary A. Maier*
DATE: December 21, 1989
SUBJECT: Permit Application No.: AC41-173305
County: Manatee
Project: New Sulfuric Acid Plant
Royster Phosphates, Inc.

The Southwest District office has reviewed the above referenced application. We have the following comments.

~~(1) The application does not contain a process flow diagram for the proposed facility. The process flow diagram in Figure 3-1 is described as "typical"; however, Figure 3-1 and the plant layout shown in Figure 3-2 do not agree with each other. (For example, Figure 3-1 places a Dryer upstream of the Furnace, but Figure 3-2 does not show a Dryer.) A process flow diagram for the proposed facility should be requested.~~

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- (h) What is the effect of "turn-down" on collection efficiency?

In addition to the above, historical operating data for identical mist eliminators on sulfuric acid plants without a dryer upstream of the furnace should be requested.

BEST AVAILABLE COPY

(3) The application does not contain design information, calculations, or historical operating experience for the proposed absorbers. Information such as size, packing type, pressure drop, efficiency as a function of gas rate, gas compositions, superficial gas velocity, flood and lean rates, etc., should be requested.

(4) The application does not contain design information, calculations, or historical operating experience for the proposed converters. Engineering estimates for SO₂ emissions are not possible based upon the information submitted by the applicant. Information such as size, number of passes, efficiency, flow rates, reaction rates, vendor guarantees, maintenance plans, etc., should be requested.

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~~(6) All of the Air Quality Modeling submitted by the applicant was based on a stack height that does not comply with Rule 17-2-270. Air Quality Modeling should be re-done based upon an appropriate stack height.~~

If you have any questions regarding these comments, please call me at Suncom 552-7612 ext 360.

copy to: J. Harry Kerns



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

JAN 10 1990

4APT-APB-cdw

Ms. Patricia G. Adams
Planner
Bureau of Air Quality Management
Florida Department of Environmental
Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

RE: Royster Phosphates, Inc. (PSD-FL-144)

Dear Ms. Adams:

This is to acknowledge receipt of the permit application for the above referenced source, dated December 6, 1989. As discussed between Mr. Barry Andrews of FDER and Mr. Gregg Worley of my staff on January 8, 1990, we have the following comment.

In determining the "actual" emissions of the existing sulfuric acid plant, the maximum production rate and emission rates which occurred during the previous five years were used. The "actual" emissions, however, should be an average of the previous two years operating data unless another period is more representative. Therefore, it is likely that the actual emissions from the existing facility are in fact lower than the maximum numbers presented by the source. Consequently, the source may also be subject to PSD review for NO_x. In any case the greater changes in emissions should be included in the modelling.

By letter dated December 14, 1989, we transmitted to your office a copy of the First Circuit Court of Appeals upholding the "actual-to-potential" applicability rules of the PSD requirements. Please refer to this ruling as a basis for our comments.

Thank you for the opportunity to review this package. Any questions or comments may be directed to Mr. Gregg Worley of my staff at (404) 347-2864.

Sincerely yours,

Bruce P. Miller

Bruce P. Miller, Chief
Air Programs Branch
Air, Pesticides, and Toxics
Management Division

S. Benson
B. Andrews
C. Holladay
B. Simpson
JHF/BT

MEMORANDUM

TO: Teresa M. Heron, DER BAQM, Tallahassee
THRU: W. C. Thomas, P.E. *WCT*
FROM: Gary A. Maier, DER Tampa *Gary A. Maier*
DATE: April 5, 1990
SUBJECT: Permit Application No. AC41-173305
County: Manatee
Project: Sulfuric Acid Plant
Applicant: Royster Phosphates, Inc.

RECEIVED
APR 09 1990
DER-BAQM

I have reviewed Royster's response dated March 13, 1990 and have the following comments.

Royster's response to item #2 of my December 21, 1989 memo is inadequate. Royster did not submit any of the information requested. Royster's response to this item is nothing more than an engineering conclusion, without showing any of the work as to how the conclusion was reached. Royster states that similar plants are operating in Florida. They should have provided some historical operating data for a similar plant without a dryer upstream of the furnace as was requested by the last sentence of item #2.

Royster's response to item #3 of my December 21, 1989 memo is inadequate. Royster did not submit any of the information requested. Royster states that similar plants are operating in Florida. They should have provided some historical operating data for a similar plant.

Royster's response to item #4 of my December 21, 1989 memo is inadequate. With the exception of the number of converter passes, Royster did not submit any of the information requested. Royster states that control of SO₂ emissions in double absorption plants similar to the proposed plant is well documented and accepted. They should have submitted some of this documentation. It is not the DER's responsibility to conduct literature research for a permit applicant.

In summary, I recommend that items 2, 3, and 4 of my December 21, 1989 memo to you be requested again in a second incompleteness letter to Royster. Day 30 is April 13, 1990.

INTER-OFFICE MEMORANDUM

TO: Teresa M. Heron, DER Air BAQM, Tallahassee

THRU: W. C. Thomas, P.E. *WCT*

FROM: Gary A. Maier, DER Tampa *Gary A. Maier*

DATE: December 21, 1989

SUBJECT: Permit Application No.: AC41-173305
County: Manatee
Project: New Sulfuric Acid Plant
Royster Phosphates, Inc.

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copy to: J. Harry Kerns

MEMORANDUM

TO: Teresa M. Heron, DER BAQM, Tallahassee
FROM: Gary A. Maier, DER Tampa *Gary A. Maier*
DATE: April 5, 1990
SUBJECT: Permit Application No. AC41-173305
County: Manatee
Project: Sulfuric Acid Plant
Applicant: Royster Phosphates, Inc.

Royster's response dated March 13, 1990 requests confidentiality. In order to accommodate their request to the extent possible, I prepared an edited version of their response for the public file and created a second confidential file. Attached for your convenience, and so that we can be consistent are:

- (1) a copy of my memo to file justifying the deletions from the public file, and
- (2) a copy of the two pages from Royster's response which I edited for the public file.

MEMORANDUM

TO: File

FROM: Gary A. Maier *Gary A. Maier*

DATE: April 4, 1990

SUBJECT: Permit Application No. AC41-173305
County: Manatee
Project: Sulfuric Acid Plant
Applicant: Royster Phosphates, Inc.

Royster's response dated March 13, 1990 requests confidentiality. Royster also requested that no information be disclosed without Royster's prior express written consent. The DER is not authorized to fully honor all of Royster's requests.

In Florida, AGO 071-394 adopted a holding that stated "a person who sends a communication to a public officer, relative to the public business, cannot make his communication private and confidential simply by labeling it as such. The law determines its character, not the will of the sender."

Pursuant to the requirements of Ch. 119 and Section 403.111, F.S., the DER is authorized to prevent disclosure of processes and methods only if they qualify as trade secrets.

In order to best satisfy the conflicting goals of open government and the protection of private interests, I prepared an edited copy of Royster's response for the public file. The following is an itemized list of specific deletions from Royster's response which, in my best engineering and legal opinion, may qualify as trade secrets.

- (1) The last sentence of response #2 is deleted because it identifies where acid mist generation is addressed in the process.
- (2) The middle of the sentence of response #4 is deleted because it describes the arrangement of the individual chemical unit operations.
- (3) The material balance numbers, except for the emissions data, are deleted from Block Flow Diagram #321-200 because they indicate the performance of individual chemical unit operations which are internal to the process.

- 1) Find in attachment one a revised process flow diagram.
- 2) The lack of a drying tower upstream of the sulfur furnace will have no impact on acid mist emissions from the plant. This design will utilize a final absorption tower equipped with mist eliminators operating in the same manner as many other double absorption sulfuric acid plants in operation and permitted by the state.

EDITED

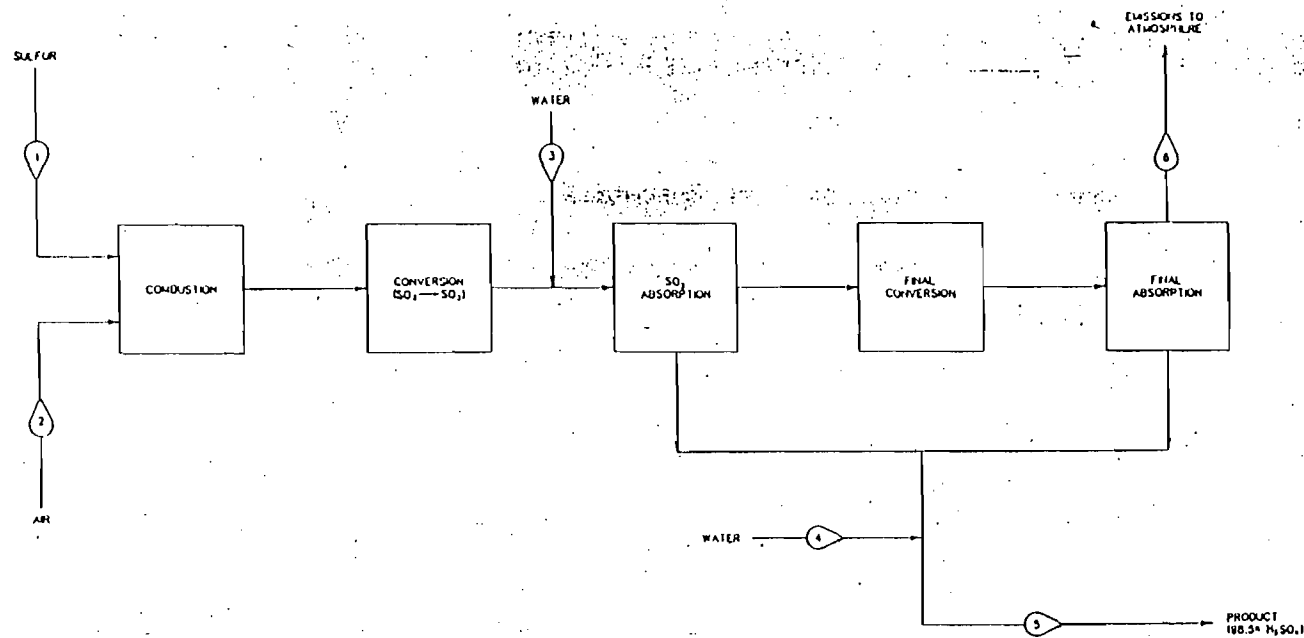
Operation and testing of the proposed plant under the authority of the requested construction permit will allow for the generation of needed operating data prior to granting of an operation permit.

- 3) As stated in response number two - plant design, in terms of final absorption tower and mist eliminator design are typical of other permitted double absorption plants currently permitted and in operation in Florida.

- 4) Control of SO₂ emissions in double absorption type plants with

EDITED

are well documented and currently accepted as capable of meeting all SO₂ emission limitations.



