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ABSTRACT

Dynamic classifiers were retrofitted at Central Hudson Gas & Electric's Danskammer Station to increase the capacity and improve the fineness of the existing pulverizers. The dynamic classifiers, which went on line in April 1995, replaced the existing static centrifugal cone type classifiers in CE Raymond Mills.

The new dynamic classifiers consist of five main components: the drive, fixed vane inlet louvers, rotating cage assembly, reject cone, and classifier discharge. Classifier speed is controlled by a variable frequency AC motor controller.

The fixed vanes initiate the classification process by controlling the direction and distribution of the air-coal mixture and by rejecting most of the grossly oversized particles from entering the rotating cage. The rotating cage efficiently completes the classification process.

The rotational speed of the classifier can be varied with boiler load or with changes in coal characteristics to better match the fineness with the furnace requirements. Inherently, the rotational effects of the dynamic classifier and better fineness improve coal and air distribution to the coal pipes and to the burners.

Improved coal and air distribution allows operation at lower excess air, which results in increased boiler and plant efficiency and reduced NO_x. Better fineness has a positive impact on combustion efficiency by reducing flyash LOI.

Instead of maximizing coal fineness improvements only, the dynamic classifiers can be used to increase mill capacity while improving the pre-retrofit fineness level somewhat or the capacity can be maximized by allowing the fineness to drop to lower levels. The enhanced capability can be used to increase the pulverizer and boiler capacity with the present coal or to maintain the present boiler load with a coal that is more difficult to pulverize.

At Danskammer, the existing pulverizer capacity was increased by more than 15 percent while the coal particles larger than 50 mesh were essentially eliminated.

INTRODUCTION

The Danskammer Plant is located in the Town of Newburgh, New York on the west bank of the Hudson River. It is owned by the Central Hudson Gas & Electric Corporation (CHG&E). There are four steam electric generating units at the site, all of which are currently capable of burning heavy fuel oil. Only Units 3 and 4 can fire pulverized coal. Unit 4 boiler is a type CCRRP manufactured by Combustion Engineering with a 1,553,400 lbs/hr steam rating. Construction of Unit 4 was completed in 1967. Unit 4 burned coal from 1967-1970. In 1971, this unit was converted to heavy oil firing and then converted back to coal firing in 1987.

As a result of the Clean Air Act Amendment (CAAA) Title I, CHG&E has reduced the NO_X emissions from Unit 4 steam generator to a level that complies with the requirements of this regulation.

In conjunction with this work, CHG&E elected to add dynamic classifiers to the four pulverizers (mills) of Unit 4.

Each mill system consists of a separate exhauster, control damper, cold and hot tempering air dampers, gravimetric coal feeder, Combustion Engineering No.RPS703 mill, riffle distributors, and DB Riley SLS 140 internal dynamic classifier. (See Figures 1 and 2).

The air-coal mixture passes upward into the dynamic classifier with its stationary and rotating vanes where the direction of flow is abruptly changed and the coarse particles are returned to the bowl for further grinding. The fine particles, remaining in suspension, leave the classifier and pass on to the exhauster.

Seal air for the mill gear box is taken from each cold tempering air duct. A separate seal air fan is not required for this mill. The mill inlet pressure downstream of the rating damper is normally between 0 to -1.0" w.c.

The exhauster is connected to the mill worm shaft through a flexible coupling. The exhauster is essentially a straight bladed semi-shrouded overhung wheel type fan, equipped with renewable blades and liners.

The exhauster supplies pulverized coal to three riffle type distributors. The riffle distribution system on each mill supplies pulverized coal to eight coal nozzles, a total of 32 coal nozzles for the entire boiler.

The exhauster discharge pressure is approximately 10 to 12" w.c. under full load operation.

A single motor is connected to a common shaft for the mill and exhauster drive. This 600 HP motor is rated for 166 amps, 884 RPM and 2300 volts.

