SHAKEDOWN TRIALS: NEW YORK STATE RDF STEAM GENERATING PLANT – ALBANY, NEW YORK

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ABSTRACT

All new plants require a shakedown period. That first operational trial of equipment is to determine operational characteristics, debugging of operational problems, and required modifications for good plant performance. The New York State RDF Steam Generating Plant was no exception. It all started with the first light off of RDF in April 1981 and has continued to the present time. This paper is presented to tell of the problems as they arose and how the operating forces dealt with them.

PLANT DESCRIPTION

The plant is equipped with two 100,000 lb/hr (45,455 kg/hr) boilers delivering steam at 250 psig (1725 kPa) and 450 F (232 C). The fuel is transferred from pit storage by two bridge cranes supplying the live center surge bins. Each bin meters the RDF to its boiler by varying the speed of the horizontal screws. Each surge bin discharges RDF through two gravity chutes and air sweep distributors to a front ash discharge traveling grate stoker. Emissions are controlled by utilizing electrostatic precipitators installed on each unit. Ash is removed by drag conveyors. Figure 1 is a section showing equipment arrangement.

SLAGGING OF FURNACE WALLS

Each furnace has a water cooled membrane wall. The lower 7 ft had a refractory lining held in place by studs welded to the tubes. This contributed to our first major problem. As the RDF was burned, slag deposits began to form. The magnitude of these deposits was staggering; adhering to the refractory surface and extending downward from the 7 ft level and outward over the grate surface as much as 6 ft. This buildup followed approximately 30 hr of operation and reduced the grate surface by 30 to 40 percent.

Several attempts were made to remove these deposits and continue operation. The deposits were poked unsuccessfully with pikes in an attempt to break them free from the membrane walls. A high pressure air lance was then used, but did not get to the middle of the deposit, which was molten and extremely hard. The unit was fired with oil only, which allowed the deposits to cool considerably. When this occurred, the deposits pulled free of the walls and we were able to force the material off the walls using long pikes. As the large masses of slag moved to the front of the boiler, they became trapped under the bridge wall and had to be broken up by brute strength.

The slag removal operation required from 4-8 hr to accomplish and the combined efforts of six to ten men. It was concluded that the only option was to shut down, cool the boiler and remove the deposits from inside the firebox. This was accomplished using pikes and sledge hammers.

Our greatest concern was the elimination of the slagging problem. Test strips of refractory and studs were removed from the membrane walls. This
was done to determine what effect the studs would have on the material as it was burned. During the test firing, we found the slag build up was minimal on the test strips and the material did not collect on the bare tubes whether studs were present or not. The decision was made to completely remove the refractory from the membrane walls without removing the studs, which has eliminated the major slagging problems.

At the same time, we were experiencing difficulties in the catenary area of the stoker. There was a sizable gap between the stoker grates and the rails supplied. The problems arose from the tramp iron delivered in the fuel finding its way into the catenary area, resulting in damage to the grate carrier bars and fouling of the sprockets.

After studying the problem, the decision was made to replace the rails originally supplied in the firebox with rails we fabricated. These rails were 6 in. wide and extended out over the grate surface an inch and a half on each side (Fig. 2). This modification eliminated the migration of tramp metal into the catenary area and solved the problem. Over the top of these rails, a 2 in. header pipe drilled every 4 in. with quarter inch holes, was installed. These header pipes were supplied with high pressure steam and high velocity air. The steam blow is operated at 30 min intervals and assists in keeping the side walls clear of slag. The high velocity air is used to keep the pipe cool and prevents damage to the pipe when steam is not being used. These modifications have completely solved the slagging problems and have worked so well on the No. 8 unit that they have been incorporated into the No. 7 unit.

**FLY ASH REINJECTION**

Another contributing factor to the slag buildup was the reinjection of economizer fly ash to the furnace. This material has the consistency of fine
beach sand and when it was analyzed was found to contain 87 percent silica. The fly ash material was being reinjected approximately 36 in. above the stoker through three-fourth inch tubes, equally spaced across the back of the firebox. The bulk of this material migrated to the corners of the firebox where it fused with the refractory and the slag deposits already formed on the membrane walls. As the deposits grew, they would cover the reinjection ports, causing the tubes and their rotary valves to plug up. This in turn caused shear pin failures in the rotary valves and created bridging in the economizer hoppers.