SO ₂	LB/HR
SO ₃	LB/HR
O ₂	LB/HR
N ₂	LB/HR
H ₂ O	LB/HR
H ₂ SO ₄	LB/HR
SULFUR	LB/HR
TOTAL	LB/HR

EDITED

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23478
44382
467303

CONFIDENTIAL

ROYSTER COMPANY, INC.
 ACID PLANT AND COGENERATION
 PALMETTO, FLORIDA
 MONSANTO ENVIRO-CHEM SYSTEMS, INC.
 ST. LOUIS, MISSOURI

BLOCK FLOW DIAGRAM AND MATERIAL BALANCE

ISSUED FOR PERMIT				DESCRIPTION				DESCRIPTION					
DATE	DESCRIPTION	BY	BY	NO.	DATE	DESCRIPTION	BY	BY	NO.	DATE	DESCRIPTION	BY	BY

THE PROPERTY OF MONSANTO ENVIRO-CHEM SYSTEMS, INC.
 12-11-88 PERMIT
 ISSUE DATE PURPOSE OF ISSUE

BY	DATE	APPROV.	DATE	JOB NO.	REV.
	12/11/88			2590	
				EXAMINER NO.	
				321-200	A



Florida Department of Environmental Regulation

Twin Towers Office Bldg. • 2600 Blair Stone Road • Tallahassee, Florida 32399-2400

Bob Martinez, Governor

Dale Twachtman, Secretary

John Shearer, Assistant Secretary

April 11, 1990

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. Gary L. Dahns
Vice President and General Manager
Royster Phosphates, Inc.
P. O. Box 1329
Palmetto, Florida 34220

Dear Mr. Dahns:

The Department has reviewed the additional information for a permit to construct a double absorption sulfuric acid plant at Royster Phosphates, Inc.'s chemical complex in Palmetto, Manatee County, Florida. We still need additional information to continue processing this application. Please complete the application by supplying the information requested below:

General Information

Page 4, Item 2.1 of Section 2.0 - Description of Existing Facility (see table of content) indicate that actual emission rates of sulfur dioxide and acid mist from the existing plant were determined from a review of emission measurement and production data from the past five years. For purpose of PSD regulations, the "actual" emissions shall be an average of the previous two years operating data unless another period is deemed to be more representative of normal operating conditions. Please submit this data (actual emissions) for the previous two years period for all criteria pollutants at this facility.

Are there any emissions from the waste heat boiler and the HRS boilers? If so, please quantify. Are they new sources? What type of fuel are they burning?

Submit a complete block flow diagram that will include all units in the proposed new sulfuric acid plant (i.e., waste heat boiler, HRS boiler, turbine generator, etc.).

In reference to Mr. F. Ivan Nance's letter of March 13, 1990, Mr. Gary A. Maier, of the DER Tampa office, feels the responses are inadequate. Please refer to his memo dated December 21, 1989, and provide answers to items No. 2, 3, and 4 as requested.

Mr. Gary L. Dahns
Page 2
April 11, 1990

We will resume processing your application upon receipt of the requested information.

If you have any questions on this matter, please contact Gary Maier at (813)623-5561, Rob Baum at (813)542-1408, Cleve Holladay or Teresa Heron at (904)488-1344, or write to me at the Department's Tallahassee address.

Sincerely,

C. H. Fancy, P.E.
Chief
Bureau of Air Regulation

CHF/plm

c: Bill Thomas, SW District
Rob Baum, Manatee County
John Koogler, P.E.

CM: P 377 462 161
7/13/90 (Post Mark)
Palmetto, FL

File Copy

Royster Phosphates, Inc.

13300 U. S. Hwy. 41 North
Palmetto, Florida 34221
(813) 722-4555

Cert. Mail
Number 377 462 161

July 6, 1990

RECEIVED

JUL 20 1990

DER-BAQM

Mr. C. H. Fancy
Bureau of Air Regulation
Florida Department of
Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32899-2400

Re: Permit Application Number AC 41-173305
Royster Phosphates, Inc, Sulfuric Acid Plant

Dear Mr. Fancy:

In the following, please find responses to your request for further information dated 13 April 1990. In an effort to gain understanding of the department's request and to provide the requested information in a positive manner, a meeting was held on 21 May 1990 with FDER staff from your office, Southwest District office, Manatee County Public Health Unit, Royster, and Monsanto, (see attachment one). In this meeting, the request was thoroughly discussed with Monsanto staff addressing many of the technical issues.

Monsanto staff provided a technical paper entitled, "The Monarch Process," (provided as attachment two). This paper describes several process variations that will be incorporated into the sulfuric acid plant contemplated in the above referenced permit application. Foremost of the variations is a new method that allows for higher operating temperatures in the interstage absorption step. Monsanto further provided their current strategy for controlling acid mist formation in the interstage absorption step.

During the meeting, many of the issues concerning the lack of drying tower and acid mist formation were addressed to the satisfaction of those present. Further information and data were requested on the proposed plants ability to meet sulfur dioxide and acid mist limitations. Monsanto staff offered to attempt to assimilate available data on these items from actual operating plants where the process variations are being utilized. Find in attachment three that available information. (At present, the only plant utilizing these variations is located in Namhae, Korea). Routine tests on acid mist are not performed, however, the paper provided in attachment three does review sulfur dioxide emissions at that facility.

Mr. C. H. Fancy

-page two-

In the following, please find more specific responses to your request -- in request and response format:

REQUEST ONE

Page 4, Item 2.1 of Section 2.0 - Description of Existing Facility (see table of contents) indicate that actual emission rates of sulfur dioxide and acid mist from the existing plant were determined from a review of emission measurement and production data from the past five years. For purpose of PSD regulations, the "actual" emissions shall be an average of the previous two years operating data unless another period is deemed to be more representative of normal operating conditions. Please submit this data (actual emissions) for the previous two years period for all criteria pollutants at this facility.

RESPONSE ONE

Emission measurements and production data for the previous five year period is not available due to the plant not being in operation during that entire period. The data submitted with the application represents the most recent information available for emissions measurements and plant production.

REQUEST TWO

Are there any emissions from the waste heat boiler and the HRS boilers? If so, please quantify. Are they new sources? What type of fuel are they burning?

RESPONSE TWO

There are no emissions from the waste heat boiler or the HRS boiler. Both of the referenced boilers receive heat energy from process gas streams within the sulfuric acid manufacturing process. No other fuels are utilized nor do they have emission points that qualify as new sources.

REQUEST THREE

Submit a complete block flow diagram that will include all units in the proposed new sulfuric acid plant (i.e., waste heat boiler, HRS boiler, turbine generator, etc.).

RESPONSE THREE

The previously supplied diagram accurately reflects the components mentioned. Please accept the diagram on page three of attachment two if further documentation is needed.

REQUEST FOUR

In reference to Mr. F. Ivan Nance's letter of March 13, 1990, Mr. Gary A. Maier, of the DER Tampa office, feels the responses are inadequate. Please refer to his memo dated December 21, 1989, and provide answers to items No. 2, 3, and 4 as requested.

Mr. C. H. Fancy

-page three-

RESPONSE FOUR

Mr. Maier's request was discussed in detail during the 21 May 1990 meeting. In brief, the need for details concerning the generation of acid mist were resolved upon explanation of process control methods within the interstage absorption step. Monsanto has identified process conditions that diminish greatly the generation of acid mists in the manufacturing process with or without a drying tower present. This concept is found in detail on page eight of attachment two.

REQUEST FIVE

Mr. Ivan Nance's letter of March 13, 1990 also stated that Koogler and Associates would be forwarding under separate cover the computer printouts for the modeling results in both magnetic and paper format. We have not received any of this information.

RESPONSE FIVE

Koogler and Associates have provided the requested information at this time.

REQUEST SIX

Please respond to attached memo from Mr. Rob Baum, of the Manatee County HRS.

ITEM ONE

In regards to Royster's response #2 about the lack of a drying tower, are there any operational plants in the United States which do not use a drying tower upstream of the sulfur furnace in a double absorption sulfuric acid plant? If there are no other plants like this would this be the first plant of its kind including any pilot type plants?

ITEM ONE RESPONSE

Monsanto constructed in 1962 for Climax Chemical a sulfuric acid plant with no drying tower. It operated successfully for 25 years prior to shut down a few years ago.

Please see further information on this subject at page two of attachment two, "Wet catalytic Process."

ITEM TWO

If there are sulfuric acid plants of this kind (no upstream dryer) do they operate in a high humidity environment such as Florida and what impact will the high humidity have on the operation of the plant concerning emission of Sulfur Dioxide? If there is a relationship between humidity and emissions of sulfur dioxide please provide a graph showing the relative relationship.

ITEM TWO RESPONSE

No specific knowledge of a relationship between humidity and

Mr. C. H. Fancy
-page four-

sulfur dioxide emissions is known. Please see page two of attachment two, "Wet Catalytic Process."

ITEM THREE

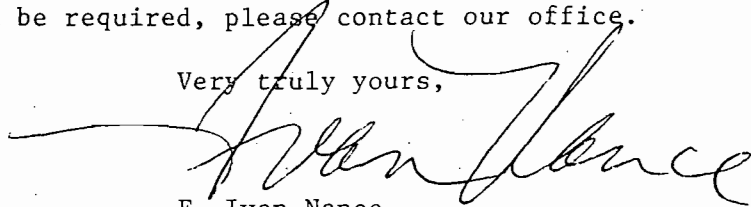
Would the addition of a drying tower reduce the emission of sulfur dioxide with all other factors being equal even though it is known that the energy consumption would be greater using the drying tower, and that cogeneration could be used to offset this additional energy usage.

ITEM THREE RESPONSE

Utilization of a drying tower would not reduce sulfur dioxide emissions as contemplated in this request. Please see pages two and four of attachment two "Process Overview."

Hopefully, the foregoing responses and information in attachment three will satisfy the departments request. Royster appreciates the departments cooperation in this matter. Should further information be required, please contact our office.

Very truly yours,



F. Ivan Nance
Environmental/Technical
Manager

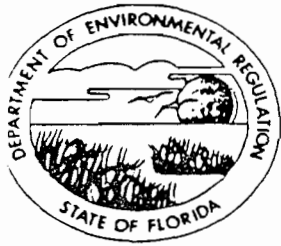
FIN: dam

Attachments

cc: R. Baum, MCPHU
W. C. Thomas, FDER SW District
G. Maier, FDER SW District
P. Raval, Koogler & Associates

cc: Barry Andrews }
Clem Holladay } 7/24/90. KT
Teresa Horon }

ATTACHMENT ONE



Florida Department of Environmental Regulation

Southwest District • 4520 Oak Fair Boulevard • Tampa, Florida 33610-7347 • 813-623-5561

Bob Martinez, Governor

Dale Twachmann, Secretary

John Shearer, Assistant Secretary

Dr. Richard Garrity, Deputy Assistant Secretary

DATE: May 21, 90

TIME: 9:30 a.m.

SUBJECT: Royster Phosphates

A T T E N D E E S

Name	Affiliation	Telephone
<u>Harry Krum</u>	<u>FDER</u>	<u>623-5561(419)</u>
<u>Bill Thomas</u>	<u>"</u>	<u>" 35</u>
<u>Gary Maier</u>	<u>FDER</u>	<u>623-5561 (360)</u>
<u>Barry Andrews</u>	<u>FDEIC (Tallahassee)</u>	<u>(904) 488-1344</u>
<u>Raul Alonso</u>	<u>H.R.S. (Manatee)</u>	<u>813-748-0666</u>
<u>Rob Baum</u>	<u>HRS (MANATEE CO)</u>	<u>813-748-0666</u>
<u>JAMES R. SHAFER</u>	<u>MONSANTO ST. LOUIS</u>	<u>(314) 275-5749</u>
<u>Robert W. Grendel</u>	<u>Monsanto St Louis</u>	<u>314/275-5743</u>
<u>RICHARD P. FLEMING</u>	<u>ROYSTER</u>	<u>813-722-4555</u>
<u>Susanne Neupauer</u>	<u>Royster</u>	<u>813-722-4555</u>
<u>Steve Kause</u>	<u>Royster</u>	<u>" "</u>

ATTACHMENT TWO

THE MONARCH PROCESS

A Sulfuric Acid Plant for the 90's

A Sulfuric Acid Plant for the 1990's

D. R. McAlister, R. W. Grendel, D. R. Schneider,
J. R. Shafer, and J. S. Tucker

Monsanto Enviro-Chem Systems, Inc.
Corporate Pointe, P.O. Box 14547
St. Louis, Missouri 63178

ABSTRACT

An active research and development program combined with the experience gained from designing and operating Heat Recovery Systems has led to another major advance which significantly improves the economics of sulfuric acid heat recovery. Monsanto Enviro-Chem's new process is based on the highly synergistic combination of two well proven technologies. This new acid plant rejects essentially no heat to cooling water, and a 2500 t/d plant can export at least 32 MW of electricity. Power generation is approaching the point where the acid plant can be justified on the basis of energy alone, with sulfuric acid being the by-product. The acid plant of the future will be the one that is most successful in maximizing energy credits, and Enviro-Chem's process represents a step change toward accomplishing that goal.