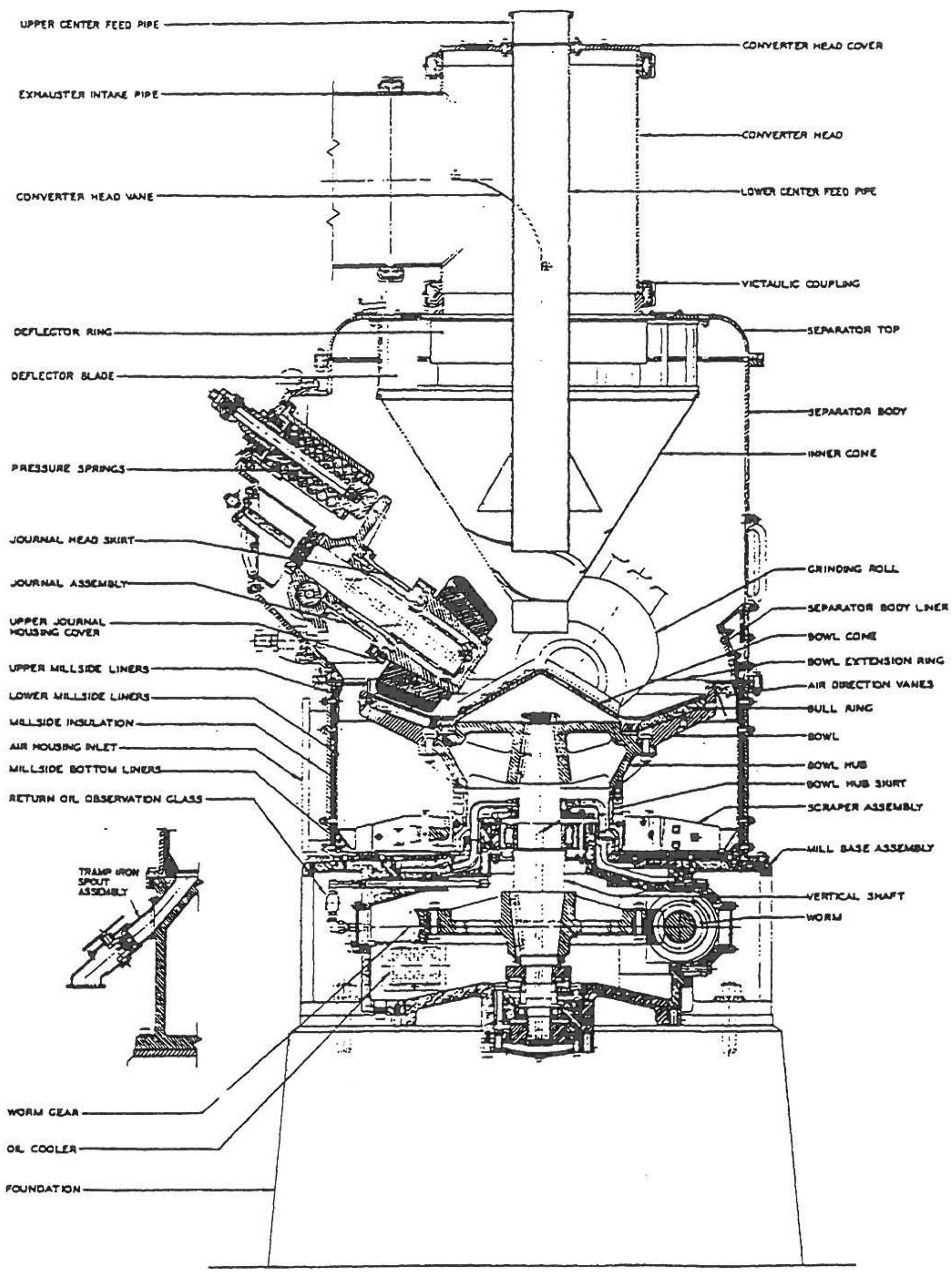

Figure 1 ABB/CE Suction Mill

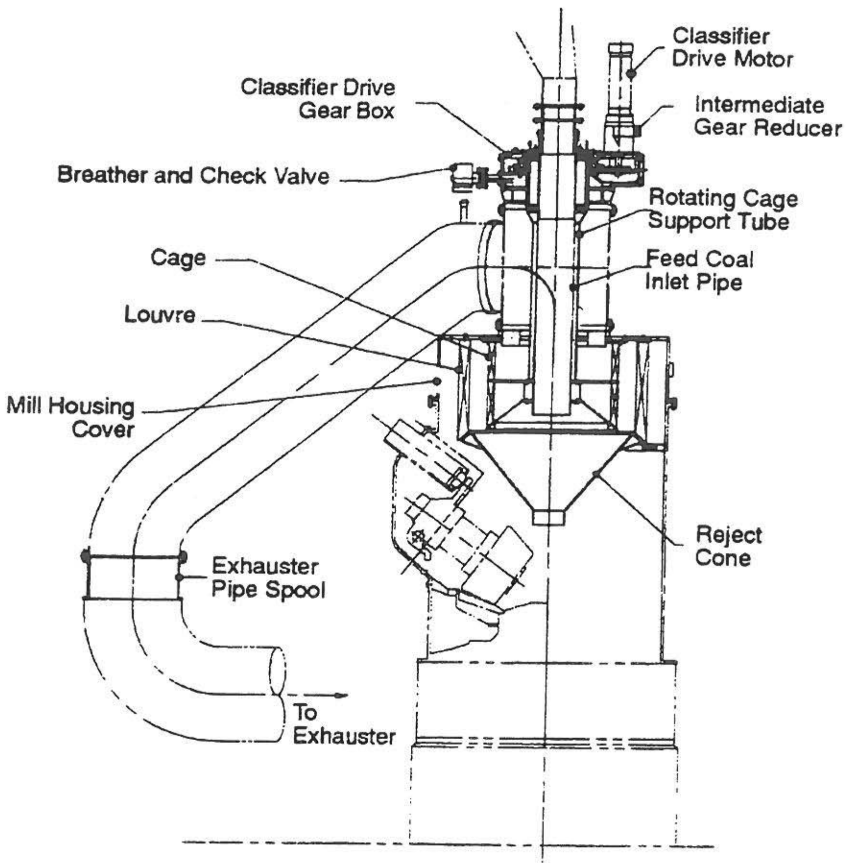

Figure 2 DB Riley SLS Classifier

SCOPE OF SUPPLY

DB Riley's work included all designing, procuring of materials, fabricating, inspecting, expediting, shop testing, supplying, installing, delivering, start-up and warranty testing of mill classifiers, accessories and controls. DB Riley was also responsible for the demolition and removal from site of all equipment which was no longer required.

Specifically, the equipment and services included:

- One dynamic classifier each for Mill 4A, 4B, 4C and 4D complete with variable speed electric drive motor
- Four free standing variable speed drive controller cabinets
- Complete seal air system
- Electrical connections from local devices to local junction boxes
- Coal conduit spool pieces, as required
- Definition of control system modifications including air-coal ratio curves
- Definition of required service and instrument air connections
- Design of supports for classifier
- Suggested location of platforms, stairs, ladders, and structural steel
- Supervision of mill clean air test, preparation of calibration data as required and reporting of test results

- Shop and field painting, as required
- Special tools
- Instruction manuals
- Training at site for five operator courses and two mechanic courses
- Demolition and installation drawings
- Spare parts
- Field startup support
- Acceptance testing

TECHNICAL DESCRIPTION

DB Riley's SLS Classifier is based upon technology licensed to DB Riley from its parent company, Deutsche Babcock Energie and is a second-generation design rotating type centrifugal classifier. It is designed to improve the coal classification processes that occur in DB Riley's MPS mills and other coal pulverization equipment.

