

MEMORANDUM

TO: S. McAlpine
CC: K. Blower
FROM: K. Morton
DATE: Feb. 8, 1989
SUBJECT: TRIP REPORT - VISIT TO FERMENTA, HOUSTON

Introduction

Board approval for the WAROX project is conditional upon the feasibility of the process, the key of which is the high temperature gas filtration system. The process was successfully tested at pilot scale by RPC but this does not necessarily represent full scale plant experience under rigorous operating conditions. The filter manufacturing firms, Pall Corporation and Mott Metallurgical, have therefore been trying, for some time now, to arrange visits to suitable operating facilities.

Though there are a large number of processes using high temperature gas filter technology, only very few are willing to permit visits by outside firms. One of these is Fermenta, a chemical manufacturing firm in Houston using Pall filters, and Pall was finally able to arrange a visit for us.

Summary

The visit took place at Fermenta's plant in Houston during the morning of Feb. 7. Present for Giant were K. Blower and K. Morton. N. Figess of Fenco also attended on behalf of Giant. B. Wilemsteyn of Pall Corporation was there, and Jim Amodeo of Fermenta conducted the tour. Amodeo was very helpful and withheld only very little proprietary information. Due to severe freezing conditions, the outdoor plant was not operating smoothly during the visit.

The attached reprint from a magazine article describes the function and operation of the filters in the process. Our specific questions and Amodeo's responses are listed below.

Operating Conditions

Particle size	Down to 1 micron - 30% less than 10 micron.
Operating temperature	750 deg. F (400 deg. C.)

Filter area	Reactor 900 sq.ft, oxidizer 1200 sq.ft.
Number of elements	Reactor 342, oxidizer 456
Blowback pressure	Reactor 40 psi, oxidizer 100 psi
Blowback initiation	Timer
Delta P	1.5 to 15 psi, typical 8 psi
System pressure	Positive

Q. How long have the filters been in service?

A. Since 1976.

Q. What major modifications have been made.?

A. Fuse filters have been added inside the main filters, to prevent loss of catalyst in the event of a filter failure. The reoxidizer filter elements were changed from stainless steel to Inconel shortly after startup.

Q. What is a normal service interval?

A. 6 to 9 months for the reoxidizer and up to 3 years for the reactor. Failure occurs as a result of high pressure drop caused by plugging of the pores. Dependent entirely on application. Elements can also develop cracks.

Q. How are cracks detected?

A. Initial knowledge that a crack has occurred is by a loss of catalyst. Cracks can be detected by submerging the element in water and blowing air through it. The bubble pattern reveals the crack. I've also heard that fluorescent powder can be used. (feed powder into gas stream on the dirty side and scan the filter with black light on the clean side. Leakage shows up under black light.)

Q. What is involved in filter replacement?

A. Normally it takes 5 days to change 8 tubesheets (8 filter vessels) Work is scheduled to coincide with a maintenance shutdown. Emergency repairs are seldom required. Complete sets of tubesheets and filters are prepared in advance and replacement simply involves exchanging the old for the new. Tubesheets are sent out for washing and repair. They are returned as good as new. The washing process is proprietary.

Q. Who does your washing and repair?

A. Southern Metals, a national company, washes and tests the elements. Damage often occurs to the filters while in transit, especially when shipping by rail.

Q. Are the filters easy to operate?

A. They are not difficult to operate. They are the key to the process and it is important that they be kept operating effectively. Routine checks of pressure drop across a bank of filters and across individual filters provide good operating information.

Q. What do the operators have to watch out for?

A. Watch the pressure differential on each unit. If there is no change in the delta P in the other units when one is taken off line, that unit is plugged. High temperatures can destroy filters and close

control of reactor temperatures and of flammable or explosive gas production is required. When installing new filters, be sure they are bone dry as water can cause blinding.

Q. Is your blowback air heated?

A. Yes. One process uses a heat exchanger; the other a heated receiver.

Q. What spares are required?

A. One tubesheet complete with filter elements (triads) per vessel. Also a number of individual triads for emergency repair. In blowback configuration, as opposed to pulse jet, the air actuated globe valves are cycled twice every 90 seconds. They must be rebuilt every three months. These valves are not required for pulse jet operation.

