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AIR POLLUTION CONTROL EQUIPMENT ASSESSMENT

SUEZ CEMENT COMPANY

CAIRO, EGYPT

Report Prepared By: Mr. James D. Parsons
APCO Services, Inc.
for the World Environment Center (WEC)

DISCLAIMER

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I. EXECUTIVE SUMMARY

The writer, Mr. James Parsons of APCO Services, Inc. in Kearney, Missouri, was sponsored by the World Environment Center (WEC) to conduct air pollution control equipment assessments at the Quatamia and Suez cement plants of the Suez Cement Company in Cairo, Egypt during the period between February 21 and March 1, 1992 under the sponsorship of the World Environment Center. The air pollution control equipment assessed included electrostatic precipitators, baghouse/fabric filters, and gravel bed filters. The writer praises the staff and administration at both plants. My recommendations for improvement focus on the design, operation, and maintenance of the air pollution control equipment. Ten such recommendations are offered for each plant, the most important are discussed in the following.

At both plants, the lack of spare parts inventory and the long delivery time on parts needs to be improved. In addition, there is a need for better communication and response time in resetting precipitators after high CO levels since the present delays cause equipment tripping with excessive dust discharge to atmosphere.

There is a need for training at both plants. At the Quatamia plant, a training program is recommended to instruct personnel on the start-up and proper operation of baghouses after new bags are installed. At the Suez plant, training classes are recommended to assist personnel with baghouse and precipitator maintenance and operation.

Specifically at the Quatamia plant, it is recommended to upgrade finish mill spray lances and controls to avoid a moisture problem in the precipitators. At the Suez plant, the upgrading of the spray conditioning towers is recommended to improve the precipitator's collection efficiency by conditioning dust and reducing air volume. Replacement or modification to the main process plenum pulse baghouse is also recommended at the Suez plant to convert them to conventional pulse jets design.

Finally, the precipitator capacity at both plants is marginal at best. This means that there is no surplus capture efficiency that allows for process upsets, operator error, damage or broken components or conditioning tower inadequacies. In addition, most of the emitted dust at both plants is valuable product that could otherwise be counted as additional production tonnage at the end of the year and thus additional dollars ($).

II. INTRODUCTION

A visit was made to the Suez Cement Company's facilities in Egypt by the writer, James Parsons of APCO Services, Inc., a representative of the World Environment Center (WEC), New York, New York. Funding for this trip was provided for by the U.S. State Department's Agency for International Development (USAID). The trip occurred during the period between February 21, 1992 and March 1, 1992. The purpose of this visit was to tour 2 plants for the Suez Cement Company examining their air pollution control devices, reviewing their maintenance, testing, and operating procedures, and provide any recommendations, suggestions, and training that could assist them in a more efficient operation. The writer spent equal time at both the Quatamia Plant and the Suez Plant. I met with Mr. A. Fakhr El Din Daly, Chairman of the Suez Cement Company, who reviewed the history and current condition of these 2 cement facilities. Dr. A. Hamdy Sadeeh, Suez Cement Environmental Manager, was made available to assist the representative throughout his visit. Prior to my departure from each plant site, a meeting was held with responsible plant personnel to discuss his finaings and recommendations.

III. FINDINGS

Quatamia Plant

The Quatamia Plant was commissioned in 1989 and is of the dry process type. The plant utilizes 1 cement kiln and was designed to produce 1.35 m/tons per year. However, in 1991, they exceeded this level with a 1.52 m/tons per year production.

As part of the cement-making process, fine particulate matter is generated in all areas of the operation such as quarry, transporting, raw material feed and preparation, kiln, clinker handling and grinding, and finish product bagging. In an attempt to reduce potential air pollution emissions and capture valuable cement product, the Quatamia facility utilizes 3 types of high efficiency collection devices on all of their large process sources. These devices consist of 5 Lurgi electrostatic precipitators, Griffen Fabric Filter baghouses, and a Lurgi gravel bed filter. I believe it is beyond the scope of this study and report to address each and every potential emission point source and every individual collector. I will concentrate my discussion and evaluation on the larger process pieces of equipment.

