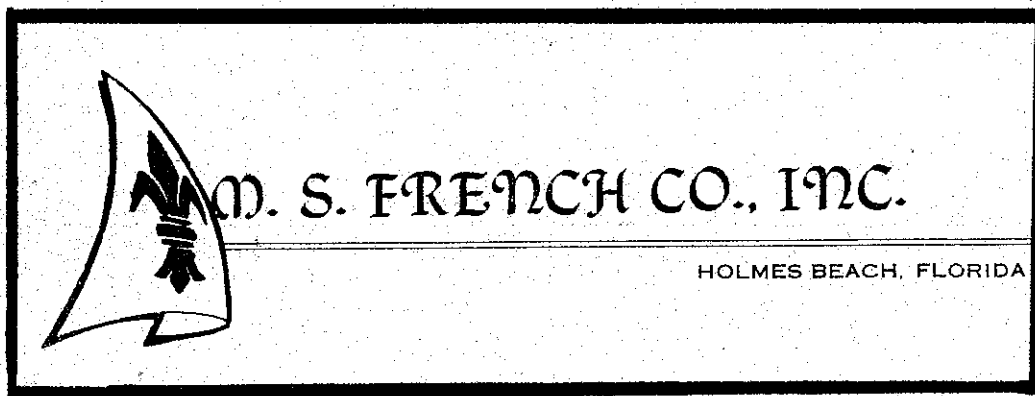


USE OF THICKENERS IN LIMING STATIONS

by

ARCHIE E. BRUMFIELD



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Archie E. Brumfield
M.S. French Co., Inc.

Background

Enviro-Clear, a Division of Amstar Corporation, are the designers and manufacturers of a fast throughput clarifier/thickener. The terms clarifier and thickener are used interchangeably and indicate certain required operating conditions. Clarification implies clearing the overflow of suspended solids in process water for reuse in the process, and thickener implies the concentration (thickening) of solids for ease of disposal or the recovery of a valuable commodity. Today, because of environmental concern over discharge of industrial wastes and waste water, both functions are important. Also, with the zero discharge law becoming more prominent, the reuse of process water and the reduction of waste settling areas is extremely important.

The Enviro-Clear concept of continuous solids-liquid separation evolved from the demand by industry for methods that can separate finely divided suspended particles in liquids more quickly and in less space than with, what was known as conventional methods. The concept was originally conceived for use in the sugar beet processing in first carbonation effluent. The success of the first operating units led to further development of the concept and applications soon developed in a wide variety of industries, including coal preparation, mineral processing, paper industry processes, chemical processes and now find wide use in the phosphate industry. Not only in the chemical end but the mining end also.

Operating Principal

The Enviro-Clear clarifier/thickener concept is different in the method in which the feed is introduced. Conventionally, feed is added to the top of the thickener through a center well. Free settling, hindered settling and compaction zones are set up. The Enviro-Clear unit is designed so that the flocculated feed is introduced at a controlled velocity in a horizontal direction into an active sludge bed. This eliminates the free settling zone. Particles move at random through the sludge bed promoting additional agglomeration with resulting accelerated settling and a clearly defined sludge bed level is established. The line of demarcation between the sludge bed and clear effluent is very sharp and this interface is used for control of the sludge bed level and sludge withdrawal.

Phosphate Industry

In October of 1975 personnel from the M.S. French Company and Enviro-Clear demonstrated the feasibility of rapid dewatering of waste phosphatic clays, commonly called slimes.

This demonstration was made using a 3½" diameter bench scale model Enviro-Clear thickener. The tests were performed in Lakeland, Florida, at the Florida Phosphatic Clays Research Project Laboratory under the direction of Leslie G. Bromwell, Sc. D.

With the use of settling aids (flocculants) in moderate dosages we were able to rapidly dewater the slimes. With the addition of tailing sand to the feed slimes and flocculating this mixture indicated a marked improvement in settling ability. The results were favorable enough to warrant further investigation and the lease of a larger pilot unit by the Florida Phosphatic Clays Research Project group. Tests at USS Agri-Chemicals, Rockland Mine, were started in early 1976. Since this time similar tests

have been ran at most of the companies in the area and in North Carolina. Due to these results we have received orders for three large units which are presently in the installation phase. The first full size operational unit (85' diameter @ 15,000 gpm) will be in operation later this year at Estech Watson Mine, and two units (80' diameter @ 14,000 gpm, ea) will be operational at the Texasgulf complex in North Carolina later this year.

