

Polk Power Station IGCC

4th Year of Commercial Operation

October, 1999 - September, 2000



Polk Power Station IGCC 4th Year of Commercial Operation

by John E. McDaniel (Speaker)

and Mark J. Hornick (General Manager)

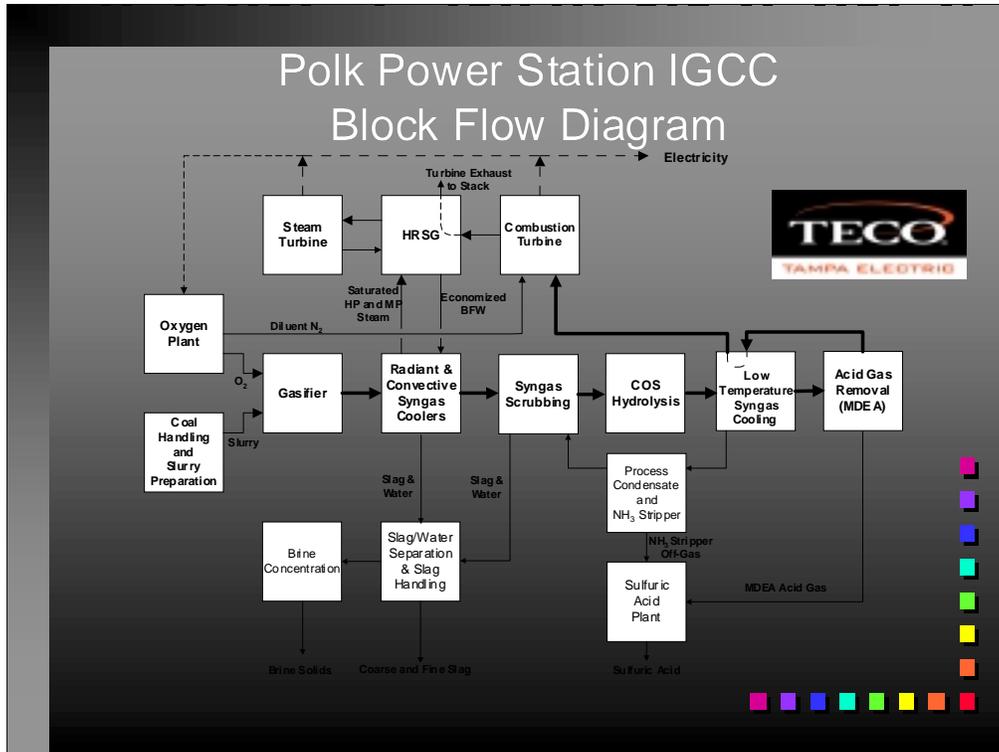
Presented at

2000 Gasification Technologies Conference

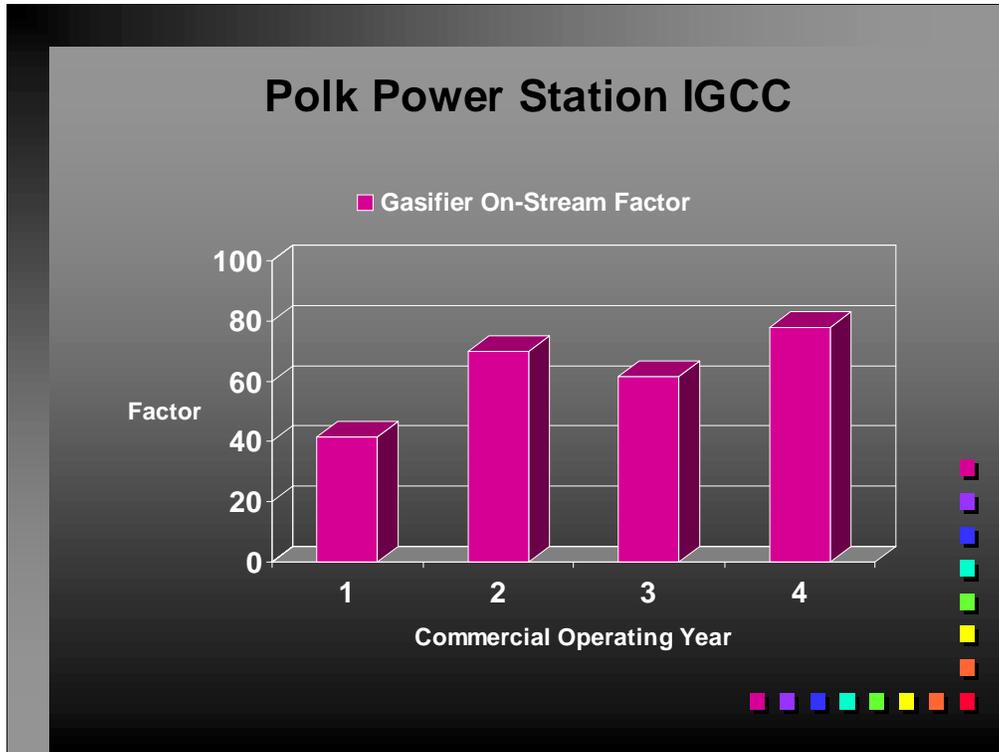
San Francisco, California

October 8-11, 2000

Polk Power Station recently completed its 4th year of commercial operation. It was a very good year - the gasifier's best in its history. Today's presentation will cover some of the problems we solved which enabled us to achieve these results, the actual shutdown causes we encountered in year 4, and our plans for the next 12 months.



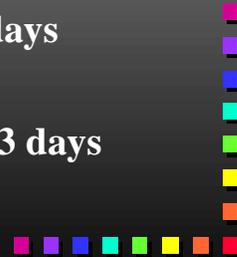
Most of the audience is familiar with the Polk Power Station IGCC block flow diagram. Last year's GTC paper contains a detailed description of the process. The basic flow scheme has not changed. In fact, this is the first year we haven't had to alter the diagram because of adding or removing a significant process step. This in itself reflects considerable progress.



In the first year of commercial operation, the gasifier's on-stream factor was relatively low, barely over 40%, much as expected. The second year was quite good at 70%. Year 3 was disappointing due primarily to convective syngas cooler plugging and problems related to carbonyl sulfide. Solving these and eliminating some other shutdown causes led to our excellent results in year 4: nearly 80% gasifier on-stream factor.

Last 12 Months Best Gasifier Performance Yet

- **77.8% Gasifier On-Stream Factor for the Year**
- **91.3% Gasifier On-Stream Through Summer Peak**
- **Record Gasifier Runs - 46.3 and 48.1 days**
- **Record Gasifier Campaigns - 59 and 73 days
(Back - To - Back)**