BACKGROUND

In the 1970's a typical sulfur burning sulfuric acid plant recovered only about 55% to 60% of the process heat as steam. With Monsanto Enviro-Chem's Heat Recovery System (HRS), 95% of the process heat can be recovered as steam. The HRS process involves holding absorbing tower exit acid concentrations at 99% to 100%. This protects stainless steel equipment at operating temperatures which are high enough to generate medium pressure (10 bar) steam. (1, 2) While most prospective customers have been fascinated by the simplicity of the process, there were critics who insisted it wouldn't work.

A pilot plant was constructed and first operated in 1983. Today, more than 9000 operating hours have been logged on the pilot plant. Three plants with HRS have operated for over two years, and construction has started on three new installations. The first HRS, which started up at Namhae (Korea) in November 1987, continues to meet or exceed design expectations. (3) There was a process excursion at the Falconbridge plant in Norway, but this was unrelated to the basic technology.

Whenever a new technology is introduced, opportunities for optimization and improvement quickly follow. An active research and development program combined with the experience gained from designing and operating full scale systems has led to another major advance which significantly

improves the economics of recovering energy from sulfuric acid. Enviro-Chem's new process is based on the highly synergistic combination of two well proven technologies: HRS and the wet catalytic process. This new technology is the basis of several pending patent applications.

There are two major features of this technology. First, essentially all the process heat is recovered as steam, which eliminates the need for cooling water in the acid plant. Second, heat is shifted from the production of medium pressure steam to the production of high pressure steam. In the future, the successful sulfuric acid plants will be those that concentrate on generating maximum electric power.

WET CATALYTIC PROCESS

The manufacture of sulfuric acid by processing gas containing water, sulfur dioxide, and sulfur trioxide is a well established and proven technology. It is sometimes referred to as the wet catalytic process. Such plants typically operate on feedstocks like hydrogen sulfide, which produce water when burned.

Cooled combustion gases are taken directly to the converter, thus eliminating the capital cost associated with drying. Conventional vanadium catalysts have worked very successfully under these conditions. Enviro-Chem built such a plant for Climax Chemical in 1962. It operated for 25 years before it was shut down a few years ago.

PROCESS OVERVIEW

A flow diagram for the new process is shown in Figure 1. Moist ambient air is drawn through a filter by the main blower. The compressed air is preheated prior to entering the sulfur burner. The preheater uses hot acid from the heat recovery system (HRS) to heat combustion air, which effectively shifts additional heat to high pressure steam production. The gas exiting the sulfur burner is cooled by a waste heat boiler before entering the first converter pass. A superheater after the first pass and a hot heat exchanger after the second pass are standard gas cooling equipment for these locations.

Dilution water, in the form of 0.3 bar saturated steam, is added to the gas leaving the third pass. As the gas is cooled in superheater 3A and economizer 3B, some of the sulfur trioxide reacts with the water vapor to form sulfuric acid vapor. About one fourth of this reaction heat is recovered in the superheater and three fourths is recovered in the economizer 3B. Some acid is condensed in the economizer. This heat of reaction and condensation is recovered as high pressure steam.

The gas from the economizer enters the first of two HRT stages. High temperature absorption and condensation occurs in the lower stage. The upper stage is a cooler condenser, where the gas is contacted with cool sulfuric acid to reduce sulfur trioxide and sulfuric acid vapor to normal levels. The gas is slowly cooled in the upper stage to minimize mist formation. Acid circulating through the tower absorbs the heat from acid condensation and sensible gas cooling. The circulating acid

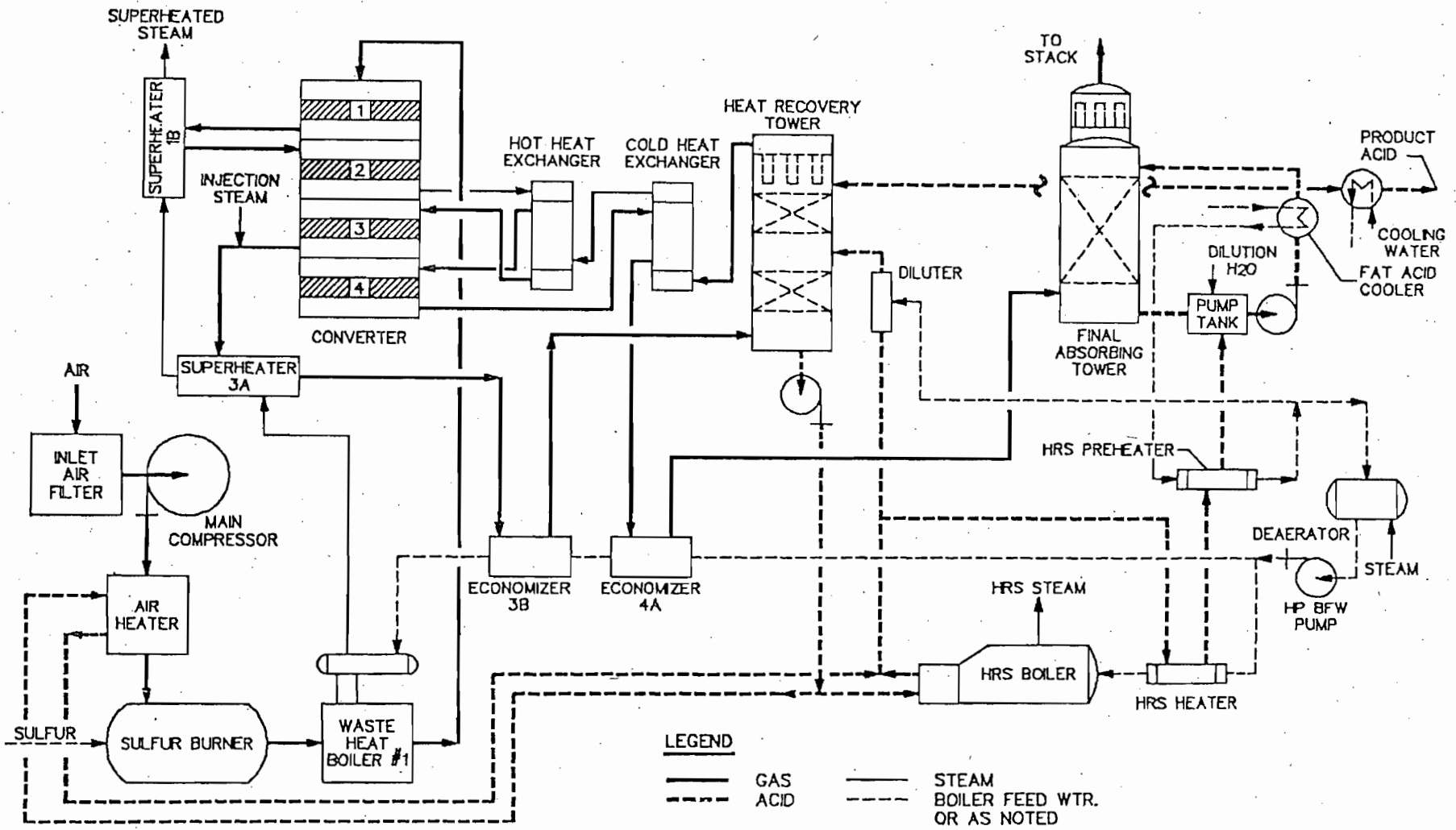


FIG.1 : PROCESS FLOW DIAGRAM

is cooled in the air preheater and the HRS boiler. The cooled acid stream flows to the dilutor where it is mixed with boiler feed water for trim concentration control, before flowing back to the first HRT stage.

The overflow from the HRT flows to the HRS heater where it is cooled by feed water to the HRS boiler. This acid stream is further cooled in the HRS preheater before flowing into the final tower pump tank.

The gas leaving the HRT is heated in the cold and hot interpass heat exchangers before entering the fourth converter pass. The cold interpass heat exchanger is located after the fourth pass, so it is only exposed to dry gases with a low dew point. The cold gas leaving the cold interpass exchanger enters the hot interpass exchanger at a temperature above the dew point of the hot gas entering the hot interpass exchanger. The gas leaving the fourth pass is cooled in the cold interpass exchanger and economizer 4A before entering the final absorbing tower (FAT). From there it exhausts to the atmosphere through the plant stack.

The acid from the FAT is pumped through the FAT acid cooler, which uses demineralized water to cool the acid. The cooled acid is then distributed to the FAT and the upper stage of the HRT. The water leaving the FAT cooler is further heated in the HRS preheater before going to the deaerator. The deaerator is operated at a pressure high enough to allow all the acid heat to be recovered.

The product acid cooler and the compressor lube oil cooler are the only cooling water requirements, so no cooling tower is installed in the acid plant area. The only cooling tower is for the steam condenser in the turbogenerator area.

For minimum capital cost (low power value), the process can be modified by eliminating the air preheater, steam injection system, and the alloy condensing economizer. This flow scheme shifts more heat to 10 bar steam production in the HRS. The dry tower is eliminated to take advantage of that cost savings.

The following sections provide additional information on the major equipment changes.

ELIMINATE DRYING TOWER

One of the key features of the new process is that there is no drying tower (DT). Eliminating the drying tower produces a number of advantages. The cost of the DT and its associated pump, piping, pump tank, acid cooler, and cooling water system is saved. Cross flow from the DT (or DT/FAT) pump tank to the HRT is not required to maintain the DT acid strength. This eliminates the problem of recovering energy from the hot cross flow acid leaving the HRT circuit, and that potential heat loss is avoided. Concentration control is also simplified.

There are several other factors which contribute to increased energy recovery. The heat of condensation of water vapor normally removed in the DT cooler is shifted to the HRT, where it is available to generate

steam. The low blower suction temperature reduces the blower power, and the heat of compression is recovered in the high pressure boiler without the problems associated with suction drying towers.

AIR FILTER

While the flow diagram shows a conventional air filter, the process is adaptable to using a wet scrubber, which eliminates the maintenance problems associated with conventional air filters. The air enters the process at a temperature close to the wet bulb temperature. Hot water from elsewhere in the complex can be used for scrubbing. This supplies the heat needed to evaporate additional water; however, the increased blower horsepower limits the effectiveness of this approach, especially if the same heat can be utilized downstream of the blower.