Mechanical Design (Refer to Figure 2)

The SLS ("Luftstromlamellensichter" – Finned Plate Air Separator) classifier consists of five main components; the drive gearbox, the fixed vane inlet louvers, the rotating cage assembly, the rejects cone, and the classifier discharge. The drive assembly is a single stage reduction unit adaptable for hydraulic or electric motor drives. For Danskammer, a variable speed electric drive system was supplied. The four point ball bearing/output gear combination (also referred to as a slewing ring) is designed for 100,000 hours of operating life. Lubrication is provided as a closed reservoir oil bath. Two lip-type solid oil seals protect against oil leakage and seal air is used for pressurized mill applications to prevent contamination of the oil bath. The upper drive tube is connected to a cage support tube through a series of high strength studs. The drive and support tubes are sized such that the coal feed pipe passes through the inside diameter to gain direct access to the mill.

The rotating cage assembly consists of an upper and lower section which are connected to the support tube and to each other. The top, middle, and bottom rings serve to stiffen the assembly. Blading on both the rotating cage and fixed inlet louvers is made of abrasion resistant 400 BHN plate and are of fixed and angled construction.

The fixed inlet louvers are held together as an assembly by upper and lower rings. The upper ring attaches to the top cover of the mill by bolted connections. The rejects cone mates with the bottom of the stationary vane ring and is welded to the mill body using adjustable steel supports. The classifier discharge housing provides for attachment of the coal pipes servicing the boiler.