Solving the problem created by the sand-like material from the economizer was somewhat more difficult. We tried manifolding this material into one reinjection line that discharged into the center of the back wall in an effort to prevent the material from collecting in the corners of the firebox. This modification met with a limited amount of success and the material was still migrating throughout the boiler. After this material was analyzed and found to be 85 percent silica, it was agreed that there was very little benefit gained from the reinjection of fly ash. The decision was made to completely remove this material, and a collection hopper was fabricated. This hopper did not function well. As the material moved into the hopper by high velocity air steam, the escaping air carried large quantities of particulates into the ash room. We found that the reinjected material did not collect and cause a problem after the refractory from the membrane walls was removed. The reinjection piping was modified and reinstalled, and the material is now removed along with the bottom ash and no longer causes problems in the firebox.

**RDF FEED SYSTEM**

The overriding problem associated with all RDF plants is the delivery system to the furnace and this plant is no exception. RDF is delivered to the plant from the City of Albany’s processing plant in compactor trucks loaded with 17 to 21 tons of RDF. There are two storage pits with a capacity of 500 to 600 tons of RDF each. From these pits, the material is moved by bridge cranes to the live center surge bins which are used as metering devices for the RDF. There are eight vertical screws along the center line of the surge bins and two variable speed horizontal screws used to feed the gravity chutes that supply RDF to the firebox.

At the bottom of the gravity chutes, an air sweep distributor with a cast iron deflection plate is used to spread the RDF evenly on the grate surface. Within 10 days of operation, the RDF wore holes through the deflection plates, which caused the RDF to spread poorly and provided an area where RDF became trapped and plugged the chute. To alleviate this problem, we had a 304 stainless steel liner one-quarter inch thick formed to cover the cast iron plate. The plates are showing some wear and it is estimated that they will last 2 months. The operation of the deflection plates was controlled by a hand wheel which utilized a gear arrangement to position them, and hold the plates very rigid. Large heavy particles are distributed throughout the RDF product delivered to the facility. As the particles beat down on the
rigid deflection plates, teeth broke off the gears and in some cases the deflection plates were cracked. To eliminate this problem, the gear arrangement was removed and an arm was installed on the shaft of the deflection plates. A spring with a chain operator was attached to the arm and now when heavy objects hit the plate, it gives and the spring returns it to its original position.

The live center surge bins are the heart of the plant and a great amount of difficulty has been experienced in establishing reliability with this piece of equipment. On the first day of operation, a fire was experienced in the surge bin; the induced draft damper failed to close and the products of combustion were forced up the gravity chutes. After the ID damper was restored, the fire was cleared from the bin by increasing the horizontal screw to maximum speed and moving the burning material from the bin to the furnace. Since that episode, a steam smothering system has been installed in the lower section of the surge bin and in the gravity chutes that feed the boiler.

Several problems have arisen due to the nature of the RDF that is delivered from the ANSWERS Plant. Municipal Solid Waste that is delivered to the City's tipping floor is sent directly to the hammermills, except for the material spotted and pulled out by the pickers as it moves by on the conveyors. After leaving the hammermills, the material passes through magnetic separators and into the compactor trucks for delivery to the boiler plant. Consequently, much of the material delivered is impregnated with glass, tramp metal and wire with a good percentage of rags mixed throughout. The hammermills have very little effect on rags which constitutes a major problem at the boiler plant. Rags become trapped between the flights on the vertical screws. Wire, rope, cable, chains, hose and anything of this nature becomes entwined with rags and as the screws rotate, the mass becomes tighter and tighter, bigger and bigger. This ragging problem extends upward from 7 to 10 ft on all eight screws; the lower 4 to 6 ft stay relatively clean.

The vertical screws would operate for approximately 5 days before the heaters in the motor starters began dropping out due to overheating. The mass that had collected on the screws had to be removed, which is a very difficult and labor intensive manual operation. Pneumatic tools and electric tools have been tried, but nothing makes this job easy. We tried running the screws in reverse, resulting in the breaking off of the bottom flights from the vertical shafts. We tried staggering the operating time of the vertical screws, which contributed to bridging problems that occurred. We found the bridging occurred immediately whenever a screw was shut down. The next approach was to remove flight sections from the vertical screws. We measured up 7 ft from the bottom of the surge bin and removed the flights for the next 6 ft, which presented a much smaller surface area for the rags and wire to work on. Presently, there is a limited amount of operating time with this modification, but the initial runs have looked good. The severity of the ragging has been substantially reduced.