COMBUSTION AIR PREHEATER

Using HRS acid to preheat combustion air provides an effective means of moving heat from medium pressure steam production to high pressure steam production. There is a synergism with eliminating the dry tower, wherein the cold suction temperature minimizes the horsepower and reduces blower discharge temperature. Substantial heat is recovered in the preheater, and the burner inlet temperature is increased. The water vapor increases the mass flow and specific heat, which keeps the burner exit temperature down.

The preheater is a fin tube heat exchanger. Alloy materials are required where the tubes contact hot acid; however, the fins may be constructed of less expensive materials.

STEAM INJECTION

Table I shows the heat evolved when sulfur trioxide and water react to form sulfuric acid under different phase conditions. The gas phase reaction (Equation 2) produces 74% of the heat produced by the normal liquid phase reaction (Equation 1). Figure 2 shows the extent of the gas phase reaction of an equimolar mixture of sulfur trioxide and water at various temperatures. With steam injection, much of the reaction heat is available at temperatures considerably higher than the HRS operating temperature.

The steam injection is carried out after the third catalyst stage. While some reaction heat is picked up in the 3A superheater, this is not thermodynamically efficient because of the large difference in stream temperatures. The purpose of injecting steam after the third pass is to maintain temperatures well above the dew point until the gases are completely mixed. At this location, the bulk gas temperature is about 200°C above the dew point.

Potential sources of injection steam are boiler blowdown flash, deaerator vent steam, turbine low pressure port, steam generated from low temperature acid, HRS steam, and low pressure steam sources from outside the acid plant.

Table I

Sulfuric Acid Standard Heats of Reaction

No.	Reaction Conditions	Heat of Reaction
1)	$\text{SO}_3 \text{ (g)} + \text{H}_2\text{O (l)} \longrightarrow \text{H}_2\text{SO}_4 \text{ (l)}$	31.7 kcal/mole
2)	$\text{SO}_3 \text{ (g)} + \text{H}_2\text{O (g)} \longrightarrow \text{H}_2\text{SO}_4 \text{ (g)}$	23.3 kcal/mole
3)	$\text{SO}_3 \text{ (g)} + \text{H}_2\text{O (g)} \longrightarrow \text{H}_2\text{SO}_4 \text{ (l)}$	42.2 kcal/mole

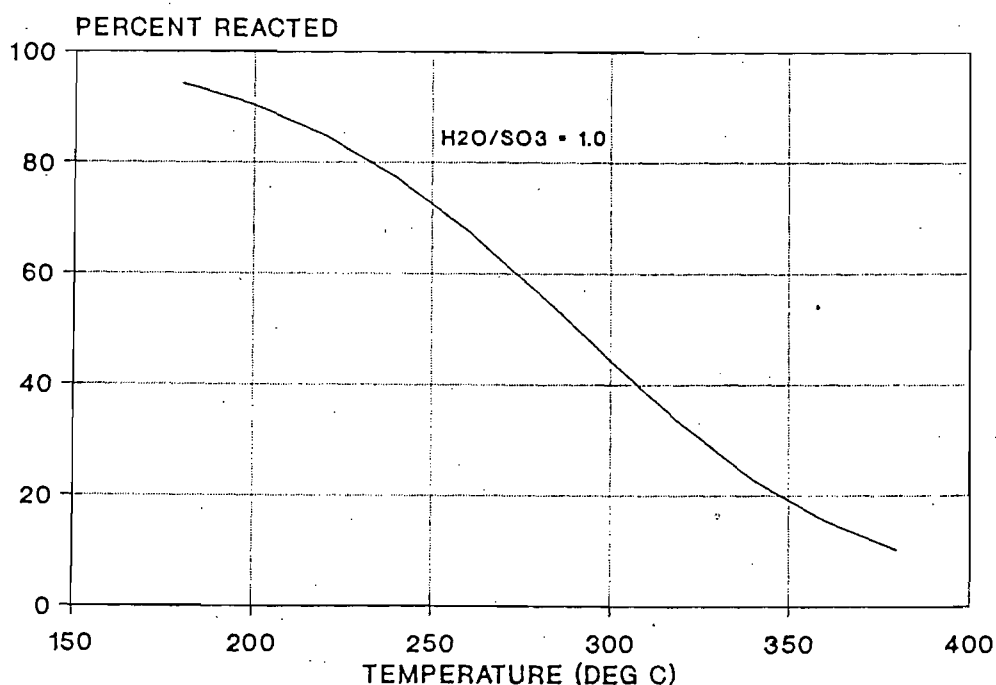


FIG. 2: EXTENT OF VAPOR PHASE REACTION

Localized cooling and high water concentration produces weak acid on the steam injection nozzle. This nozzle is constructed of ceramic material to withstand the aggressive corrosive conditions.

CONDENSING ECONOMIZER

The 3B economizer allows more of the acid heat of reaction to be recovered as high pressure steam. The gas phase reaction is approximately 60% complete at the economizer exit. Since the tube wall temperatures are below the dew point, some condensation heat is also recovered. The economizer is constructed of the same corrosion resistant alloy materials that have been proven in HRS service.

The dew point of the gas stream ranges from about 210°C to about 270°C. The lower end of this range is typical for a plant where ambient air is the main source of moisture. The upper end of the range is typical for a plant where steam injection is used to produce a nearly equimolar mixture of sulfur trioxide and water.

The mole ratio of water to sulfur trioxide is kept below 1.05, which corresponds approximately to the concentration of the sulfuric acid azeotrope. This insures that the condensation product will have a concentration greater than the sulfuric acid azeotrope, which is about 99% at 210°C and 98.6% at 270°C. These high acid concentrations are well suited to alloy materials previously described. (4, 5, 6)

The condensate concentration is not very sensitive to water vapor content. If there are excursions in the steam addition rate, the condensate film is maintained at relatively high acid strength, where the corrosion rate is low. Figure 3 shows that 140% of the stoichiometric water can be added without decreasing the condensate concentration below 98% acid. The excess water vapor passes to the HRT, where the large holdup of acid prevents the concentration from dropping rapidly. As a concentration decrease is detected, the steam valve is throttled.

While not shown in the flow diagram, under some circumstances it is advantageous to employ a heat exchanger to heat high pressure boiler feed water with HRS acid. Such a unit can operate in parallel or series with the HRS boiler. This is another way of utilizing acid heat to produce high pressure steam rather than medium pressure steam. Such a unit can not recover heat at as high a temperature as a condensing economizer, but the better heat transfer can reduce equipment cost.

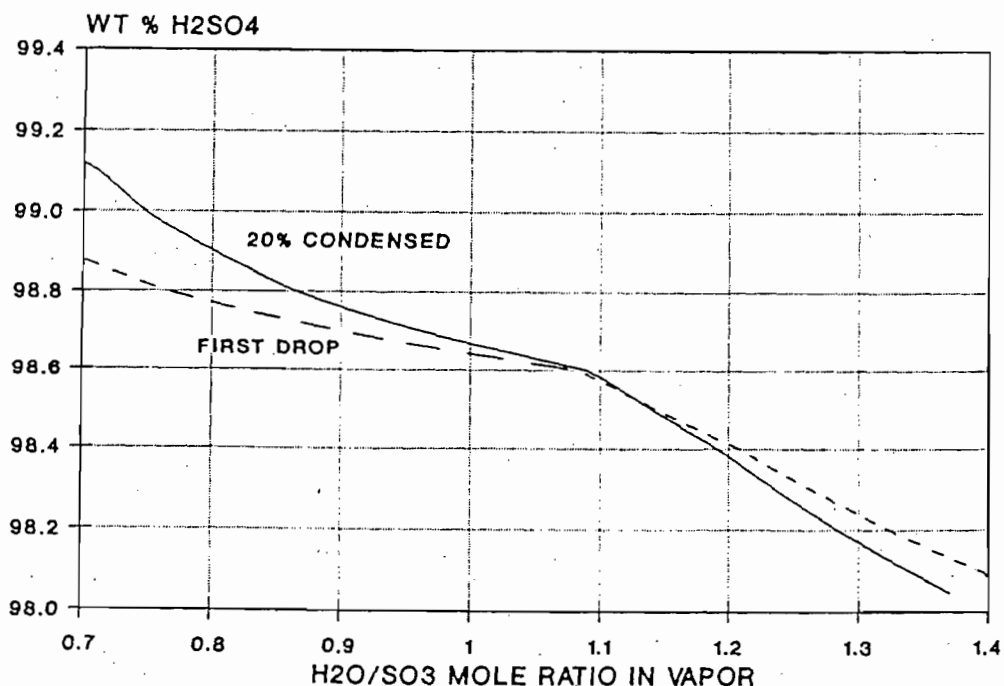


FIG. 3: CONDENSATE COMPOSITION

HEAT RECOVERY TOWER

Increased Steam Production

Table I shows the reaction of sulfur trioxide with water vapor (Equation 3) produces 33% more heat than the reaction with liquid water (Equation 1). This heat of reaction can be converted to medium pressure steam in the HRS. Sources of water vapor are humid air and low pressure injection steam, as previously described. The HRS acts like a chemical heat pump, in that low pressure steam used for acid dilution in the HRT is effectively upgraded to medium pressure steam.

Mist Formation

When a wet catalytic process is operated with a conventional absorbing tower, large quantities of acid mist are formed. Sulfur burning plants with steam leaks have had similar experience. Fortunately, there is a synergism at work where the wet gases are advantageous to HRS, and HRS provides a means of overcoming the high mist levels that can be experienced in a wet catalytic process. The key is that the HRT operates with exit acid temperatures of 200°C to 230°C, which approach or even exceed the dew point of the inlet wet gas stream. This prevents rapid cooling and minimizes mist formation by an order of magnitude, as shown in Figure 4. Higher acid temperature is required as the water vapor content increases. The results shown in Figure 4 are based on an inlet gas temperature of 300°C and a constant liquid to gas ratio. HRS pilot plant tests confirm that mist is reduced to a level that is easily handled by high efficiency mist eliminators.

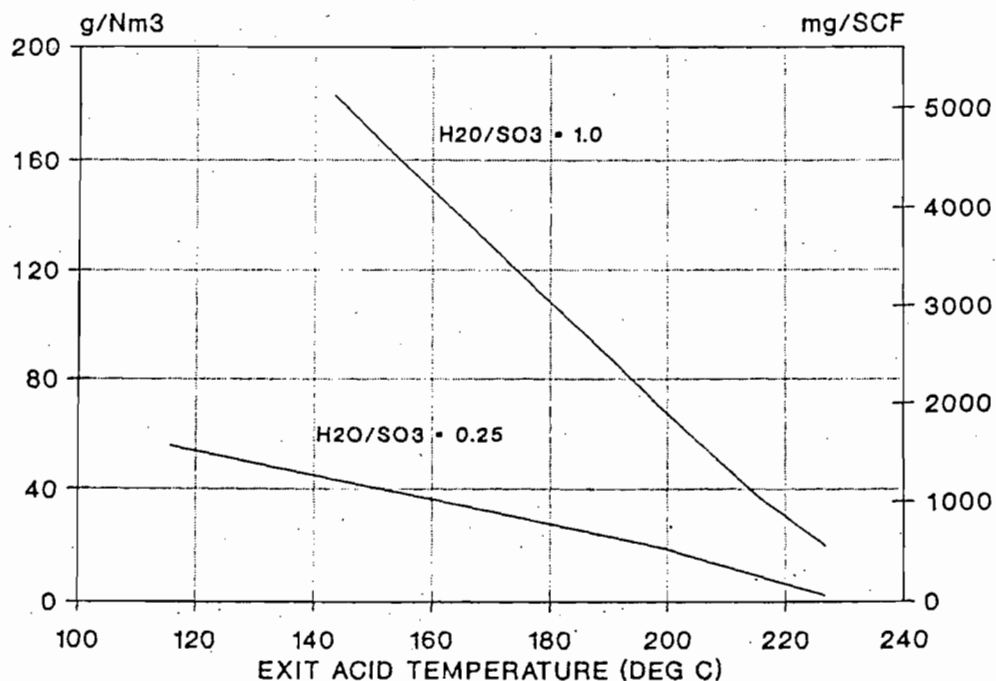


FIG. 4: MIST GENERATION IN ABSORBER

MATERIALS OF CONSTRUCTION

Wet sulfur trioxide-containing gas can be handled in carbon steel equipment provided the gas temperature is kept above the dew point. Carbon steel construction was used for the Climax Chemical plant mentioned earlier. The relatively high dewpoint generally limits cooling equipment to boilers and superheaters. Equipment operated below the dew point must be constructed of alloys or other corrosion resistant material.