Q. Have you considered converting to pulse jet?

A. Yes. We're currently testing a pulse jet filter and are planning a larger scale test. It's unlikely that we will find it economical to retrofit the existing filters.

Q. How is your relationship with Pall?

A. Very good. They have done a lot of work to make this system as good as it is. Their product is very durable. These filters are operated under very tough conditions and they perform very well.

Conclusion and Recommendation

Judging by Fermenta's satisfaction with Pall filters in their gas cleaning application, there seems to be no reason that we cannot have the same success with similar filters in our plant.

It is recommended that the WAROX proposal be resubmitted to the board for approval, with the assurance that our proposed gas filter technology has been well proven under difficult operating conditions.

K. Morton



Porous metal filters prevent fluid bed catalyst loss

Expensive vanadium catalyst retained in fluid bed; no other particulate collection required

MICHAEL N. SCHWENDEMAN, Plant Manager

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DAN REUTER, Process Engineer

Diamond Shamrock Corporation

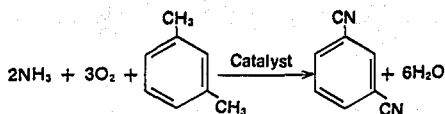
Greens Bayou Plant

Houston, Texas

MARX ISAACS, Houston Regional Editor

Porous metal filters are the only devices required to provide high retention of catalyst solids in two high temperature fluidized beds at Diamond Shamrock's Greens Bayou site. Operating at over 750°F, the reactor and re-oxidizer fluid beds contain a vanadium catalyst that is too costly to lose by elutriation. The porous metal filters not only retain the catalyst within the fluid beds, but, since optimization of the filter metallurgy, do so with a minimum of downtime for cleaning and maintenance.

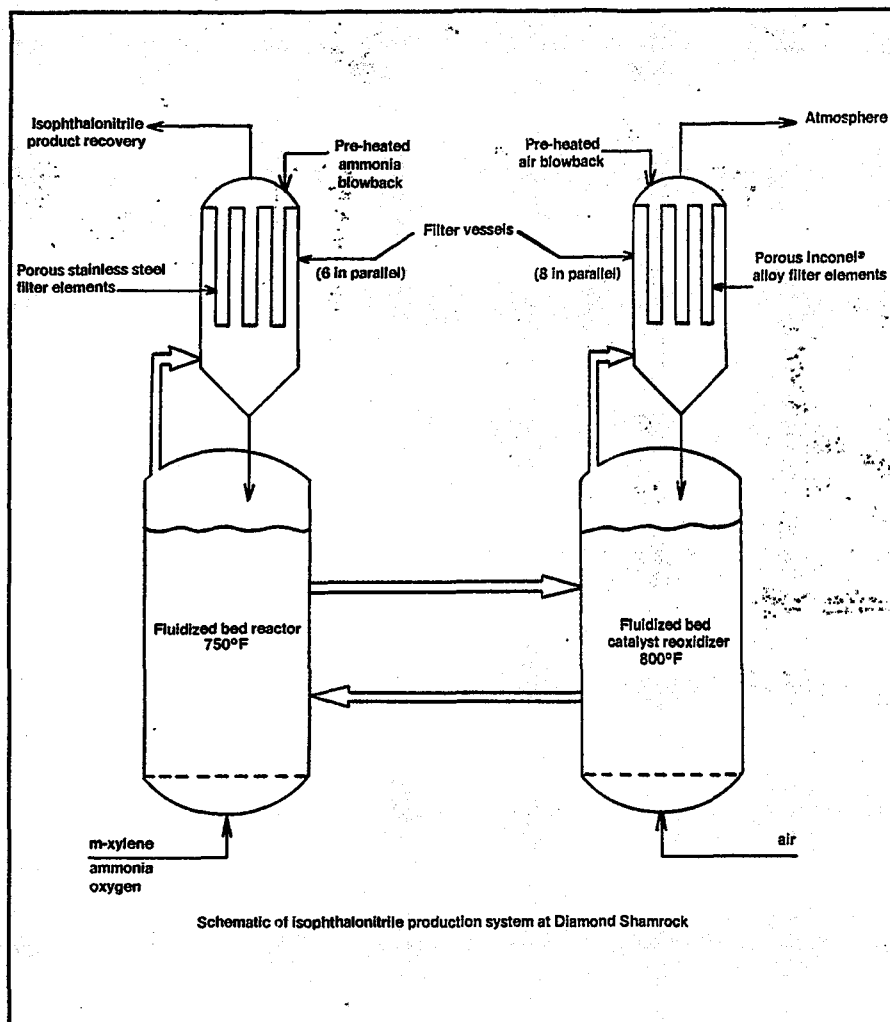
In 1976, Diamond Shamrock began operation of a unit to produce isophthalonitrile, an intermediate in the production of herbicides and fungicides. Using the basic chemical reaction