Test work has also been demonstrated in the clarification of phosphoric acid, 28%, 40%, 46% and 54% acids. There are three units in operation at this writing and more in the planning.

Test work with the 3½" diameter lab unit resulted in two 26' diameter units in operation at Occidental Chemical Company's facility in North Florida on Synspar production.

Tests are now going on in other areas of the phosphate operation in the chemical and mining areas, however these tests are not far enough along to discuss in any detail.

Liming Stations

All phosphoric acid fertilizer producers generate a sizable amounts of waste water, highly acidic, which at times create a considerable containment problem. The large land area required for the gypsum stack and cooling ponds, along with the seasonal rain showers which occur in this area, becomes a water management nightmare.

One method of relief, which many producers have already initiated, is the installation of a single or double stage liming station. The purpose of the liming station is to neutralize, as necessary, the acidic waste water, clarify it for subsequent reuse in the process as make-up or for discharge off the property.

To enable discharge off the property, EPA has established standards

in which concentrations of phosphorous and florides must be maintained. The limits are 25 mg/liter for florides and 35 mg/liter for phosphorous as an average. These have been established for 1983 BATEA guidelines.

Laboratory and Pilot Tests

Laboratory tests for single and double stage liming has been in effect since early 1977. The first test we ran, was the treatment and clarification of "toe ditch water". This water is the seepage from an existing operational gypsum stack. The water is captured in an underground ditch which circles the stack and flows to a common sump. The contents of this water is similar but not quite the same as the cooling pond water. One constituent found in this water, not because it was from the toe ditch, was chlorides. The presence of chlorides in this water, we believe, became a significant factor later on in our evaluation.

Using lime to neutralize this water to a Ph 7-7.5, we ran a complete series of tests with an Enviro-Clear 3½" diameter laboratory clarifier/thickener. Neutralization times were varied, different flocculants were investigated, throughput rates were varied, various process changes were made and tried and at the end of the test program, the data was evaluated. The results were conclusive enough to warrant a larger and a more energetic test program. Since this company had an existing liming station, the decision was made to lease a 3' diameter Enviro-Clear pilot plant and set it up adjacent to the liming station. Extensive tests were ran and the results confirmed the laboratory data.

Feed Conditions

Flow rate	2 GPM per square foot of clarifier surface area
Solids	2.0 - 3.5%
PH	6.2 - 7.5
Temperature	95° - 105° F

Overflow

Turbidity < 50 PPM
Phosphorous < 35 PPM
Fluorides < 25 PPM
Recovery 50-80% of usable water

Underflow

Density 1.04 - 1.07 S.G.
Solids 6 - 15%

Flocculant Consumption - < 5PPM

Notes:

1. Due to the chlorides in the water a single stage of neutralization was adequate to meet EPA standards. Normally a two stage liming system would be required to achieve EPA standards.
2. Neutralization time for the lime addition needs to be at least thirty minutes or longer. The longer the better.
 - A. The shorter the reaction time, more lime must be used to achieve the Ph requirements.
 - B. Excess lime addition creates temperature of the slurry to rise and we found if the temperature was above 105° F the settling and compaction characteristics change dramatically.
 - C. Tests have been ran since which demonstrate that even longer reaction on times (up to 90 minutes) may be required to achieve a favorable recovery rate.
3. Ph variations effect the performance of the system, so a steady state operation is necessary.
4. In these tests we found recycling a portion of the underflow back to the feed (10% of underflow) improved the

performance and stabilized the whole process. The reason for the improvement in performance is, further agglomeration of preflocculated solids takes place and also the addition of solids to the incoming feed enhances the collection efficiency of the flocculants.

Based upon the above tests a 28' diameter Enviro-Clear clarifier/thickener was installed and has been in operation for three years. The clarifier was sized to handle a maximum flow rate of 1,000 gpm of treated water.