Two gravity feed chutes feed RDF from the surge bin into the boiler. A splitter plate is located at the outlet from the horizontal screw to divert RDF to these chutes. Rags and streamers have a tendency to bridge across the splitter plate and reduce the RDF feed from the surge bin. The first attempt at solving this problem was to completely remove the splitter plate and completely open the mouths of the gravity chutes. This did nothing to alleviate the problem; it intensified it. Removing the splitter plate created a large dead space. Experience has shown that whenever there is a dead space, you have a source of trouble. The next attempt at solving this problem was to remove the bottom 2 ft of flights from the first vertical screw and replace the splitter plate (Fig. 3). The splitter plate was carried all the way out to meet the shaft of the No. 1 screw to prevent the material from bridging across the front of the splitter plate. Once again, there is a limited amount of operating time with this modification, but our initial runs have given us cause to be extremely optimistic.

The elimination of the mass of material that built up across the splitter plate also solved an excessive wear problem that had been experienced on the No. 1 vertical screw. As the mass built up, it came in contact with the flights of the No. 1 vertical screw and within 28 days, 3 in. had been worn off the lower flights. The screw had to be removed for repairs due to the excessive amount of wear in a relatively short period of time. The redesign of the splitter plate has eliminated this problem. We are experiencing some wear on all vertical screws, but it is minimal.

The moisture content of the RDF is a contributing factor to some of the operating problems experienced with the surge bins. When the material is wet, it will not flow easily along the horizontal screws and has a tendency to compact.
As the density increases, a tremendous amount of pressure is exerted on the bin inspection doors which causes them to blow open and deposit tons of RDF on the floor, shutting off the RDF feed to the boilers. This problem was eliminated by installing additional supports (one half inch plate, 4 in. wide and 36 in. long) across the inspection doors, reducing pressure on the door hinges and adding support to the doors.

Another problem attributed primarily to RDF moisture content is bridging in the surge bins. At 100 percent capacity, the surge bins will normally hold approximately 4 hr supply of RDF. However, we have found that when the bins are filled to capacity, bridging always occurs about 6 ft up in the bin. We have tried running the vertical screws in reverse, which does not break up the bridging and damages the equipment. With the screws running in reverse, RDF is forced under the flights of the vertical screws and breaks them away from the shafts of the vertical screws. We have found in these circumstances the only effective way to break the bridging is to remove the material from the surge bin by utilizing the overhead cranes. Once a hole is broken through the bridge, the RDF will begin to feed. We have determined it is much more effective to operate the surge bin at 25 percent of capacity. This reduces our storage to only 1 hr of operation, but we have not experienced a bridging problem since this level control was instituted, regardless of the amount of moisture present.
DEEP PIT STORAGE

The prevalent thought about storing RDF is that it should be avoided and that it should not be stored over 11 ft deep. The fuel pits are 30 ft high by 30 ft wide by 30 ft long, and hold from 500 to 600 tons of RDF. It has been our experience that the longer the material is kept in storage, the drier it becomes and the better it burns. The density of the material does increase with storage but the cranes handle the product easily and the surge bins perform better. The product burns better, more evenly and with a more constant heat release.

WORKING CONDITIONS

The quality of working conditions throughout the plant is a definite problem. Whenever employees come in contact with RDF or RDF and ash particulate matter, they have to be protected. The forced draft fans pull a suction from the crane deck, which keeps the fuel pits under negative pressure. This helps in containing any odors that might be given off by the RDF and also prevents the buildup of methane gas. The filters for the F.D. suction are located on the crane deck. During operation, the cranes move RDF from storage and dump it into the surge bins and large amounts of fine particulates are released into the atmosphere and pulled into the filter bank. These particulates also contaminate the air throughout the crane deck, causing discomfort and concern to anyone working in this area. It is a facility policy that all naked skin must be covered and respirators are to be worn at all times when working around the RDF. Professional help has been requested to set up clothing and breathing standards for employees working in contaminated areas.

STAFFING

The burning of RDF is a labor intensive operation. When the staffing requirements were developed, we drew on experience gleaned from past operations and from our Design and Construction Group. Even with this wealth of knowledge, we underestimated requirements by some 40 percent. When burning oil, our operation requires five employees per shift. When we are burning RDF, it requires 11 employees per shift. There is much more manual labor involved with the burning of RDF and much more to go wrong to interrupt the plant output.