Instruments and Controls

At Danskammer Unit 4, instrumentation and control philosophy supplied with the classifier consist of the following: Classifier RPM is controlled by the variable frequency AC motor controller; a tachometer is provided for classifier speed feedback purposes; classifier RPM is programmed to follow mill coal flow to obtain a desired fineness vs. mill load relationship; manual override with manual control of classifier speed from the control room is also provided; instrumentation for monitoring drive assembly oil bath temperature and oil level is utilized for protection purposes; positive braking of the drive assembly is also provided.

Principles of Operation

To obtain the fineness levels required in the industry today, the SLS classifier makes proper use of aerodynamic, gravitational, and centrifugal forces. Deutsche Babcock's first dynamic type classifier, the SLF, utilized a one stage classification process (i.e., absence of outboard fixed directional vanes relative to the rotor) and consisted of a conical shaped rotor without the use of a coal return hopper. The SLS classifier design improves upon each of these three areas.

The SLS classifier utilizes what can be called a two-stage classification process. Outboard of the rotor, a circumferential ring of fixed angled vanes initiate the classification process by altering the direction of the air-coal mixture. Pre-classification of coal particles at this stage occurs via a static classification process, and serves to reject most of the grossly oversized particles from entering the rotating cage.

Additionally, the outboard vaning directs the air-coal mixture evenly across the height of the rotating cage and at the most advantageous angle. With this accomplished, maximum classification efficiency is achieved by the cylindrical rotor which imparts equal centrifugal force across its height. As each coal particle enters the rotor, it is acted upon by two opposing forces. The aerodynamic force of the transport air acts to "push" the coal particle through the rotor. At the same time, the rotation of the rotor imparts a centrifugal force on the coal particle in the opposite (outward) direction. Coal particle size and resultant magnitude of each force dictates whether the coal particle passes through the rotor or is rejected. Oversized material is not re-entrained into the air and coal stream entering the classifier.

PERFORMANCE

Classifier technology in the Power Industry has improved significantly with the advent of rotating classifiers. Compared to mill operation with a static-type classifier, the SLS classifier offers a number of performance advantages.

Improved "Sharpness" of Classification – The SLS classifier is inherently more efficient than static-type classifiers and this offers many benefits. Higher classifier efficiency defined here means that for the same average exiting particle size, the outgoing particle size distribution (total population of exiting particles) is less varied. The classifier is more selective. Refer to Figure 3. In terms of benefits, "sharper" classification can result in: improved particle burning without mill capacity reduction, mill capacity increase and milling system (air fan and mill) power reduction. Please note that all three benefits cannot typically be realized simultaneously.

Positive Fineness Control – Operation of the SLS classifier allows positive fineness control throughout the load range of the pulverizer. This feature benefits many aspects of both mill and furnace operation. From a milling system standpoint, fineness control makes it possible to optimize mill operation/fineness at each mill load point. This increases overall milling system efficiency by eliminating under and over grinding. For other specific purposes, fineness control can be used to increase mill responsiveness to load change as well as maximize mill turndown capability. Overall fuel firing characteristics are also improved as inconsistencies due to multiple coal usage, unit load firing variations, and coal nozzle "combination in operation" sensitivities can be minimized with proper fineness adjustments.

Equalized Coal and Air Distribution – Inherently, the rotation effects of the SLS classifier improves coal and air distribution to the coal pipes. The degree of improvement has not been firmly established but distribution is enhanced (vs. static classifier operation). Also, the combination of increased fineness and "sharper" classification reduces coal roping in