Electrostatic Precipitators

The precipitators at this facility were supplied by the Lurgi Corporation. Each unit is a single chamber, 2 field in the direction of gas flow arrangement. They each utilize rotating drop hammers for both the collecting plate and wire frame rapper cleaning. Each field has its own single high voltage DC transformer/rectifier for supply. The main kiln and bypass precipitators are each preceded by a gas conditioning spray tower to reduce gas temperature and volume plus add additional moisture to the gas stream to act as a dust conditioning modifier. The finish mill precipitators utilize direct spray lances in each mill to reduce temperature and provide additional dust moisture conditioning.

Each precipitator has an inlet perforated plate to help equally distribute the air volume throughout the unit, thus ensuring adequate residence time for collection efficiency. The collected dust is discharged into individual hoppers and through airlocks into screw conveyors for reprocessing or discharging to landfill as required.

All of the precipitators were on-line and operating during the representative's visit on-site with the exception of the No. 1 finish mill. An external inspection of all the on-line units, including the kiln and bypass precipitators, found them operating with reasonably good power levels and typical outlet stack visual opacity in the 20% to 30% range. The DC power levels were approximately 65 KV DC secondary and 300 mA DC secondary. The outlet field on the kiln precipitator showed high primary amps and approximately 400 secondary mA indicating a possible close clearance or broken emitter wire condition.

It was a common occurrence to have the precipitators go into the trip mode due to high CO levels (0.5% set point at the kiln). This condition could typically occur 2 to 3 times per day and resulted in extremely high outlet stack visible emissions. After the high CO condition had cleared in the kiln, it required a person to place a phone call to the precipitator operator and have him manually place the unit back in reset and in operation. The time period required for this series of events could exceed 30 to 60 minutes.

It was also observed that it was very common for the precipitators to have either a control panel or high voltage transformer set problem requiring a cross connection of 2 or more fields to 1 operating unit. It was reported by plant personnel that this was due to very long delivery time and minimal spare parts kept on-site. Numerous small air leaks were observed around doors, seals, flanges, and conveyor covers allowing ambient air to infiltrate into the precipitators.

An internal inspection was made on the No. 1 finish mill precipitator while the unit was out of service. The primary problems were observed in the first field where approximately 10 collecting plates and corresponding high voltage wire support frames were badly bent, causing either a short or extremely close clearance condition. Additionally, a hard dust coating was present in all areas of the precipitator, particularly on the inlet flow perforated plate blocking approximately 70% of the open area. It was reported by plant operations personnel that the bent collecting plates had occurred during a period when high hopper levels allowed dust to build up into the collecting section, warping the plates.

An external inspection of this finish mill precipitator found the roof to be in an extremely deteriorated collapsing condition, allowing ambient air to leak into the unit. Further inspection of the finish mill system found the water spray lance system to be manually regulated by an operator based on the required outlet cement temperature. The 2 lances in each mill consisted of 7 mm diameter hydraulic nozzles. The manual operation of these nozzles would typically result in a maximum temperature reduction of 15 degrees Centigrade.

Baghouses/Fabric Filters

There are approximately 50 baghouses at this facility, all supplied by the Griffen Company. They are all of the pulse-jet cleaning design and utilize wire cages to support the polyester felted bags (9" diameter x 99" long). There are 6 primary process collectors, each ranging in design from 86 to 100 m^3/m^2/hour. The remaining units are of the smaller design and are considered nuisance or process venting collectors and will not be discussed, but many of the same problem and maintenance recommendations will apply.

Each of the primary baghouses inspected at this facility were operating with approximately 11.5 m/bar compressed air pressure to the cleaning manifold and typical on-line differential pressure was 3-1/2" cm H_2O. The exception to this condition were 3 collectors in the pack house venting system ranged in differential pressure between 8 and 19 cm H_2O. These high operating differential units required bag change-out as often as every 3 months to maintain adequate airflow and ventilation in the packaging area. Normal bag change-out for the other collectors at the pack house was reported to be 2 years. Inspection of bags removed from the problem collectors found heavily blinded fabric and a moist crustation coating on the external surface of the bags.

Gravel Bed Filter

Lurgi Company supplied a gravel bed filter to collect emissions from the clinker cooler facility. This unit utilizes 20 individual gravel filled vessels (19 in operation, 1 off-line for cleaning) to capture the fine outlet dust emissions. This unit was designed to operate at 865,000 m^3/hour at 250 degrees Centigrade with an average maximum differential pressure of 18 m/bar.