There are a number of stainless steel and nickel alloys that can be used in high temperature strong acid service. This is well proven by HRS experience. Alloy performance can be characterized by a corrosion index (CI) which is defined in terms of alloy composition by the relationship:

$$CI = 0.4[Cr] - 0.05[Ni] - 0.1[Mo] - 0.1[Ni] \times [Mo] > 8$$

Where: [Cr] = Weight percent chromium
[Ni] = Weight percent nickel
[Mo] = Weight percent molybdenum

Alloys most likely to exhibit low corrosion rates in strong high temperature sulfuric acid are those with the highest corrosion index. Preferably the corrosion index should be greater than 8. As indicated by the corrosion index formula, high chromium is desirable, and it is preferable to avoid alloys which have both high nickel and high molybdenum. Alloys with 18 to 30% chromium which contain high nickel and very low molybdenum, or low nickel and moderate amounts of molybdenum usually give satisfactory service.

PILOT PLANT CORROSION TESTS

HRS pilot plant tests with wet sulfur trioxide containing feed gas has confirmed low corrosion rates. More than 1000 operating hours have been logged to date.

Table II shows corrosion rates for a number of alloys placed about 1.5 meters downstream of the steam injection nozzle. This data was taken with steam injection supplying 100% of the dilution water requirement. At 235°C, the metal surface temperature was well below the dew point.

Table II

Corrosion Rates Measured in Pilot Plant

Alloy	Corrosion Rate	
	mm/a	(mpy)
304 Stainless	0.020	0.8
309 Stainless	0.013	0.5
310 Stainless	0.008	0.3

START UP AND SHUT DOWN

For safe and corrosion free start ups and shut downs, two extra ducts have been added (not shown in the process flow diagram). There is a recycle duct from the final absorbing tower outlet to the blower inlet, and a heat recovery system bypass from the third pass outlet to the fourth pass outlet. In this plant, the cold interpass heat exchanger is after the fourth pass instead of the more typical third pass.

For cooling and purging the plant, dry air is recycled through the entire plant. Residual sulfur trioxide and heat are removed in the final tower and its acid cooler.

At start up, liquid dilution water is used instead of steam injection. This lowers the dew point by about 60°C. Steam injection is initiated when the heat exchanger surfaces are close to the steady state operating temperature.

ECONOMIC BENEFITS

While the development of a new technology is always interesting, what is most important is the results achieved. Table III shows the benefits of Enviro-Chem's new design are quite impressive.

The three cases shown in Table III are all based on a 2500 t/d sulfuric acid plant in a typical phosphate fertilizer operation. In all cases, 54.5 t/h (120,000 lb/h) of 3 bar steam is exported for phosphoric acid evaporation. Some additional 3 bar steam is required for the deaerator, and about 5.9 t/h (13,000 lb/hr) of nominal 10 bar steam is utilized for ejector operation and sulfur melting/heating. The main compressor is turbine driven, and all the excess steam from the acid plant goes to the turbine generator to produce electric power. About 2 MW of power is used in the acid plant, and the rest is available for export. The scope for the turbine generator area includes all the normal ancillary facilities such as cooling tower, building, and electrical distribution.

The "conventional plant", case 1, is a typical plant built in the 1980's with a nominal 70% energy recovery. About 25% of the reaction heat is rejected to cooling water. A portion of the export steam is supplied by a back pressure turbine on the main compressor. The balance is obtained by extraction from the generator turbine. The net export power for this case is about 21 MW.

The "high power" design, case 3, can export about 32 MW of electric power. Comparing case 3 and case 1, the economics for the new design are seen to be outstanding. The export power is increased by about 11 MW (more than 50%), while the capital cost for the new design is only about \$6 million more than the conventional plant. In terms of investment equivalents, this is about \$550/kW, whereas a typical hurdle rate for \$0.05/kWh power is about \$1200/kW. Based on these economics, the new process is extremely attractive and would pay out in about one year. With 32 MW being generated for an investment of \$1380/kW, the economics are approaching the point where the plant can be justified on the basis of power alone, with sulfuric acid being the by-product.

Table III

Capital Cost and Operating Credits
2500 t/d Sulfur Burning Plant

	Conventional (Case 1)	New Process	
		Low Capital (Case 2)	High Power (Case 3)
High Pressure Steam			
Nominal Press (bar)	50	50	60
Temperature (°C)	400	400	480
Production (t/h)	143	128	151
Production (t/t)	1.37	1.23	1.45
Medium Pressure Steam			
Production (t/h)	0	65	40
Production (t/t)	0	0.63	0.38
Electric Power			
Gross (MW)	23	30	34
Internal Use (MW)	2	2	2
Net Export (MW)	21	28	32
Capital Cost			
Acid Plant (M\$)	26	27	30
TG Area (M\$)	12	13	14
Total (M\$)	38	40	44
Investment Equivalent			
Total Plant (\$/kW)	1810	1430	1380
Incremental (\$/kW)	-	280	1000
Case 1→3 (\$/kW)	-	-	550

The "low capital" option, case 2, should be considered when the value of electric power is in the range of \$0.02/kWh. This option basically deletes some of the energy recovery equipment with a corresponding reduction in capital cost. As can be seen, the capital cost is about \$2 million more than case 1, and the power generation is about 7 MW higher. The investment equivalent for this increment is only \$280/kW.

While only two examples of the new process are presented, there are intermediate options which can be considered. Specific project needs might require more low pressure steam and less power generation. The process provides considerable flexibility, and an optimum design can be developed to match specific site requirements.

In either case the sulfuric acid plant is not tied to the phosphoric acid operation. Considerable work can be produced when 10 bar steam is expanded to 3 bar before exporting to the phosphoric acid evaporators. Furthermore, when the evaporator rates are reduced, the turbine

generator can be designed to utilize that excess steam. The new process takes full advantage of these opportunities, and this provides a significant benefit over simply recovering process heat as hot water.

SUMMARY

Sulfuric acid heat recovery is well proven by more than two years of successful operating experience. Monsanto Enviro-Chem's new process is based on a highly synergistic combination of HRS and the wet catalytic process. By recovering more process heat and by shifting heat to high pressure steam production, the new process increases electric power generation by more than 50%. The process is highly economical, with the investment for incremental power ranging from \$280 to \$1000/kW. It is our belief that this process is so significant it will set the standard for sulfuric acid plants for the next decade and perhaps longer.

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ATTACHMENT THREE

Monsanto Enviro-Chem

Monsanto Enviro-Chem Systems, Inc.
Corporate Pointe
P.O. Box 14547
St. Louis, Missouri 63178-4547
Phone: (314) 275-5700

June 11, 1990

Mr. Richard Fleming
Royster Phosphates
Highway 41 North
Palmetto, FL 34221

Dear Dick:

During our joint meeting of May 21, 1990 with the Florida Department of Environmental Regulation, they requested some additional information from Monsanto Enviro-Chem Systems, Inc. For background, in 1987 Monsanto's technology was used to modify two 1500 STPD sulfuric acid plants in Korea. The primary objective of the project was to reduce the sulfur dioxide emissions to 500 ppm to meet the Korean Government regulation of 99.6% conversion. This was accomplished by converting each plant from single absorption to double absorption by the addition of an interpass tower. The interpass towers employed Monsanto's patented heat recovery system technology. With this technology the interpass tower serves its normal function of absorbing sulfur trioxide for achieving the required overall sulfur dioxide conversion. In addition and most significant is the process heat is recovered as intermediate pressure steam for electrical power generation. This is process heat that traditionally is rejected to a cooling tower.

When the modified sulfuric plants were started up in 1987, sulfur dioxide conversion of 99.8% was demonstrated and today with well over two years of operation conversion is still over 99.7%. This data demonstrates that Monsanto's interpass tower heat recovery system continues to meet the original design Korean Government sulfur dioxide conversion regulation of 99.6%. Further, it also meets the United States New Source Performance Standards of 4.0 pounds sulfur dioxide per ton sulfuric acid which is equivalent to 99.7% conversion. The enclosed report, "Sulfuric Acid Heat Recovery System (HRS) Operations at Namhae Chemical Corporation, Korea", by Smith, Sheputis, Kim, and Chin was given at "Sulfur 88" in Vienna, Austria. A summary of the startup data is included on page 10.

While there was major emphasis on sulfur dioxide conversion, the Korean Government did not impose regulation on sulfuric acid mist emissions. Consequently acid mist emissions have not been measured.

In terms of reliability, the on-stream time of the interpass tower heat recovery system has proven to be equal to or better than traditional interpass tower systems. For example, during the first four months of operation in Korea, the total downtime attributed to the Heat Recovery System interpass tower heat recovery system was four hours. Overall since 1987 high on-stream time has been achieved and there has been no replacement of major components.

In summary, Monsanto's interpass tower heat recovery system is well proven. The Korean project demonstrates that the specified design criteria can be met or exceeded on large sulfuric acid plants.

Sincerely,



Robert W. Grendel
Process Design Manager

RWG:pap



Monsanto Enviro-Chem

SULFURIC ACID HEAT RECOVERY SYSTEM (HRS) OPERATIONS AT NAMHAE CHEMICAL CORPORATION, KOREA

R. M. Smith, J. Sheputis

Monsanto Enviro-Chem Systems, Inc.
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U. B. Kim, Y. B. Chin

Namhae Chemical Corporation
CPO Box 3259, Seoul, Korea

Presented at "Sulphur 88" - Vienna, Austria
November, 1988

ABSTRACT

Monsanto Enviro-Chem's (MEC) patented new Heat Recovery System (HRS) recovers most of the heat from sulfuric acid plant absorbers at up to 10 bars pressure. HRS was proven in pilot plant operation from 1983 to 1985. The first commercial unit was started up very successfully on Namhae Chemical Corporation's (NCC) 1350 t/d plant in November, 1987. With almost a year of operating experience, HRS has proven easy to operate, met all design criteria and has operated with a high on-stream time. HRS has been sold to several other customers and many others are evaluating the economics in their plants.

The following comment was made by K.P. Chae, Managing Director of Engineering and Projects and former Plant Manager of Namhae's Yeosu site:

"Without challenging spirit, you can't get much. We are proud of being the first case of commercial application of Monsanto Enviro-Chem's HRS technology.