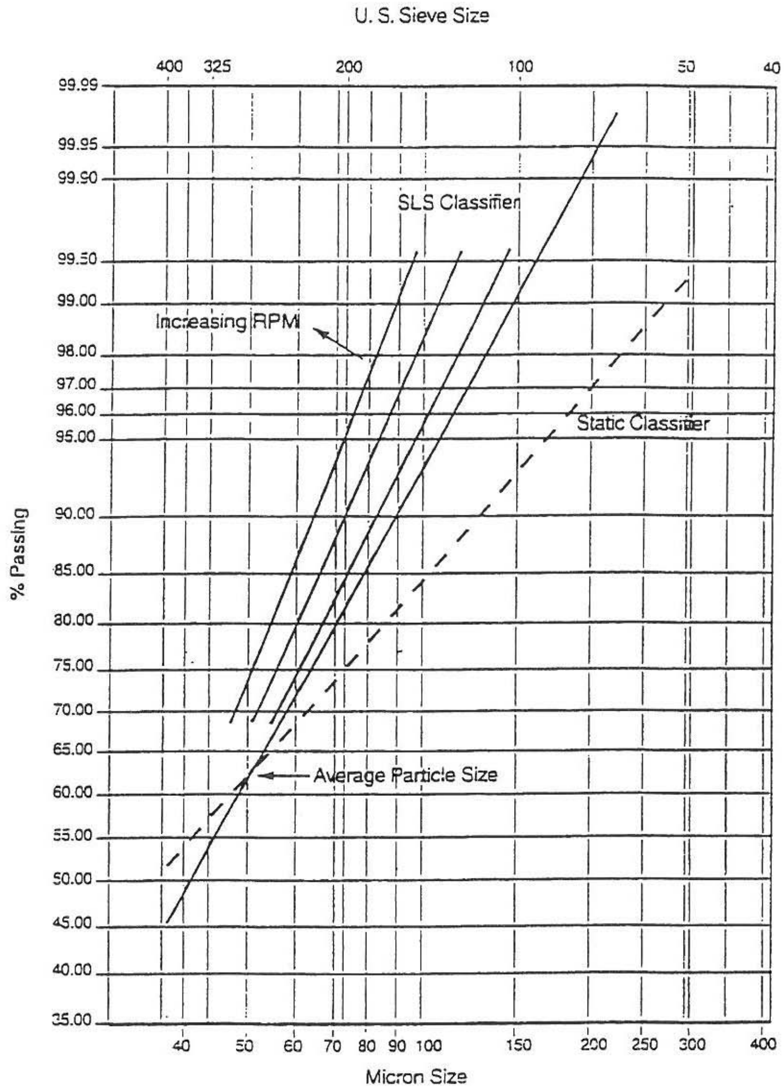

Figure 3 Particle Size Distribution

individual burner lines. This results in improved and more consistent fuel air distribution at each burner nozzle. Overall, improved coal and air distribution can have benefits in low load flame stabilization, reduction of O2 and CO imbalances, reduction in coal transport problems, and fuel pipe erosion equalization.

FIELD TEST RESULTS

A large number of performance tests were made at Danskammer Unit 4. Tests were run at 42 Klbs coal/hr and 56 Klbs coal/hr which represents full boiler load with 4 mills and 3 mills, respectively. The results are summarized in Tables 1 and 2 and Figure 4. In general, the results proved to be very positive.

The first test series, summarized in Table 1, shows a comparison between the best fineness attainable with the original static classifier at 42 Klbs coal/hr compared to and the performance of the SLS dynamic classifier at the same mill load. With the SLS dynamic classifier, the 50 mesh particles were eliminated, 100 mesh particles were reduced by 80% and 200 mesh particles were reduced by about 45%. This improved performance was accompanied by a slight decrease in power consumption.

Table 1 Fineness Optimization at 42,000 lbs coal/hr

Item	Original Static Classifier	SLS Dynamic Classifier
Coal Flow, Klbs/hr	42.2	42.0
Airflow, Klbs/hr	91	91
Motor Amps	153	150
Bowl dP, "wc	10.8	10.9
PC Fineness		
% > 50 Mesh	0.2	0.0
% > 100 Mesh	3.5	0.7
% < 200 Mesh	79.9	88.9
Feed Coal HGI	45	44

A second series of tests (shown in Table 2) were run, comparing the original static classifier, operated at its design capacity of 49 Klbs coal/hr and a mill with an SLS dynamic classifier, at 56 Klbs coal/hr. The results were as follows:

Table 2 Capacity Optimization

Item	Original Static Classifier	SLS Dynamic Classifier
Coal Flow, Klbs/hr	48.7	56.0
Airflow, Klbs/hr	83-91	83-97
Motor Amps	158	165
Bowl dP, "wc	11.7	12.1
PC Fineness		
% > 50 Mesh	0.4	0.15
% > 100 Mesh	5.6	2.7
% < 200 Mesh	76.9	80.1
Feed Coal HGI	44	44
% Capacity @ indicated fineness	100	115

The mill with the SLS dynamic classifier was able to achieve a 15% increase in capacity over the mill with the static classifier, while maintaining better fineness. The coal particles on 50 mesh were reduced by over 60% and on 100 mesh, by over 50%. The mill power only increased by 4.4% and stayed within the capability of the existing motor.

