The IMC Fertilizer, Inc.
Filter Pan Project

by

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An Overview Of The Project

New filter pans and new pan turnover cams were recently installed by IMC Fertilizer, Inc. in the three phosphoric acid plants inside the New Wales (Florida) Complex. The first tilting pan filter was retrofitted in October 1989 while the second and third filters were modified in November 1989 and February 1990, respectively. Retrofitting was accomplished during the annual turnaround period taken for each plant.

The design was based on patented technology licensed by IMC Fertilizer, Inc. (IMCF) from Freeport-McMoRan Resource Partners, Limited Partnership and upgraded by the IMCF design team. Total active filtration area of each pan was increased by more than 14% over the prior art. Also, the shorter turnover cams provided by the new art allowed IMCF to modify the filter timing crowns to further increase effective filtration area under vacuum by as much as 2.2%. Completion of this project has led to increased phosphoric acid production capacity at the IMCF New Wales Plant.

Disclosure

All technical information or other information of any kind transmitted by this public disclosure relating to the IMCF filter pan project and the License Agreement executed between the parties relating to the patented technology is in accordance with the prior consent and written authorization of Freeport McMoRan Resource Partners, Limited Partnership.

The IMCF Design Team

A special design team was required for the IMCF project to adapt the licensed technology to fit the size of tilting pan filters installed at the New Wales Plant. This was necessary because the two phosphoric acid filters retrofitted by the Freeport Chemical Company (now Agrico) in their Uncle Sam, Louisiana Plant were smaller than the filters in operation at New Wales.

Extensive use of Computer Aided Design equipment (CAD) was required to finalize the pan size and design, the turnover cam design and the design of other auxiliary equipment. All CAD work was completed in-house by the IMCF New Wales Project Engineering Department except for assembly drawings completed by fabricators under contract to IMCF.

The chance to install new filter pans at IMCF provided an opportunity to incorporate several design enhancements in the IMCF filter pan project that were not included in the two filter systems retrofitted by Freeport. The design team organized in March 1989 completed retrofitting of the first filter in October of that year.

The New Art--Pan Design

The basic shape of the pan design used by the new art is significantly different from the prior art (original filter installation). In the new art, the pan's leading and trailing sidewalls are parallel to each other and are sloped at a predetermined angle to enhance both filtration efficiency and capacity. The general parallelogram-shaped, cross-sectional design of each pan coupled with the new art turnover cam allows closer spacing of adjacent pans without risk

of damage during pan rotation. As a result, clearances between pans can be maintained at one inch or less along the whole height of adjacent sidewalls. Whereas, sidewall clearances used in the prior art may be one inch at the top of the pan and three to four inches at the bottom of the pan.

The New Art--Turnover Cam

The turnover cam arrangement of the new art permits rotation of the larger filter pans and at the same time reduces the total length of pan travel while the pans are in rotation. The new arrangement also provides minimum mechanical stresses on the pans throughout the turnover operation. Pan acceleration is nearly uniform through the critical points.

Advantages Of The New Art

The new art is perceived to offer several improvements and economic advantages over the prior art. A list of the major advantages are shown below followed by a brief discussion of each key point.

(1) Increased volume for filter cake
(2) Increased filter surface area
(3) Improved caulking design
(4) Improved turnover cam
(5) Allows more filter area under vacuum
(6) Improved pan drainage

(1) Increased Pan Volume

Larger filter pans provided by the new art also mean that the effective volume of each pan is increased. This is seen to offer at least three advantages over the prior art (original filter installation).

For a given production rate and filter speed, the larger pan volume reduces the thickness of the applied filter cake. As a result of the thinner cake, the pressure differential driving force across the cake changes. This in turn, following well known theoretical principles of fluid mechanics, is expected to increase filtration efficiency. The larger pan volume also decreases the likelihood of liquid splashing and volumetric surging from sidewall to sidewall in the pan for a fixed production rate. The tendency of spillage from the pans is thereby decreased.