The gravel bed filter at this facility was found to be operating at a very high differential pressure exceeding the design limit. Outlet visual opacity spikes were noted in excess of 20% after each module returned on-line after cleaning. The plant maintenance personnel reported that due to deterioration of the original gravel filled material, local desert rock had been suggested and inserted as a replacement.

Suez Plant

This plant initially experienced start-up problems during the early 1980's which resulted in equipment redesign and modifications that delayed full production until approximately 1985. The plant is of the dry process design and utilizes a single cement kiln for production. The facility was designed to produce 1 m/tons per year of cement, however, in 1991, it exceeded this level with an output of 1.015 m/tons.

As part of this cement-making process, fine particulate matter is generated in all areas of the plant such as quarry, transport, raw material feed and preparation, kiln operation, clinker grinding, and finish product bagging. In an attempt to reduce the potential air pollution and to capture cement products, the Suez Plant utilizes 3 types of high efficiency collection devices on their major process sources. These pieces of equipment are electrostatic precipitators, baghouse fabric filters, and a gravel bed filter. I believe it is beyond the scope of this report to address each and every individual emission point source.

Electrostatic Precipitators

There are 4 electrostatic precipitators at this facility. All were supplied by the American Air Filter Company. Each unit is a single chamber, 2 field in the direction of gas flow. Each field utilizes 1 high voltage transformer/rectifier set for DC power. The collecting plates are spaced on center line of 300 mm. The alkali bypass unit and kiln unit are both preceded by an American Air Filter water spray conditioning tower. These spray towers not only reduce gas temperature and volume, but add moisture for conditioning of the dust to modify the electrical dust resistivity. This reduction in resistivity greatly enhances the fine particulate capture of the particulate vented through these units. Each conditioning tower utilizes a single ring of high pressure hydraulic fluid spray nozzles to inject moisture into the flue gas stream.

Due to all precipitator systems being on-line and operating, no internal inspections were performed during the representative's visit to the Suez Plant. Review of the electrical power readings at the control panel found all fields in all units operating at what is considered low power levels with light to heavy sparking being experienced. External inspection found numerous high voltage transformer/rectifier sets out of service and jumper leads applied to those fields where the units were bad. This, as reported by plant personnel, was necessary due to the lack of spare parts availability on-site and the extremely long delivery times for replacement parts. Based on our discussion with plant personnel and the observed poor power levels in numerous fields, we highly suspect that internal damage to the collecting plates and wires have occurred in some precipitators, which may require repairs and/or rebuilding.

Typical on-line precipitator operating opacity would range between 30% and 40% average.

Inspection of the upstream water spray conditioning towers found approximately 50% of the spray lances in each tower out of service due to missing parts, damaged piping or lances, and pump and filtering failures. Recent structural casing repairs have been performed, however, large areas remain with exposed ductwork.

Numerous precipitator trips occurred during my 2 day visit at the Suez Plant which resulted in excessively high outlet stack emissions. These trips would be instituted due to high CO levels at the kiln monitoring probe.

Baghouse

The primary process baghouses are supplied by the Fuller Company and are of the plenum pulse isolating design. The bags are supported by wire mesh cages and hold polyester 5" diameter x 96" long bags. All the primary collectors range in size from 100 to 125 m^3/m^2/hour. There are numerous other small dust collectors through the plant that are either of the pulse-jet or shaker cleaning design. It is beyond the scope of this report to address each of these individual units, however, the information contained herein regarding bag filters will apply.

All of the primary baghouse collectors were of the Fuller plenum pulse design with individual compartment isolation during the cleaning process. Each collector for the most part was operating at very high differential pressures in excess of 15 cm H_2O differential. The compressed air pressure to the pulse cleaning system was between 6 and 8 m/bar and contain an excessive amount of moisture in the line.

The No. D-61 raw mill bag collector was made available for an internal inspection. This unit is typically a problem unit and can require bag replacement every 3 to 4 weeks to maintain adequate flow at the mill. The recently removed bags were found to be heavily coated with dust and were wet and heavily crusted in particular areas. The isolation dampers and several pulse valves were allowing leakage.