Figure 4 was developed to show the trend of fineness vs. capacity for both the static and SLS dynamic classifiers. The slopes of the trends are very similar, but the capacity of the mill with a dynamic classifier is typically about 15 to 20 percent more than the mill with the static classifier, for the same fineness. Because of the greatly improved classification efficiency of the SLS dynamic classifier, the power consumption change for the 15 to 20 percent increase in capacity is only 4 to 5 percent as discussed above. If improved fineness, rather than increased capacity, is the goal, the figure clearly shows that the fineness can be improved significantly with an SLS dynamic classifier. Obviously, a range of capacities and/or finenesses can be achieved by varying the speed of the dynamic classifier.

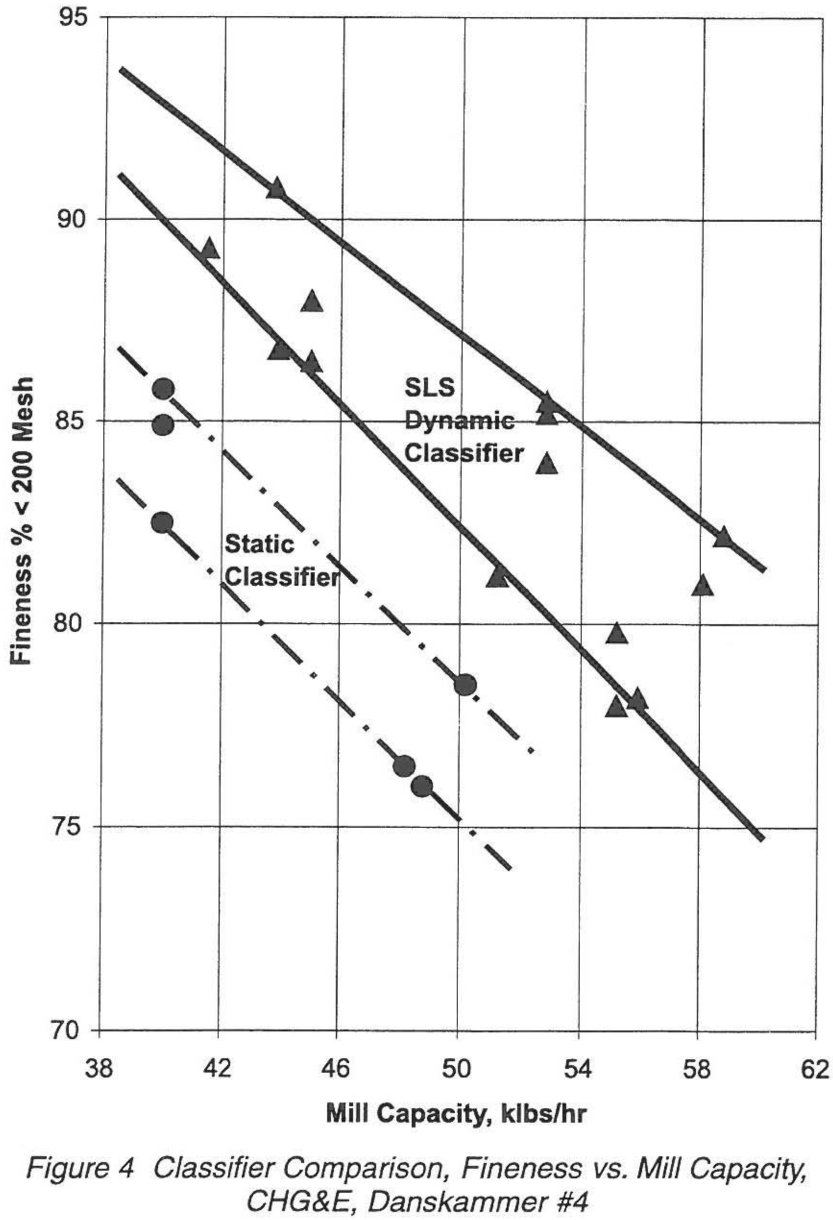

Figure 4 Classifier Comparison, Fineness vs. Mill Capacity, CHG&E, Danskammer #4

Figure 5 shows the trend of fineness through 200 mesh vs. SLS classifier speed. Note that at 90 RPM the fineness through 200 mesh was a little higher than 75 percent. As the SLS classifier speed was increased from 90 RPM to 160 RPM, the fineness improved from 75 percent to nearly 90 percent, a 20 percent improvement in the percent through 200 mesh. At a coal flow rate of 42,000 lb/hr, this fineness improvement was achieved without an increase in motor horsepower, as shown in Table 1.