Two Stage Liming

The Guidelines Document, which preceded the final discharge standards for the phosphate industry, indicated that double lime treatment was the latest available technology to meet the EPA standards.

With the above as a criteria several companies became interested in evaluating the technology. Laboratory studies were made and the results indicated that the EPA limits could be met if certain Ph levels could be maintained in each stage, especially the first stage.

We set up the 3½" diameter laboratory unit at the first site and ran batch tests on pretreated cooling pond slurries at a Ph of 4.0 for the first stage. Operating data was taken and the overflow and underflow samples were evaluated. The overflow saved from the first stage was neutralized further to a Ph of 9.3. Operating data was taken and the overflow and underflow samples were evaluated.

The results were as follows:

<u>Feed</u>	<u>1st Stage</u>	<u>2nd Stage</u>
Rate	4 gpm/ft ²	2 gpm/ft ²
Solids	1.0%	1.0%
Ph	4.0	9.3

<u>Overflow</u>	<u>1st Stage</u>	<u>2nd Stage</u>
Turbidity	not measured	< 150 PPM
P ₂ O ₅	" "	< 10 "
Florides	" "	< 10 "

<u>Underflow</u>		
Solids	25%	6%
Flocculant Consumption	2 PPM	5 PPM
Water Recovery	95%	80%

The second series of tests were set up at another site on their cooling pond water and similar tests were run. The only exceptions were that limestone was used for the first stage neutralization and chemically hydrated lime was used for the second stage neutralization; the second stage Ph was 8.0.

The results were as follows:

<u>Feed</u>	<u>1st Stage</u>	<u>2nd Stage</u>
Rate	4 gpm/ft ²	2 gpm/ft ²
Solids	1.8 - 3.2%	1.7 - 2.1%
Ph	4.2	8.0

<u>Overflow</u>		
Solids	< 100 PPM	< 50 PPM
P ₂ O ₅	< 6,000 PPM	< 450 PPM
Florides	< 50 PPM	< 15 PPM

<u>Underflow</u>		
Solids	28%	14%
Flocculant Consumption	5-10 PPM	10-15 PPM
Water Recovery	95%	85%

At a later date tests were ran in the laboratory and determined that a Ph level of 9.5 - 10.0 was necessary to reduce the P₂ O₅ level to EPA standards.

Operating Experience

A full scale, two stage liming station has been installed and has periodically been in operation during the last eight months. The system was designed to treat 1,000 gpm of cooling pond water in the first stage and approximately 800 gpm in the second stage. Part of the clean lower Ph water is to be used in the process.

A 23' diameter clarifier/thickener was selected for the first stage and a 26' diameter clarifier/thickener was selected for the second stage. Several modifications to the station have been made and thixotropic rakes were installed in the second stage clarifier.

The modifications to the station were primarily to the Ph probes, instrumentation, limestone and lime feeders and the decision to use lime in the first stage instead of limestone.

The thixotropic rakes were installed because the sludge bed, under certain operating conditions, turned with the rake arms. This eliminated the above problem.

The station will be restarted as soon as the rainy season raises the level of the pond.

The station to date has been operating near design rates and when the station becomes operational, we will evaluate the overall station performance.

Conclusions

The decision to use the Enviro-Clear unit as a liquid/solids separator was based not only upon the test results but because of the expertise, through experience, on other applications and industry.

The Enviro-Clear concept leads to some clear cut advantages:

Faster Separation - They are operating at rates from 2-30 times faster than conventional units.

Improved Clarification

Even at higher throughput rates the effluent clarity is improved significantly.

Compaction

The underflow concentrations, in some applications, have reached 60-70% solids.

Economy of Space

Both area and height are reduced significantly. Therefore, not only saving space but installation costs.

The above are all tangible reasons for choosing the Enviro-Clear concept. The intangible reasons are too numerous to list, however, some of the important ones are:

1. Quick response to changes because of the shorter retention time.
2. Because of the smaller size start-ups and shut downs of the units is short. Effluent clarity and underflow concentrations are easily and quickly established.

Due to the difference in acidic waste waters from plant to plant and the normal characteristic changes which take place periodically, we strongly recommend laboratory and possibly pilot studies be made prior to the sizing and selection of equipment.