Gravel Bed Filter

The Rexnard Company supplied the gravel bed filter for capture of fine particulate venting from the clinker cooler. It utilizes 18 chambers with 1 chamber off-line for cleaning at all times to capture this dust. It was designed to handle 640,610 m^3/hour at 255 degrees Centigrade at a maximum operating differential pressure of 330 mm of water.

The Rexnard gravel bed filter was operating satisfactorily with a differential pressure at the upper limit of the designed 300 m/bar H_2O. The visual opacity spikes after each cell came on-line was less than 20% and considered to be very satisfactory by the representative.

IV. CONCLUSIONS AND RECOMMENDATIONS

Quatamia Plant

In general, the operation and maintenance of this plant's air pollution control equipment was very good compared to other similar facilities that have been visited. However, there are some areas of concern that should be discussed and need attention.

Due to the relatively new age of this plant, it has only started to experience wear and equipment failures. This can be seen in the finish mill precipitator where the manually operated hydraulic nozzles are badly worn and do not provide the necessary finish mill temperature reduction that is required. These worn nozzles have created a moisture spray problem in the precipitator, causing hopper pluggage that has resulted in damage to the collecting plates. The spray system needs to be upgraded to a more modern design with an automated control loop based on a given set point temperature. A system such as this would not only prevent the previously described problem in the precipitator, but would also enhance the finish mill production.

The deterioration of the gravel in the gravel bed filter and replacement by local supplied rock is another indication of potential problems as equipment becomes used and ages. In my opinion, this change of gravel is part of the reason for the high operating differential pressure and observed visual dust spikes after cleaning. The specific type of material and size of rock packing in these filters is important for collection efficiency and differential pressure operation. Any further replacement should be done only after the approval of the original equipment supplier.

The Griffen pulse-jet baghouses, for the most part, operate with approximately 2 years of bag life and with very few problems noted. The exception to this is several collectors in the pack house bagging area. I believe the primary problems related to these pack house collectors' short bag life and high operating pressure is due, in part, to the new bag start-up procedure. It has been reported that after each re-bagging process, the unit is started with the dampers and fan at their maximum operating capacity. This high velocity will ultimately drive the fine dust particulate into the collector bags, resulting in a blinding condition and poor clean down. This condition usually creates a loss in ventilation after approximately 3 months of operation. It is extremely important that anytime the Suez Company replaces bags in any fabric filter, that its initial flow volume be reduced for approximately 24 to 48 hours. Another concern with these collectors is that they are in the continuous cleaning cycle mode. This may result in an over cleaning condition that removes the protective dustcake and can result in bag blinding. I recommend that some type of clean on differential pressure control be adapted to these collectors to ensure that the residual dustcake is always in place, plus add an energy saving.

The bypass and kiln precipitators are preceded at this facility with water spray conditioning towers. These conditioning towers not only provide gas temperature reduction and volume decrease, but also add additional humidity to the dust particles which improves the electrical dust resistivity. This conditioning allows for higher collection efficiencies by the precipitator. These towers appear to be operating adequately, but a key factor in the operation of any precipitator must be preceded by an efficient spray conditioning tower.

The Lurgi design, which utilizes 2 electrical collecting fields in the direction of gas flow, in my opinion, does not provide any surplus collecting plate area or resident time for any unexpected upset conditions. This 2 field arrangement can easily be using the excess 20% visual opacity spikes seen at this plant during rapping and process changes. Based on my experience at other similar cement facilities around the world, it is not uncommon to see 3, 4, and even 5 fields in the direction of gas flow to ensure a reasonable margin of safety.

The other area of concern with the precipitators operation at this plant is a very common occurrence of high CO levels in the kiln, causing a precipitator trip condition. This situation requires manually resetting the precipitators by an operator. The communication from the control room to the operators and his physical action of resetting can take as long as 30 to 60 minutes. During this extended period, the outlet stack opacity is very high, resulting in excessive air pollution plus the loss of fine cement particles, which 50% can be re-injected back into the process.