SUSPENSION BURNING

In one of the shakedown requirements, it was decided to try burning as much RDF as possible in suspension. The deflection plates were elevated and the material was blown upward. The material appeared to burn better; however, the economizer and two cells of the precipitator had bridged over after a short period of operation. Fires occurred in the conveyor system leading from the precipitator and a large amount of unburned RDF showed up in the reinjection from the economizer. The clinker that formed in the economizer and the precipitator were huge masses that grew quickly and the unit had to be shut down to remove the buildup manually. With the deflection plates elevated, it was found that a great amount of burning RDF was being deposited in and on the registers, ignitors, diffusers and burner assemblies. The oil burning equipment was rendered useless until it could be cleaned. If a new unit were built, the RDF feed and the oil burning equipment should be on the same side of the boiler, not opposite each other as presently exists.

It has been concluded that it is much better to introduce the RDF into the boiler so that it lands on the grates just in front of the back wall. A high percentage of the light fraction is still burned in suspension with relatively little carry over. The oil burning equipment remains comparatively clean with fewer operating problems.

ASH CONVEYING

The conveyor systems have presented a few problems. As the bottom ash is removed from storage, tramp metal occasionally lodges in the links of the chains. Whenever there is a transition, tramp metal becomes lodged in the guides and shear pins are broken. This problem has been reduced by manually removing all the tramp metal that is seen. Another conveyor problem was the lack of access to sprockets and chains. Plant personnel have cut access openings and installed access doors at many locations on the conveyor housing to alleviate the problem.

There is no means to meter the precipitator ash into the bucket elevator. Whatever material is delivered, is dumped into the inlet of the bucket elevator. This occasionally has overloaded the elevator causing the chain to jump off the sprocket which becomes a major repair problem and hoppers begin to fill up, clinkers form and bridging occurs. The longer we continue to operate on RDF,
the greater the buildup becomes. The established policy is to shift to oil if there is a conveyor failure that cannot be repaired in 1 hr. Clearing the precipitator hoppers once bridging has occurred is a difficult job. It is necessary to work approximately 15 ft above the problem area between the electrodes and the collection plates or remove the rotary valve. However it is done, it is a messy task.

AUXILIARY SYSTEMS

Difficulties have been experienced with many of our auxiliaries. The feedwater pumps did not handle the load and thrust bearings were constantly being replaced. These two stage pumps are now being replaced by five stage pumps. An ID fan turbine drive has been replaced with an electric motor since the reduction gear and flexible coupling caused continued problems.

Bearing problems with the F.D. fan turbine led to another interesting experiment. The answer to unburned product coming off the dump of the stoker was to slow down the stoker and increase the air. When the F.D. fan turbine drive bearings were lost on the No. 7 unit, it was decided to find our how much output could be achieved without forced draft. The unit was operated on natural draft with the F.D. dampers open 100 percent, the stoker air at 100 percent, the I.D. fan in automatic, and overfire air used sparingly. It was possible to walk the boiler up to 93,000 lb/hr (42,273 kg/hr) of steam with plenty of ID left. This experiment has contributed a great amount to the daily operational procedures. The F.D. fans are operated at a substantially reduced speed when RDF is being fired, which also allows cut back on our ID. These small modifications have contributed to a much more stable fire. If we can meet the standards established for our operation after the emission monitoring equipment has been installed, we will continue to operate this way.

CONCLUSION

We have presented a great amount of problem areas that the plant was confronted with. In no way does the staff of the plant want anyone to get the impression that the plant is a failure. All problems have been confronted and in many cases, eliminated. Those that could not be eliminated, have been minimized; this plant does work. The only hurdle for us, now that we have proven it will work, is to complete our staffing. We feel that the OGS Design and Construction Group has given us the best possible operation based on the technology available today.

The most single important ingredient necessary to make an operation like this work is the staffing, a blend of knowledge in the total operation is essential. The staff has to be willing to put in exhausting hours and be prepared to handle physically exhausting job tasks. They must have the ability to spot problems. The plant has improved its operation from day to day, week to week, and month to month. We are extremely proud of our accomplishments.

Key Words
Ash
Materials Handling
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Slag
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Startup