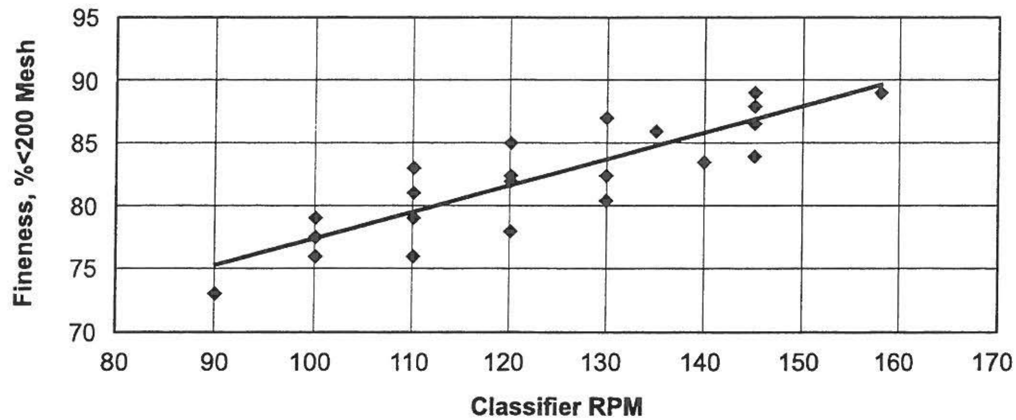

Figure 5 Trend of Classifier Speed vs. Fineness, CHG&E, Danskammer #4

PROBLEMS ENCOUNTERED

One of the most aggravating problems with the dynamic classifiers was an oil leak in the intermediate gear box. Oil had to be added daily during initial operation. Larger O-rings, a larger vent, and a different viscosity oil have made this problem manageable for Danskammer.

The plant was plagued with dynamic classifier speed control problems, mostly related to the feedback signal coming from the classifier tachometer. These problems have been corrected.

Two out of the four speed reducers had to be replaced, one because the shaft seals had been installed incorrectly, resulting in failure of the reducer, and the other because of excessive noise. The speed reducers are now operating properly.

The primary air flow measuring devices furnished as part of the dynamic classifier contract were incorrectly positioned in the primary air duct and had to be relocated for more accurate flow measurement. These air flow probes, furnished by Air Monitor Corporation, are typically very accurate when installed properly in ducts. DB Riley has excellent experience in using these probes for measuring combustion air flow in our low NO_X burners.

The dynamic classifier brake requires shoe replacement twice a year, which is more often than expected or desired. This problem is currently being investigated but has yet to be resolved to the satisfaction of Danskammer.

CONCLUSION

Since many plants are switching to lower grade coals, pulverizer capacity is often diminished, affecting the full load capability of the plant. The plant capability can be restored with no change in fineness and relatively little change in required power input to the milling system by replacing the static classifiers in existing mills with dynamic classifiers.

If unburned carbon in the ash is the issue, rather than capacity, or if a smaller increase in capacity accompanied with some improvement in fineness is desired, a dynamic classifier can be the answer.

At Danskammer, the capacity of the milling system can be increased by 15 to 20 percent, while maintaining about the same fineness as before the retrofit. At times when better fineness is desired, the dynamic classifier can be set to reduce 200 mesh particles by about 45%, 100 mesh by about 80%, and 50 mesh by 100% as compared to the original mill with a static classifier. The better fineness can be achieved at a mill load of about 42 Klbs coal/hr which is the capacity required to reach full boiler load with four mills in operation.

REFERENCES

Gillette, R., Heath, T., Cardarelli, R., "Advanced Milling System Technology Retrofit at NYSE&G Corp.'s Milliken Station" Presented at PowerGen'94, Orlando, December 1994.

Earley, D., Penterson, C., "Accurate Burner Air Flow Measurement for Low NO_x Burners" Presented at 8th Int'l. Joint ISA POWID/EPRI Controls & Instrumentation Conference, August 1998.