CONDENSER TUBE COMPARISON
WINYAH 2

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Abstract

This study is to determine the impact of different tube materials on the Winyah 2 unit condenser for possible tube replacement. The current condenser tubes are made of admiralty metal and show signs of wear due to pitting. The study reviewed the cycle performance changes of replacing the current admiralty tubes with either 90-10 copper-nickel tubes, or titanium tubes. A review of increasing the circulating water flow rates impact on cycle performance was also completed. It was found that a change in tube material resulted in a performance degrade of about 12 Btus/kWh in heat rate and 500 kWh in output. This degrade was minimized by decreasing the tube wall thickness. If the circulating water flow was increased by about 20 percent, there was an improvement in cycle performance. Therefore, a change in tube materials from Admiralty to either 90-10 or TI is feasible without a loss of performance as long as the circulating water flow increases.

Introduction

Winyah 2 is one of four generating units at Santee Cooper's Winyah Generating Station, located in Georgetown, South Carolina. It went commercial in 1977. Winyah 2 is a General Electric (GE) turbine with an output of 303 MW gross at 1,983,000 lbs./hr steam flow, 1000/1000°F throttle/reheat inlet temperatures, 2 inches Hg condenser pressure and 2,400 psig throttle pressure. The unit is a Riley coal fired boiler rated at 2,100,000 lbs./hr, 1005/1005°F superheat/reheat temperatures and 2,475 psig superheater outlet pressure.

There are 690 tubes plugged out of 16,488 total tubes in this condenser. Current tube material is now admiralty and it might be a reliability concern. This is because the tubes are showing signs of pitting corrosion. Eddy current testing is scheduled for the next outage. A change in material to either 90-10 copper nickel or titanium will reduce the corrosion.

The PEPSE run modifications included changes in tube wall thickness and circulating water flow. The number of tubes, the outside diameter and, surface area remained the same for all runs. The circulating water flow increase was an estimate based on a 20 percent increase in motor RPM. This increase amount is based on past experience at another station in increasing circulating water flow. Two speed motors would need to be installed to obtain the higher flow along with a review of the pumps reaction to the higher RPM.

PEPSE Modeling

This paper is to show another case that uses PEPSE software to give engineering support during the course of the year. It is similar to a paper previously given involving the replacement of condenser tubes and tubesheet to gain greater surface area. The older study also concentrated on the heat rejection from the condenser into a bay. This new study is to determine the effectiveness of replacing tubes with a different material while keeping the same number of tubes, outside diameters and using water flow of 100 percent and 120 percent of design. This unit uses a cooling pond for the circulating water heat sink.

A HEI design mode condenser was used in place of a performance mode condenser to obtain the desired modeling results. Cleanliness factors were 85 percent for the admiralty and 90-10 tubes and 90 percent for the titanium tubes. Tube sizes used for this study were 18, 22, and 24 BWG. The circulating water source was modeled at two temperatures and two flows.

The basic PEPSE diagram and a set of results are in the Appendix.

Results

Results of this study are presented in the two tables that follow. The first table includes the condenser performance at design temperature. Table 2 shows the results of a higher temperature that is representative of summer time averages that occurred during the time of peak generation. This higher temperature is based on data collected during the summer of 1998.

Table 1

Winyah 2 Design CWI Temperature								
	CWI Temp. (F)	Tube OD Inches	Tube Material	Tube Gauge BWG	GPM	"Hg	Heat Rate Difference (Btu/kWh) From Admiralty	Output Difference (kW) From Admiralty
Current Mat'l	79	1	Admiralty	18	115,000	2.41	0	0
	79	1	90-10 Cu-Ni	18	115,000	2.48	12	-471
	79	1	90-10 Cu-Ni	22	115,000	2.46	11	-426
	79	1	90-10 Cu-Ni	22	138,000	2.20	-42	1,660
	79	1	TI	24	115,000	2.47	11	-407
	79	1	TI	24	138,000	2.20	-42	1,678

Table 2

Winyah 2 1998 July and August average CWI temperature at loads Greater than 280 Gross MW								
	CWI Temp. (F)	Tube OD Inches	Tube Material	Tube Gauge BWG	GPM	"Hg	Heat Rate Increase (Btu/kWh) From Admiralty @79F	Output Decrease (-) (kW) From Admiralty @79F
Current Mat'l	92	1	Admiralty	18	115,000	3.51	180	-6,865
	92	1	90-10 Cu-Ni	18	115,000	3.59	192	-7,323
	92	1	90-10 Cu-Ni	22	115,000	3.58	191	-7,279
	92	1	90-10 Cu-Ni	22	138,000	3.20	134	-5,148
	92	1	TI	24	115,000	3.58	191	-7,260
	92	1	TI	24	138,000	3.20	134	-5,130

Conclusions

Projects arise that use knowledge obtained from previous experience and older PEPSE models. As in this case, the modeling is much like the previous study that used a HEI condenser. Therefore, it is important to have a history of what models you have been built in the past. I have personally used older models and made modifications to complete new studies for a different steam unit.

This project was put on hold pending the results of the spring outage eddy current tests.

References

The following references were used during the course of the analysis and in preparation of this paper.

1. PEPSE computer code, Scientech Inc, PO box 50736, Idaho Falls, Idaho, Version 62H
2. PEPSE manual: volumes I, II, III, IV, Scientech Inc, PO box 50736, Idaho Falls, Idaho, Version 62H