After many sleepless nights during the initial start-up and then following eight months' uninterrupted operation, now I can comfortably say that Namhae has made the right decision to go ahead with HRS, which has been tremendously profitable for Namhae Chemical Corporation by killing 'three birds with one stone': Energy saving, production increase and lowering emission."

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TECHNICAL BACKGROUND

The production of sulfuric acid in sulfur burning acid plants generates large quantities of heat from the combustion of sulfur to sulfur dioxide; the catalytic oxidation of sulfur dioxide to sulfur trioxide; and the heat of formation of acid as SO_3 is absorbed in sulfuric acid.

The heat of sulfur combustion and oxidation of sulfur dioxide have been utilized for years to generate steam. Until the mid-1970's, energy recovery from acid plants was about 55%. Then, as fuel prices increased, acid plants were optimized to generate more steam. Low gas-temperature economizers, low pressure drop catalyst, suction drying towers, increased SO_2 gas concentration and preheating boiler feedwater with acid became commonplace and energy recovery from acid plants increased to 70%. However, 30% of the heat was still lost. This heat loss was primarily in the acid formation and cooling process.

Monsanto Enviro-Chem initiated a major research effort in the late 1970's to recover more of this lost energy. The research progressed through studies and laboratory tests until 1983 when a pilot tower was installed in a 550 t/d acid plant to demonstrate the now patented Heat Recovery System (HRS).

The basis of the HRS is that sulfuric acid in the 99% range has low corrosivity toward certain commercially available alloys at temperatures up to 220°C and higher. The high acid temperature provides the driving force to economically generate steam while the acid still readily absorbs SO_3 gas.

The HRS becomes commercially viable when it is located before existing absorption towers or is used as the interpass absorption tower in a new plant. Figure 1 is a process diagram showing the major equipment items. The sulfur trioxide laden gas flows to the Heat Recovery Tower (HRT) where the sulfur trioxide is absorbed in sulfuric acid. The absorption of the sulfur trioxide increases the temperature and concentration of the sulfuric acid. Concentrated, hot sulfuric acid leaves the tower at Point B. The acid is cooled by generating steam in a boiler and leaves the boiler at Point C. After the product is removed, the remaining acid is diluted with water and recirculated to the tower at Point A.

The process is shown on the HRS operating cycle diagram in Figure 2. The curves on the left are isocorrosion lines for 310 stainless steel. The right hand line defines the limiting conditions for the absorption of sulfur trioxide. The points on the triangle correspond to the process conditions identified in the Figure 1 process diagram. Acid near 100% concentration leaves the tower at 200°C (Point B). The acid is cooled in the boiler to approximately 160°C (Point C). The acid is diluted to 99% with a temperature rise due to heat of dilution (Point A). Finally, sulfur trioxide is absorbed in the tower, raising the acid concentration and temperature to complete the cycle.

This example is a 3.5 bar (50 psig) steam system but steam can be generated at up to 10 bar (150 psig). HRS can boost energy recovery to 90% to 95% of the total energy generated in a sulfur burning plant.

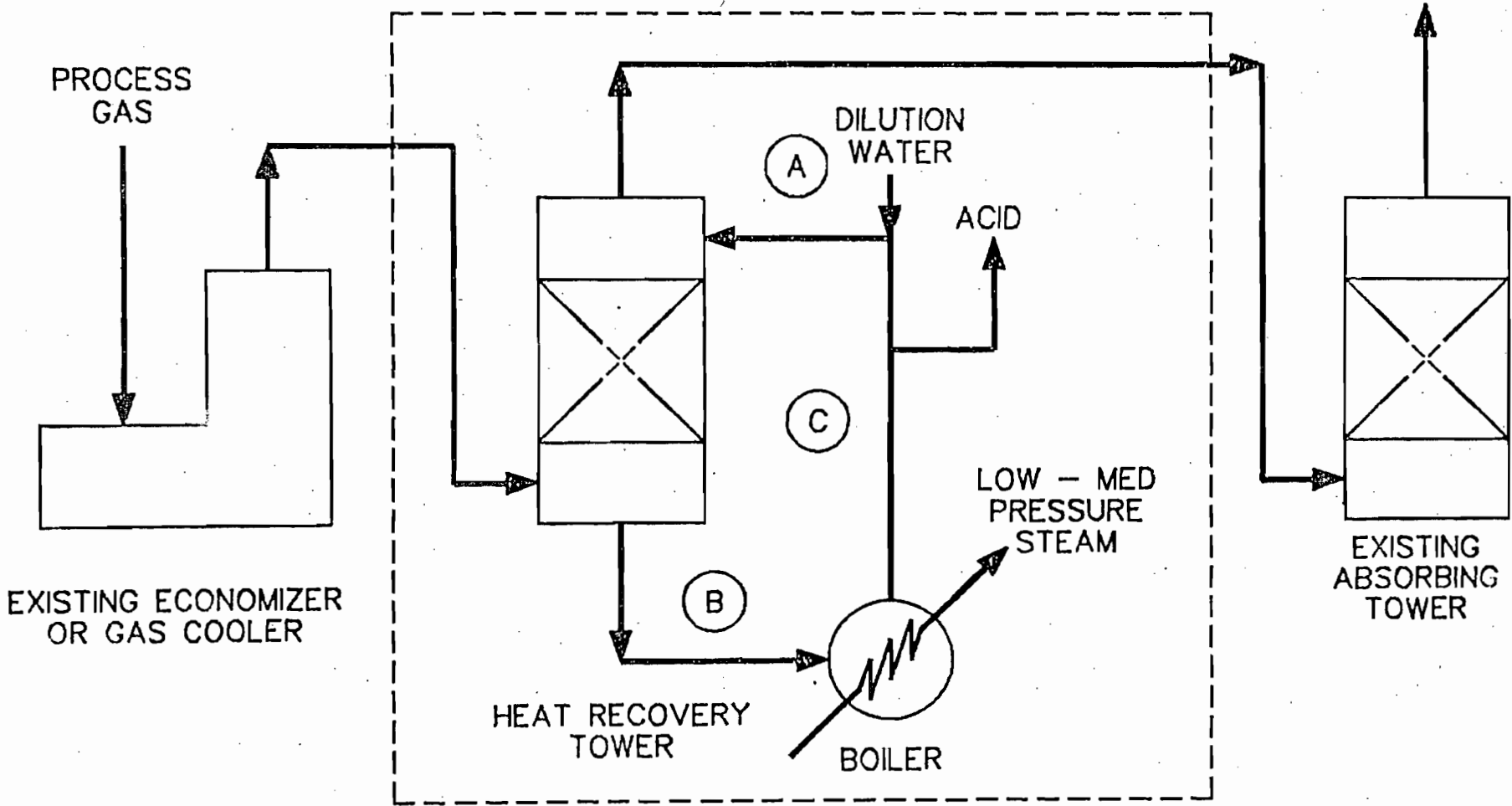


FIGURE 1 - HEAT RECOVERY SYSTEM

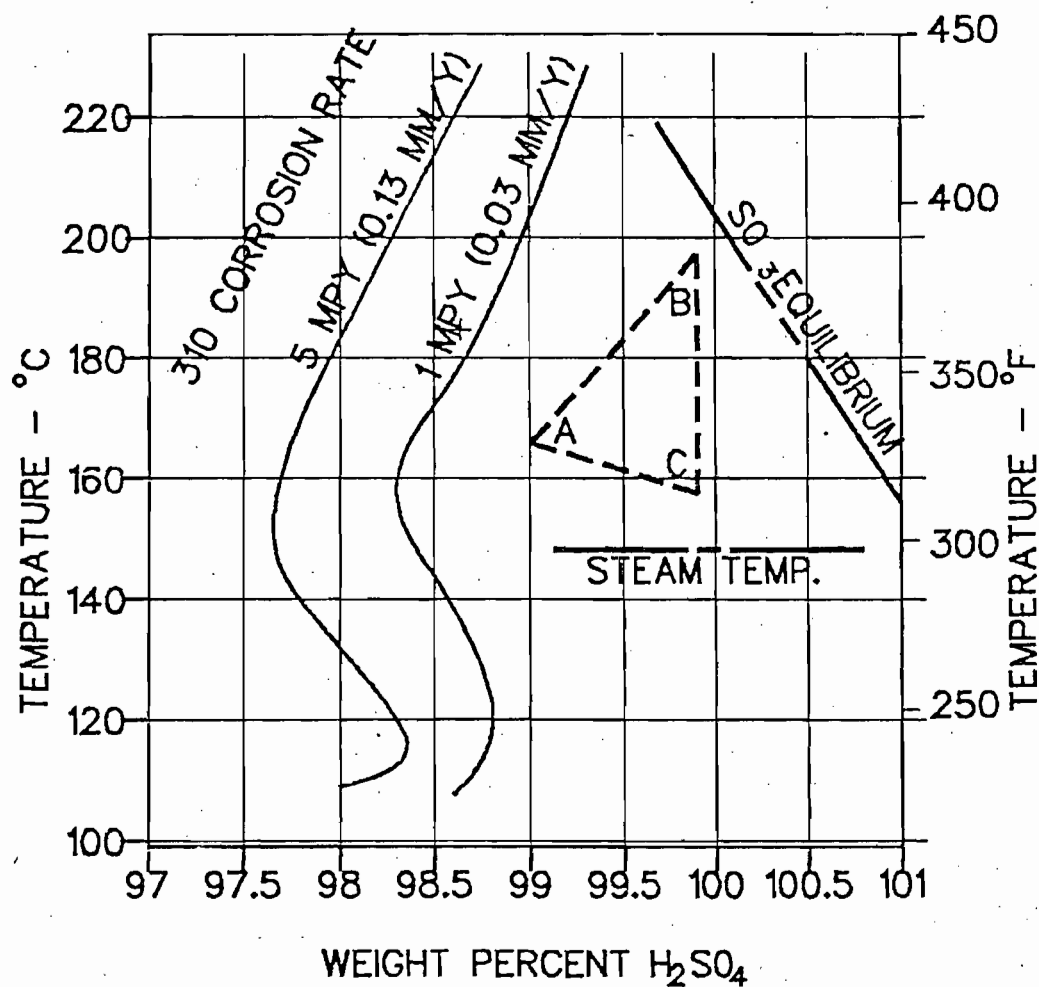


FIGURE 2 — HRS OPERATING CYCLE

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NAMHAE HRS PROJECT

Namhae of Yeosu, South Korea is a billion dollar a year producer of fertilizer chemicals. Namhae is committed to supply competitively priced quality products to their worldwide clients through efficient operations and best available up-to-date plant technology.

In 1986, Namhae initiated a project to reduce the SO₂ emissions from their two existing, ten year old, single absorption sulfur burning sulfuric acid plants. Monsanto Enviro-Chem of St. Louis, Missouri, U.S.A., made several proposals for Namhae's consideration:

- Add tail gas ammonia scrubbing tower to the plants.
- Convert the plants to double absorption plants with an interpass tower and acid cooler addition.
- Convert the plants to double absorption using the new Heat Recovery System (HRS) as the interpass tower.

Although Monsanto Enviro-Chem had extensive pilot plant experience and data, there were no commercial Heat Recovery Systems in existence at that time. However, Namhae's commitment to cost effective operations and confidence in Monsanto Enviro-Chem's 55 years of reliable acid plant design experience convinced K. P. Chae, Namhae's Managing Director of Engineering and Projects, to select the new Heat Recovery System for Namhae's sulfuric acid plants.