Recommendations

- Upgrade the existing water spray lances in the finish mill so as to provide an automatic control loop system based on desired outiet product temperature.
- Repair and seal any and all ambient air leaks into each precipitator such as around door gaskets, conveyor covers, hatches, duct expansion joints, etc.
- Provide a remote precipitator reset capability in the main control room to be activated by the operations personnel.
- Improve the current air pollution equipment spare parts inventory and perform an investigation in improving and reducing delivery time of much needed spare parts.
- Install new automatic voltage controls that can react faster and better changing load conditions.
- When necessary to replace gravel in gravel bed filters, ensure the material is of the specific size and design as recommended by the original equipment supplier.
- Initiate a new re-bagging start-up procedure that reduces total airflow through each baghouse by approximately 20% to 30% for the first 24 to 48 hours of operation. NOTE: this is done to ensure proper bag seasoning and the establishment of a residual filtering dustcake on the bags.
- Install clean-on-demand differential controls on all primary baghouses to save energy and ensure that an over cleaning condition does not occur.
- When ordering new replacement bags, specify a 16 oz. singed surface polyester duo-density fabric. This material should improve dust release and extend overall bag life.
- Conduct on-site classroom training with hands-on equipment operation and maintenance review to assist plant personnel in their function.

Suez Plant

The writer found the overall operating and maintenance of the air pollution equipment at this facility to be fair to poor. The primary reasons for this low rating are not due to the lack of dedication and work by the plant maintenance personnel, but due to lack of spare parts and the poor original design and sizing of the equipment. The plenum pulse fabric filters are a poor design and when combined with being undersized, fail to operate satisfactorily no matter what the application. Most of these Fuller plenum pulse units at other similar facilities have either been discarded or modified to a more conventional pulse-jet cleaning method. In addition, typically it will require additional fabric cloth area be added to improve the sizing for adequate collection and reasonable filter bag life. The plant maintenance personnel at this facility should be commended for the patience and diligence shown in trying to maintain these pieces of equipment.

The design and maintenance problems related to the evaporative cooling towers can, in my opinion, only be corrected with improved spray lances, pumps, filters, and automatic control system.

Excessive ambient air in-leakage that was observed around the precipitator doors, screw conveyors, and duct junctions can easily be corrected and will improve the performance of these precipitators at a relatively inexpensive cost in money and manpower.

The low compressed air header pressure, combined with heavy moisture levels, needs to be improved before any hope that these plenum pulse collectors can provide reasonable cleaning and reasonable bag life. A critical factor in satisfactory baghouse operation is a good cleaning mechanism combined with a proper sized and designed unit. Again, neither of these 2 criteria are available with this current plenum pulse collector. NOTE: After re-bagging any collector, it is very important the baghouse be operated at a reduced airflow for approximately 24 to 48 hours to ensure the bags are seasoned properly and an adequate residual dustcake is formed to protect the bags and provide fine particulate capture.

Electrostatic Precipitators

After corrective actions are made to the ambient air leaks and internal damaged plates and wire frames, some improved efficiency should be seen. It will ultimately require upgrading the spray conditioning towers for fine particulate collection. The current 2 fields in the direction of gas flow design does not provide, in my opinion, the necessary collecting plate area and particulate residence time to capture fine particulate and allow for any process or feed upset conditions.

The same problems experienced with the precipitators at the Quatamia Plant also occurred at this facility with the high CO level in the kiln, causing precipitator trips. This requires manual resetting which can take a considerable amount of time and results in excessive stack emissions and loss of valuable fine cement particulate. At the Suez plant, 100% of the catch can and is re-injected back into the process, thus making any improvement for this condition highly desirable. I recommend that the Suez Cement Company investigate and consider installing precipitator reset capability in the main plant control room.

Recommendations

- Repair and upgrade the existing American Air Filter water spray conditioning towers to a more modern design that is both faster acting and more efficient in its spray droplet sized generation. This improved system would include an updated control loop that would modulate around a given precipitator inlet temperature.

- Repair and seal any and all ambient air leaks into the precipitators from either around door gaskets, screw conveyors, duct junctions, expansion joints, etc.

- Provide remote precipitator reset capability in the main control room.

- Install new precipitator automatic voltage controls that are faster acting to any changes in load and process operation.