Among the accomplishments of the last 12 months were a 77.8% gasifier on-stream factor for the entire period. At least as important is the over 90% on-stream factor through the summer peak. We had two record gasifier runs of 46 and 48 days. And we also had gasifier campaigns of record-setting length, 59 and 73 days - back to back. Campaigns are periods of gasifier operation interrupted only by hot restarts which are a maximum of 8 hours in duration.

Previous Years' Outage Causes Which Didn't Recur in Year 4

- COS Related
Piping Failures, Deratings, High Fuel Costs
- Syngas Cooler
Plugging, Hot Spots
- Slag Crusher Seal
- Grey/Black Water Erosion
1 only, 7 hours lost production
- HP Slurry Piping
Potential Problem Avoided



Before identifying last year's shutdown causes, I'd like to point out a few items which are conspicuous by their absence, problems which forced outages in earlier years but not last year.

In year 3, higher than expected carbonyl sulfide (COS) from the gasifier led indirectly to piping failures, plugging of the slag removal system, deratings, and high fuel costs. The piping was replaced and the COS hydrolysis unit has eliminated COS as an issue.

Convective syngas cooler (CSC) pluggage limited gasifier campaign length to 30 or 40 days in year 3. We have made significant progress here. After the recent 73 day campaign, there were only minor deposits, and CSC pluggage has not forced an outage all year. The radiant syngas cooler (RSC) caused some lost production in years 1 and 2, but has not been an outage cause for the last 2 years. Slag crusher seal failure had been a frequent cause of forced outages at Polk. Our new seal design eliminated this from the list of last year's outage causes. ¹

Grey and Black water erosion had caused 8 to 12 outages per year. A series of design changes reduced this problem to a manageable level. It only caused 1 short outage last year.