In October, 1986, Namhae awarded Monsanto Enviro-Chem the contract to modify the plants. The project goals were to:

- Increase SO₂ to SO₃ conversion from 97.7% to 99.6%.
- Maintain each plant capacity at 1350 t/d. The original 1050 t/d plants were debottlenecked using Monsanto LP catalyst, increasing gas strength to 8.3% from 7.8% and adding low-temperature economics.
- Increase steam production by adding HRS and adding a new turbine generator dedicated to HRS steam.
- Maximize use of existing plant equipment.

The final design included:

- The Monsanto Enviro-Chem Heat Recovery System as the interpass absorption tower to remove SO₃ and a 150 psig heat recovery boiler to remove the heat of acid formation.
- A final separate one-pass stainless steel converter for the after interpass absorption conversion of SO₂ to SO₃. Monsanto Enviro-Chem LP catalyst was used here and in some passes in the existing converter to lower pressure drop and ensure required conversion was met.

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- Cold interpass and hot interpass heat exchangers to heat gas going from the HRS interpass absorption tower to the final catalyst pass.
- Additional economizers and superheaters to recover more heat in the form of high pressure steam than in the form of low pressure steam.
- Much existing equipment was reused without modifications (blower, boiler, economizers and superheaters).

The gas flow diagram in Figure 3 shows the modifications.

In addition, a 9000 kWh turbogenerator was installed to convert the 130,000 lbs/hr of 150 psig steam from HRS to electricity.

Namhae's Project Manager, M. K. Oh, committed to a fast 14 month schedule. The first plant came on-line 13 months after the contract award and both plants and the turbogenerator were demonstrated in an excellent 14-1/2 months.

NAMHAE HEAT RECOVERY SYSTEM

The HRS operates very similar to a sulfuric acid plant absorbing tower. The main difference is higher acid temperatures; the acid is cooled in a boiler rather than an acid cooler; and the tower is stainless steel rather than bricklined steel. The flow diagram for HRS is shown in Figure 4.

The main equipment items in an HRS are:

1. Heat Recovery Tower

This is a two stage 310 stainless steel tower with ceramic Intalox packing and Monsanto Enviro-Chem ES mist eliminators.

2. HRS Acid Circulation Pump

This is a vertical submerged stainless steel pump manufactured by the Lewis Pump Co. The pump design is very similar to the proven design of the many vertical sulfuric acid pumps now in service.

3. HRS Boiler and Heaters

This is a "kettle" type boiler with acid flow through stainless steel tubes. The water side of the boiler is operated and controlled similar to other firetube boilers.

The HRS water heaters are similar to shell and tube acid coolers but without anodic protection. Their function is to cool product acid by heating the boiler feedwater coming to the HRS boiler.

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4. The diluter is where hot dilution water is mixed and absorbed by the hot acid in a turbulent reaction.

5. Instrumentation

HRS includes flow, temperature and pressure measurement and control instruments that are normally used in acid plants, but there are also three special instruments that we want to tell you more about.

A. Concentration Control

The acid concentration to the tower must be controlled above 98.5% acid to minimize corrosion. Modern electrodeless toroidal conductivity analyzers were used to provide the reliable and accurate concentration measurement that is needed. These improved analyzers will rapidly become the standard of the industry in all drying and absorbing towers as well as in HRS.

B. Corrosion Monitor

The corrosion monitor measures the current generated by the corrosion reaction of the stainless steel probes in the acid circuit. The monitor, located in the control room, indicates the corrosion rate of the stainless steel and alarms if the rate exceeds set limits for any reason.

C. Acoustic Leak Monitor (ALM)

The acoustic leak monitor was especially developed several years ago by Monsanto and the manufacturer to detect boiler or heat exchanger leaks using acoustic (sound) emissions. The acoustic (sound) wave is transformed into an electric signal and is monitored in the control room.

Boiler or heat exchanger leaks cause an increase in the acoustic emission which sounds the alarm so the plant can be shutdown safely for repairs. There have been no leaks at Namhae.

The other materials in an HRS such as pipe, valves, thermowells and etc. are made of stainless steels compatible with high temperature sulfuric acid.

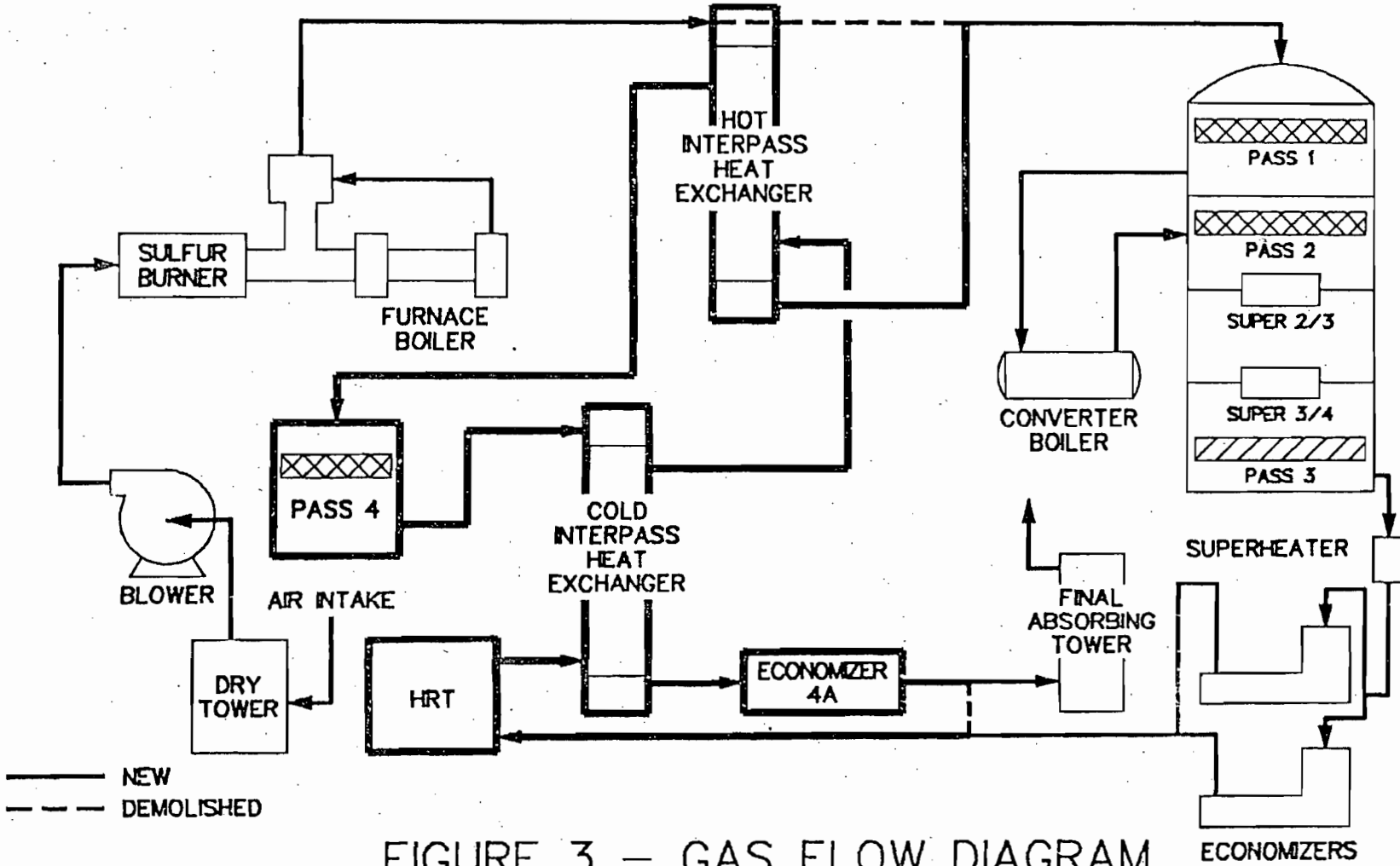


FIGURE 3 - GAS FLOW DIAGRAM

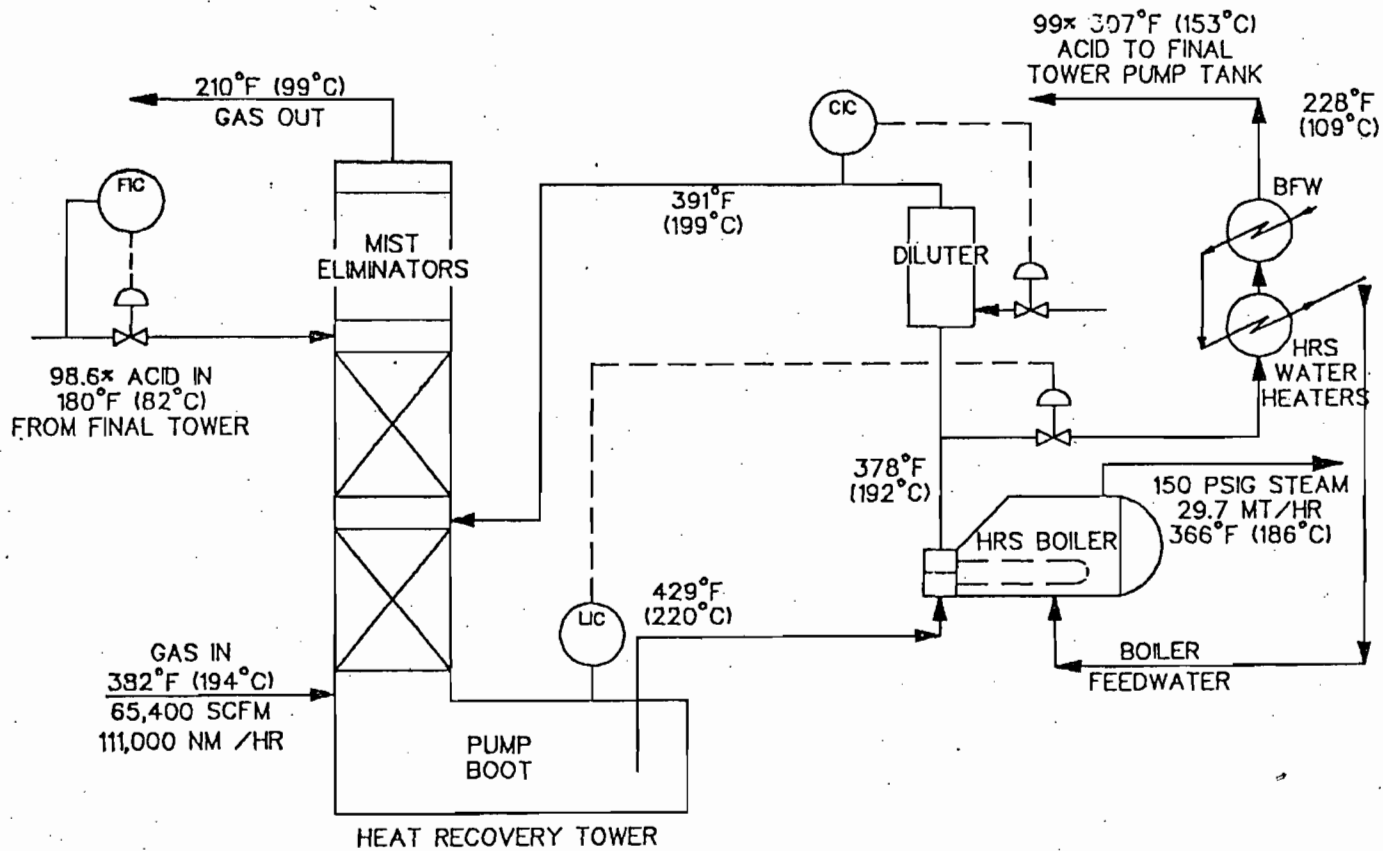


FIGURE 4 — HEAT RECOVERY SYSTEM

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HRS START-UP (NOVEMBER AND DECEMBER, 1987)

The plant and HRS start-ups went extremely well. The first plant started up November 19, 1987, and all guarantees were demonstrated within 2-1/2 weeks. The second plant and the turbogenerator power guarantees were demonstrated 1 week after the Plant No. 2 start-up December 23, 1987.