Diamond Shamrock chose a proprietary aromatic nitrile process technology that had not previously been applied commercially. The process uses a vanadium catalyst in a fluid bed reactor operating at 750°F, with catalyst being continuously reoxidized in an adjacent re-oxidizer fluid bed.

Minimizing loss of the expensive vanadium catalyst was essential to the economic viability of the project. Catalyst loss could also cause other difficulties. Elutriation from the reactor could enter the downstream product recovery system, causing operating problems, and losses from the re-oxidizer could be emitted to the atmosphere, causing environmental problems.

Conventional cyclones normally used to retain solids in high temperature fluid-



Schematic of isophthalonitrile production system at Diamond Shamrock

Filter modules removed for inspection and cleaning

ized beds were not considered efficient enough for this process. Therefore, Diamond Shamrock installed a porous metal blowback filter system on the exit gas stream from each fluid bed to provide positive particle retention.

The overall system (see flow chart) provides parallel banks of filter vessels on each fluid bed to allow sequential blow-back of each vessel. To accommodate the different flow conditions in the two fluid beds, the reactor was equipped with 6 vessels while the re-oxidizer was equipped with 8.

Initially, each vessel was equipped with 57 1/4" diam filter elements fabricated from sintered stainless steel powder to provide removal of particles 3 microns and larger. Since this was the first operating system of any size for this process, the startup was not uneventful. Operating conditions of the re-oxidizer were slightly different than anticipated. The stainless tubes experienced embrittlement, cracking, and buildup of catalyst between tubes. Thus, a change in the filter element configuration and metallurgy for the eight reoxidizer filters was



Heavy insulation covers porous metal filters on top of high temperature fluidized bed

required. Each vessel on the re-oxidizer still provides about 150 sq ft of filter area, but now contains 2 3/8" diam elements constructed of a sintered Inconel® high nickel alloy. Designed to retain particles

greater than 1 micron, the filter tubes have successfully withstood the service requirement.

Filter vessels are blown back sequentially on a timed cycle, using approximately two vessel volumes of gas for each 5-7 sec blow-back. Every 15 seconds a filter is blown back. This periodic fluctuation of gas flow through the system does not cause any noticeable disruption of the fluidization or elutriation characteristics of the units.

Since modification of the re-oxidizer filter vessels, maintenance on the filter has been minimal. High retention of costly vanadium catalyst within the beds and infrequent cleanout required of the filters have resulted in an economically sound entrainment separator system. Discharge of catalyst to the atmosphere is within acceptable limits and catalyst loss to the product stream is so low that only a

minor amount is collected in the recovery system feed tank—too little to justify recovery—and discarded by an infrequent purge.

PSS® porous metal filter supplied by Pall Process Filtration Corporation, Cortland, NY 13045.

Inconel® alloy is a product of Huntington Alloys, Inc., Huntington, WV 25720.

Aromatic nitrile process technology, engineering design and construction provided by C-E Lummus Co., Division of Combustion Engineering Inc., 1515 Broad St., Bloomfield, NJ 07003.