The high pressure slurry piping has not actually caused any lost production at Polk. We were able to act preemptively on this issue. Our mechanical integrity program identified some segments of this piping which were rapidly thinning. We redesigned and replaced the segments at risk before a problem occurred.

¹ Cool Water's RSC was also trouble-free in its last years of operation. This leads me to question Texaco's basis for assigning a 3% availability penalty to the RSC configuration compared to quench gasification in yesterday's paper. RSC operation only requires pumping and distribution of boiler feedwater. Quench operation requires pumping and careful distribution of grey water with its known plugging and scaling tendencies through a relatively intricate quench ring.

Lost Production Causes Year 4 of Commercial Operation

- **Planned / Maintenance Outages (3)**
660 Hrs 7.5% of Year 33.9% of Lost Production Time
- **Gas Turbine Distillate Fuel Systems**
416 Hrs 4.7% 21.4%
- **ASU Cold Box Piping Failure**
401 Hrs 4.6% 20.6%
- **All Others**
470 Hrs 5.4% 24.1%



This slide summarizes Polk’s main actual lost production causes for the last 12 months.

Planned outages are far preferable to unplanned outages. 3 planned outages totaling 660 hours accounted for our largest amount of lost production.

Our combustion turbine continued to operate well on syngas, but the distillate fuel system was troublesome. The turbine’s distillate fuel system was our second leading cause of lost production and our leading cause of unplanned outages at 416 hours.

An unusual piping failure inside the oxygen plant’s cold box was third. The root cause of this 401 hours of lost production can be characterized as a bad weld compounded by a weak design in an inaccessible area. Air products provided prompt qualified support to identify and permanently rectify the root cause.

All other lost production totaled 470 hours.

Planned / Maintenance Outages

660 Hrs 7.5% of Year 33.9% of Lost Production Time

- 3 (115 Hrs, 154 Hrs, 390 Hrs)
- Maintenance Outages (≥ 3 Days)
 - Replace Gasifier Thermocouples
 - Rebuild Slurry Feed Pump
 - Clean Syngas Coolers
 - Repack Slag Crusher Seal
 - Tie-Ins for Capital Improvements
- Planned Outages (≥ 2 Weeks)
 - CT Inspection / Maintenance
 - Gasifier Refractory Repair



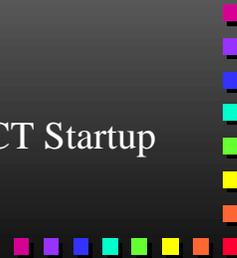
During long periods of operation, we usually compile an extensive work list such that it is appropriate to bring the gasifier down for 3 to 6 days for a “maintenance” or “clean-up” outage. In addition to repairs, the usual activities for such an outage are indicated on this slide. In the past, these outages have been required every 25 to 40 days. During the last year, we have been able to extend the interval to between 60 and 120 days.

Once a year, it is necessary to shut the plant down for a more extensive planned outage of 2 weeks’ duration or longer. Last spring’s planned outage was 16 days, long enough to make minor refractory repairs and perform a hot gas path inspection of the combustion turbine. A complete refractory replacement requires almost a full month.

Gas Turbine Distillate Fuel Systems

416 Hrs 4.7% Of Year 21.4% Of Lost Production Time

- 1 Atomizing Air Compressor Failure (189 Hrs)
- 1 Fuel Oil Fire (110 Hrs)
- 3 Startup Failures (118 Hrs)
- Plus 31 Hrs Flaring Syngas Awaiting CT Startup



The combustion turbine's distillate fuel systems were our greatest cause of unplanned outages

A failure of an atomizing air compressor resulted in 189 hours of down-time. Ironically, this occurred as a result of changes made to improve that compressor system's reliability. We quickly adopted a different approach and the atomizing air compressor system has subsequently been reliable.

One distillate fuel fire occurred following an extended period of syngas fuel operation. When we switched from syngas to distillate fuel, a bad o-ring joint on a distillate valve leaked and the distillate fuel ignited. Fortunately, the fire suppression system worked well. No one was injured and damage was kept to a minimum.

We experienced three turbine startup failures which delayed gasifier startup for 118 hours. In addition, we spent 31 very expensive hours flaring the syngas while waiting for the CT to start. These startup failures are most often caused by fuel oil distribution valves. When we transfer to syngas fuel, all the distillate fuel is not completely purged from these valves. During extended syngas runs, the remaining distillate fuel literally cooks inside the valves, making the internals sticky and inoperative. Consequently, when we try to switch back to distillate fuel, the turbine trips and will not restart. GE has proposed a modification to remedy this problem which we hope to install next month.