All project guarantees and expectations were readily achieved. The conversion of SO₂ to SO₃ was much better than expected. In fact, the conversion analysis was double and triple checked before it was accepted.

HRS DEMONSTRATION RESULTS

	Guarantee	Expected	Plant #1	Plant #2
Production, t/d	1350	1350	1442	1430
SO ₂ Emission, ppm	500	370	208	152
Steam Production, t/hr	27.9	29.7	33.2	30.6
Tons/Ton Acid	.50	.53	.55	.51
Conversion	99.6	99.7	99.85	99.9
T/G Electrical Power kWh	8760		8772 for both plants	

There were a few minor problems during the start-up. In fact, loss of control of acid strength, which is the major concern of many customers, occurred a few hours after start-up. When acid concentration was first put on automatic control, acid strength was rapidly dropped to 94% because the control action was reversed. It took a few hours to get the acid strength into control and the plant was exposed to 200°C and 94% concentration. Inspection of the plant showed that the only damage was excessive corrosion on the acid pump impeller and wear parts where velocity is highest. However, the pump was still serviceable and was put back into operation. After examination of the pump, Lewis and Monsanto metallurgists concluded that damage was related completely to the low acid strength. However, Namhae had some concerns so some parts of alternate materials were installed for testing in one pump.

A second problem was excessive vibrations transmitted from the diluter to the platform walkway. The mixing of hot water and hot acid produces a turbulent reaction. The diluter requires a solid structural support to grade. The original diluter was supported from horizontal steel beams that support the walkway. The support was redesigned on heavier steel beams that extend down to grade. Excessive walkway vibrations were eliminated.

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A third problem was collapse of some teflon lined pipe that was used between the diluter and the tower as a precaution against incomplete mixing which would cause higher than expected localized corrosion rates. Part of the pipe liner collapsed during the start-up period when the plant was shutdown and the acid was drained from the diluter causing a vacuum in the line. Some of the liner was removed as not being necessary and a vacuum breaker will be installed to further protect the remaining liner.

Typical start-up instrument adjustment difficulties were experienced on the Plant No. 1 start-up for the acoustic leak detector and the corrater. However, the Plant No. 2 instrument adjustment was minimal after Namhae's Instrument Section assumed responsibility from the construction contractor.

OPERATION - (JANUARY TO AUGUST, 1988)

Following the demonstration in December, both HRS units continued to operate according to the design and there were no significant operating or equipment problems.

In April, Namhae and Enviro-Chem showed the plant to 40 potential customers from all over the world. During the discussion a customer asked Namhae how many acid plant shutdowns had been caused by HRS equipment. After checking the record, Namhae stated there had only been one 4 hour shutdown to inspect the acid pump on the No. 1 plant. The pump was inspected in March and showed little additional corrosion since exposure to 94% acid during the initial start-up. The No. 2 acid plant continued to run well and was not even inspected until August.

Corrosion coupons that were installed in the acid system were checked occasionally. All showed the expected low corrosion rate except the one located directly after the diluter which showed 20 mils per year. This showed the need for improved mixing of the acid and water in the diluter. These modifications were delayed until the diluter supports were strengthened during the August turnaround because of the possibility that vibration would increase. It was not considered urgent because piping after the diluter was teflon and no damage was being done.

During normal operation 0.5 to 1.0 liters per shift of drip acid was drained ahead of the cold interpass heat exchanger. This was considered to be condensation particularly on the dome of the tower which was not insulated and did not cause much concern. We have increased our attention to this matter since some duct leaks developed prior to the August turnaround. Improvements are being implemented which are expected to stop the drip acid.

The HRS performed well, consistently producing steam to generate over 9 MW of electrical power. HRS equipment performed as expected. Acid quality is significantly improved with the elimination of iron sulfates, cast iron slag, brick mortar particles and etc. as compared to bricklined acid towers.

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The annual gross savings for both plants is 6600 tons of sulfur saved based on a 2.1% conversion improvement and a 350 day per year operating schedule at design rate. Also, 74,000 MWh of electrical power is generated under these conditions. The savings in U.S. dollars would be \$0.9 million for sulfur, based on a \$130/t delivered price, and \$4.6 million for electrical power, based on \$0.062/kWh costs, for a total yearly savings of \$5.5 million. These cost figures are used for illustration only and are not necessarily those used by Namhae.

TURNAROUND INSPECTION - (AUGUST, 1988)

Plant No. 2 was shutdown for scheduled maintenance on August 20 after eight (8) months of operation. Plant No. 1 was shutdown on September 3 after nine (9) months of service. Both HRS units and sulfuric plants were inspected carefully to determine if any problems were developing.

Overall, both HRS units were in excellent condition. The corrosion rates were as expected.

The corrosion rates were determined by exact weight losses of metal coupons placed throughout the system and numerous metal thickness measurements of pipe and tower walls. Excluding the first start-up days, the corrosion rate of the tower and piping system was less than 2 mils per year (0.050 mm/yr) in all areas. The corrosion rate of the acid pipe from the tower to the boiler was about 1.5 mils per year (0.037 mm/yr) and less than 0.5 mil per year (0.012 mm/yr) after the boiler.

The corrosion rate of the coupons in the teflon lined pipe between the diluter and the tower was between 20 and 30 mils per year (.5 and .75 mm/yr). This higher than expected rate was attributed to inadequate mixing of the acid and water in the diluter. Inspection showed only normal corrosion on the tower as is discussed below. However, the diluter is being modified to improve acid and water mixing.

In addition to the corrosion coupons, the HRS units were checked by taking thickness readings with an ultrasonic thickness gauge ("D" meter) and micrometer. The ultrasonic thickness gauge uses sound waves to measure the thickness of equipment when it is impractical to reach both sides of a plate or pipe wall. The actual measured corrosion rates of HRS plate and pipe supported the data of the corrosion coupons.

The No. 2 plant HRS acid pump was pulled for the first time and inspected. The visual inspection of the pump showed it to be in good condition. Corrosion was no more than that experienced on other absorbing tower circulation pumps. The replaceable static wear rings were replaced to assure reliable service until the next turnaround and the pump was placed back in service. Although replaced, most of the wear rings were still within specification. We have concluded that the original materials of construction specification for the HRS pump was the proper choice for long-term life.

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The HRS boiler was in excellent condition on both the acid and water side. The corrosion rate on the acid side was less than 2 mils per year.

All HRS equipment was inspected and found to be in good condition. The HRS tower shell, packing, packing supports and mist eliminators checked out in fine condition. Acid distributor header orifices showed some corrosion which could result from the poor mixing in the diluter or it could have occurred at the time the 94% acid corroded the acid pump.

The gas duct from the HRS tower to the cold interpass heat exchanger and the shell side inlet to the exchanger were inspected since drip acid had been routinely drained from the duct. There was significant iron sulfate in the bottom of the duct and on the exchanger tubesheet. There were a few leaking tubes which were repaired by driving a smaller tube inside. During the turnaround the top of the tower was insulated and the acid drain system ahead of the heat exchanger was modified to improve drainage and keep acid from getting into the exchanger. Drains will be monitored and gas sampling is planned to see that the problem has been solved.

The design, construction and successful demonstration of the first two commercial Heat Recovery Systems, complete with dedicated turbogenerator, is considered an outstanding success by Namhae Chemical Corporation and Monsanto Enviro-Chem Systems, Inc.

Many sulfuric acid plant operators from around the world have visited the Namhae acid plant. Visitors are quite impressed with the Namhae's HRS installation, clean and orderly facilities and Namhae's courage and dedication to install the first HRS.

SUMMARY

Namhae Chemical Corporation has proven that the HRS is a successful commercial process.

The initial concerns have been laid to rest and most of the minor problems have been solved. And, as a customer who visited the plant during the recent turnaround said, "The few remaining problems can be readily solved and I am not afraid of the Heat Recovery System".

Namhae and Monsanto Enviro-Chem will continue to review the HRS operations for good performance and maintenance. As with all new technology, improvements in design and HRS products are expected as experience is gained.

Three new HRS units are now being designed for clients who have visited the Namhae facilities. HRS projects are under consideration by other clients.

The attraction of using the HRS as an interpass absorption tower to reduce SO_2 emissions while producing an additional 0.5 t steam/t acid produced or 3.1 kWh of electrical power per t/d of H_2SO_4 will make the HRS a key component of future sulfuric acid plants.

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FALCONBRIDGE, NORWAY

Several people have asked about the Falconbridge HRS start-up status. Falconbridge Nikkelverks of Kristiansand, Norway has a 240 t/d sulfuric acid plant and HRS for their smelter SO₂ offgas. Fenco Engineers of Toronto, Canada designed and constructed the acid plant as well as the SO₂ gas purification system. The acid plant is designed so that the HRS can operate as an interpass tower with normal interpass acid temperatures or as an HRS where steam is generated from cooling the acid.

The acid plant started up in October, 1987, in the conventional acid plant mode without steam generation. The HRS circuit has not operated much of the time because of operating problems in other parts of the acid plant and roasters. However, the HRS was successfully operated several weeks during mid-1988 and tests showed that it is operating in accordance with design. However, Falconbridge has commitments to produce liquid SO₂ which have required that the acid plant be shutdown until the last quarter of 1988.

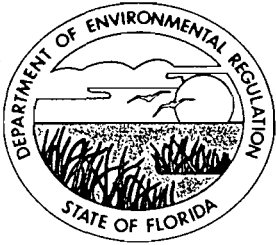
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Florida Department of Environmental Regulation

Twin Towers Office Bldg. • 2600 Blair Stone Road • Tallahassee, Florida 32399-2400

Lawton Chiles, Governor

Carol M. Browner, Secretary

September 12, 1991

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

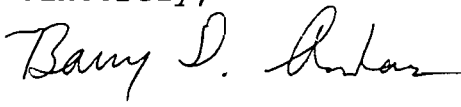
Mr. Gary L. Dahms
Vice President and General Manager
Royster Phosphates, Inc.
P. O. Box 1329
Palmetto, Florida 34220

Dear Mr. Dahms:

Re: Royster Phosphates, Inc.
AC 41-173305, PSD-FL-144

The Department has not heard from you concerning the above referenced project since your October 2, 1990, letter. Please let us know if you plan to pursue obtaining a permit for this project. If you do not respond to this letter within 30 days of receipt of it, the Department will assume you have changed your plans and will deny your request for the permit.

Sincerely,


C. H. Fancy, P.E.
Chief
Bureau of Air Regulation

CHF/TH/plm

c: Bill Thomas, SWD
Rob Baum, Manatee Co.
John Koogler, P.E.
Jewell Harper, EPA