- Consider converting existing plenum pulse baghouses to a more conventional individual pulse-jet cleaning design (similar design to the Griffen units at the Quatamia Plant). NOTE: This may require additional bag area in each collector to reduce the overall air-to-cloth ration to ensure adequate collection and reasonable bag life.

- Improve existing compressed air pressure and air quality by reducing the moisture content and increasing pressure.

- When ordering new filter bag replacements for the existing unit, specify a 16 oz. singed surface polyester duo-density fabric. This fabric, based on my experience at other similar facilities, should provide improved clean down and longer bag life.

- Initiate a new re-bagging start-up procedure that reduces total airflow through the baghouses by approximately 20% to 30% for the first 24 to 48 hours of operating to ensure properly seasoned bags and the establishment of a protective residual dustcake.

- Improve the current spare parts inventory at this plant to ensure adequate replacement parts are available plus investigate necessary steps to reduce long delivery delay for hard-to-find precipitator and baghouse parts.

- Conduct on-site classroom training with hands-on sessions for maintenance and operations personnel of both the electrostatic precipitators and the baghouses to improve and assist with their function.

Additional Comments

The writer would like to thank Chairman Daly of the Suez Cement Company and Dr. Sadeeh, along with the plant managers and staff at both the Quatamia Plant and Suez Plant for their hospitality and assistance in performing my duties during this visit to Egypt. I personally have the opportunity to visit between 10 to 20 cement facilities around the world each year and I can sincerely say that the staff and administrative body of both of these facilities could stand alongside most plants I visit. I believe the Suez Cement Company can contribute quality cement products to the world cement producing establishment, not only in an efficient manner, but also one that is environmentally conscious to the Egyptian people's needs and desires.

Curriculum Vitae

James D. Parsons

James D. Parsons currently is a principal partner in APCO Services, Inc., a closely held industrial air pollution control consulting and testing company. Jim performs various duties for APCO Services, including baghouse, precipitator, scrubber and cooling tower evaluation, report writing, product development, baghouse and precipitator training seminars. He operates an office near Kansas City, Missouri, and travels extensively throughout North America. Jim has been associated with APCO Services since 1986.

Jim's primary area of expertise over the last six years has been in the evaluation and technical assessment of baghouses and precipitator installations. On the average, he visits 25 plants per year, from large electrical utilities, cement and rock products, steelmaking, foundries and numerous other installations where high efficiency particulate collection is required.

Mr. Parsons came to APCO from Energy Repair and Service, Inc., a company specializing in air pollution control and energy related equipment. He held the position of chief engineer/project manager and was secretary/treasurer for the corporation. While with ERS, Jim initiated and designed three product lines that are currently being used in the air pollution industry. Two of these products were patented and one is considered to be the industry standard in supplemental baghouse cleaning. (AH-Series Acoustical Horns)

Prior experience and positions include: Principal Research Engineer-Environcare Industries, Novato, California, Project Manager-Western Industrial Contractors, Denver, Colorado, Resident Operations Manager for Kaiser Engineers at the Electric Power Research Institute's (EPRI) Air Pollution Control Agency, Seattle, Washington for work in their enforcement and source testing divisions. (1971-1974)

Jim is a graduate of Idaho-State University, 1971, and has completed numerous short courses with the Environmental Protection Agency and at various universities. He has written and had published technical articles pertaining to industrial air pollution control equipment.

1991 Cement Plant Summary

The following is a condensed summary of cement facilities at which Jim Parsons has consulted in the last 12 months.

1. Cementos Veracruz, Orizaba, Mexico
   Kiln precipitator and finish mill baghouse evaluations

2. Leghigh Cement, Mitchell, Indiana
   Precipitator inspection and rapping evaluation

3. LaFarge Cement, Exshaw, Alberta, Canada
   Precipitator performance study as related to kiln feed changes.

4. Medusa Cement, Charlevoix, Michigan
   Evaporative cooling tower and precipitator evaluation

5. Lone Star Cement, Greencastle, Indiana
   The effects of waste solvent burning on kiln precipitator performance.

6. San Juan Cement, Dorado, Puerto Rico
   Kiln and finish mill baghouse evaluation.

7. Blue Circle Cement, Calera, Alabama
   Six finish mill ventilation baghouse study.

8. LaFarge Cement, Joppa, Illinois
   Kiln Precipitator Inspection