“Other” Shutdown and Lost Production Causes

- ASU - Cold Box Piping Failure (1 for 401 Hrs)
- ASU - I&C (6 for 54 Hrs)
- ASU - Gasket Leak (1 for 24 Hrs)
- MDEA - Exchanger Gasket Leak (1 for 128 Hrs)
- Slurry Feed Pump - (8 for 99 Hrs)
- Gasification Flange & Pipe Leaks (6 for 59 Hrs)
- Gasification Solids Removal (3 for 19 Hrs)
- Gasifier Burner Weld Failures (2 for 26 Hrs)



This slide summarizes all the other causes of lost production in the last 12 months.

Besides the ASU cold box piping failure I've already discussed, the ASU was responsible for 7 additional gasifier outages totaling 78 hours. 6 were instrumentation and control problems, all different, and 1 was a gasket leak. First point: the time to repair the ASU was less than 1/3 of the 78 hours. The remainder of the 78 hours was required to restart the gasifier. Planners should bear in mind that subsystem unavailability statistics don't reflect the total impact on overall system unavailability for integrated plants. Second point: this level of unavailability due to the ASU was not unexpected at Polk. The Polk design made use of actual availability statistics from Cool Water's ASU and Air Products and cost estimates from Air Products for multiple ASU trains and intermediate storage. We made the conscious decision that the incremental availability we would achieve with multiple ASU trains and/or storage was not worth the added cost, so we chose a single train ASU with no storage. Contrast this with Eastman Chemical who experiences much higher oxygen supply availability. They chose multiple ASU trains with storage. In their case, the cost of the redundancy was justified. We went through a similar exercise for slurry feed pumps and concluded that a single slurry feed pump was our most cost effective configuration even though we expected some down-time as a result. Slurry feed pump problems did result in 8 outages and 99 hours of lost production over the last 12 months, about as expected. It is critical for project planners/developers to know the value of availability up front and to obtain credible subsystem/component availability statistics to make rational decisions about their plant configuration.

Finally, note that we experienced 2 forced outages due to burner problems. One was a cracked weld on an external nozzle. This could occur in any piping system. The second was due to a pin hole leak in a weld on a cooling coil. Very sensitive instruments detected this leak almost immediately during operation, but it took almost 2 weeks to find it in the shop after the burner was removed. This was traced to a bad weld. These burner problems are not the same type as are often experienced in higher pressure gasifiers such as Eastman Chemical's. Polk's lower pressure operation is much less severe on burner metallurgy, and burner life is not a significant concern for us.

Polk Power Station's 5th Commercial Year Balance Between:

- 1) SURVIVAL: Eliminate Shutdown Causes**
- 2) IMPROVE QUALITY OF LIFE: Cost Reduction**

- Petroleum Coke Blends (50/50)
- Slag Handling/Separation/Recycle/Sales
- Combustion Turbine Starting Reliability
- MDEA Heat Stable Salts
- Brine Concentration Blower
- Steam Leaks



Until recently, the Polk staff has had to concentrate on survival - eliminating serious shutdown causes to keep the plant running. We still have some work to do there, but we can also now begin to focus on improving the quality of our life - cost reduction and optimization.

We expect to begin processing blends of coal and petroleum coke early next year which will significantly reduce our fuel cost.

Slag is a major concern for us. We recently installed a slag handling system which should reduce the amount of slag we have to dispose of by 2/3.

I already mentioned that GE has a fix for our distillate fuel starting reliability problem which we hope to install soon.

We will soon be going out for bids for a lower cost approach to dealing with heat stable salts in our MDEA acid gas removal solvent.

Finally, we will soon be installing a blower in our brine concentration system and tightening up on steam leaks to improve our efficiency.

Polk Power Station IGCC

4th Year of Commercial Operation

October, 1999 - September, 2000



In conclusion, Polk's fourth year of commercial operation was excellent. We solved a number of serious problems, and this resulted in a significant improvement in reliability from the previous year. We are looking forward to continued reliability, cost, and efficiency improvement in this, our fifth commercial year of operation.