However, the third advantage is viewed to be the more significant. The larger pan volume allows the production rate to the filter to be increased while maintaining the same cake height and the same filter speed.

(2) Increased Filter Surface Area

The parallel sidewall design of the new art coupled with the improved cloth caulking design and the new art turnover cam design increases the effective surface area of the pan at the filter cloth grid. Patents issued for the filter pan design and for the turnover cam design indicate a theoretical 8.4% increase in filtration capacity. However, the IMCF design team, working in conjunction with technical assistance from Freeport McMoRan Resource Partners, was able to increase the active filtration area of the new pans installed at the IMCF New Wales Plant by 14.3%.

In order to gain the incremental area, the overall width and length of the pans had to be increased. This required development of an innovative design for the pan journal bearings. Modifications also had to be made in the design of splash guards around the inside and outside of the filter as well as to the internal splash guards inside the gypsum collection hopper. A new cloth wash spray header design was also required to properly direct spray nozzles for full contact of the increased pan surface area.

The overall length of the pans installed at IMCF New Wales using the new art technology are 5" longer than the original pans installed on the three filters. Termination points for end walls of each pan were extended 1 1/2" closer to the journal bearing pin on the inside carframe and 3 1/2" closer to the journal pin on the outside carframe.

Filtration area inside each new pan (excluding the area lost by the cloth caulking system) was increased to 77.3 sq. ft. By comparison, the total area provided by the prior art design was 68.7 sq. ft. per pan.

(3) Improved Caulking Design

An improved filter cloth hold down design is used by the new art system. Total volume occupied by the new caulking arrangement has been reduced from that occupied by the prior art. As a result, a larger percentage of the total pan area measured at the grid is made available for active filtration. Total active filtration area inside the caulking strips of each pan based on the new art design is 73.6 sq. ft. and 64.4 sq. ft. for the prior art design. The new caulking design allows 95.2% of the total pan area to be active for filtration compared to 93.7% for the prior art.

Comparison Of Total Active Filtration Area

The total active filtration area of all pans using the new art design is 2208 sq. ft. compared to 1932 sq. ft. for the prior art. However, the actual effective filtration area of the entire filter depends on the distribution between the vacuum and non-vacuum sections. This distribution varies from plant to plant depending on individual design and needs.

(4) Improved Turnover Cam

The new art turnover cam arrangement has several advantages as previously described. Another important advantage expected from the smoother tilt action of the cam rollers is reduced maintenance problems and maintenance cost. No mechanical problems have developed since the first filter system was installed last October.

(5) More Filtration Area Under Vacuum

The larger filter pans cannot be rotated using the prior art turnover cam arrangement. Therefore, the new cam is an integral part of the new art. However, the new art offers another important advantage. The short turnover cam design provides a means of changing the distribution between the vacuum and non-vacuum sections of the filter and increasing the effective filtration area.

For example, the first trip point in the turnover section remains in the same radial position for the new art design as for the prior art. However, the second trip point is much closer in the new art. This allows moving of slurry boxes to take advantage of more filtration area under vacuum.

The net gain made on one filter in operation at the IMCF New Wales Plant was 2.2%. Smaller gains were made on the other filters.

(6) Improved Pan Drainage

The new filter pan design has an improved drainage rate when compared to the prior art. To study the effect of pan drainage, one pan of each type was set up on wooden blocks and leveled. Drain nozzles were capped and the pans filled with water to the top of the grid surface. The nozzle caps were then removed and the drainage rate determined with respect to time. Results of the test are discussed below.

The volume required to fill the prior art pan design was approximately 50 gallons while the new art pan internal volume below the grid was almost 120 gallons. The new pan with the higher volume was found to drain twice as fast as the prior art design. On an equal volumetric basis, the drain time of the new pan design is more than four times as fast as the prior art.

Acknowledgment

I want to take this opportunity to personally thank everyone who contributed to the success of this project. Applications of new technology bring change to our industry and hopefully, contribute to its continued growth. Thank you very much!

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