An Analysis Of Energy Generating System Concerns

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Abstract

A primary focus of this research project was to collect and analyze data pertaining to operating and maintenance concerns being experienced by owners and operators of energy generating systems and the vendors who supply these systems. An important purpose in collecting the information from these various groups was to provide some direction to research (both funded and unfunded) relating to specific energy generating system problems currently being experienced or anticipated in the future.

Introduction

A focus of this research project was to collect and analyze data pertaining to operating and maintenance concerns being experienced by owners and operators of energy generating systems and the vendors who supply these systems. Data was collected from the following populations:

- Fluidized Bed Combustion (FBC) owners and operators
- Industrial Conventional Pulverized Coal (PC) plant owners and operators
- Industrial Conventional Stoker-Fired plant owners and operators
- Utility owners and operators utilizing FBC technology
- Utility owners and operators utilizing PC technology
- Utility owners and operators utilizing Stoker-Fired technology
- Vendors supplying FBC technology combustion based systems
- Vendors supplying PC technology combustion based systems
- Vendors supplying Stoker-Fired technology combustion based systems

One important purpose in collecting the information from these various groups was to provide some direction to research (both funded and unfunded) relating to specific energy generating problems currently being experienced or anticipated in the future.

Operating and Maintenance Concerns Analysis

It was decided to collect the necessary operations and maintenance data by use of a survey instrument, which was distributed to the various populations electronically, as well as by mail. The same questions were included in each survey, irrespective of the population being targeted.

Attachment 1 contains a set of tables, which compare the boiler operating and maintenance concerns for several combinations of responding groups. The numbers in the body of each table reference specific questions addressed in the survey form. Table 1 in this attachment is a presentation of the top five, middle five, and lowest five boiler operating and maintenance concerns for each of the six responding groups that were analyzed. It was noted that Items 7 (Impact of environmental regulatory activity) and 14 (Tube failures [corrosion and erosion]) from the survey were among the top five concern issues for all six groups. Item 9 (Material handling, preparation, transport, and injection or removal [fuel, ash, sorbant]) was among the top five concern issues for five of the six

groups. Items 3 (Combustion and plant control systems) and 10 (Mechanical failure of pressure parts [drum superheater, economizer, air heaters, and generating tubes]) were among the top five concern issues for four of the six groups.

A question then arose as to the possible relationship between type of combustion boiler technology being referenced and responder perceptions relating to boiler operating and maintenance concerns. Table 2 in Attachment 1 is a presentation of the top five, middle five, and lowest five boiler operating and maintenance concerns for each of the two responding groups that referenced FBC combustion technology in their responses. As observed, Items 7 (Impact of environmental regulatory activity), 9 (Material handling, preparation, transport, and injection or removal [fuel, ash, sorbant]), and 14 (Tube failures [corrosion and erosion]) were among the top five concern issues for both groups.

Table 3 in Attachment 1 presents this comparison analysis for the three PC responding groups. In this case, Items 7 (Impact of environmental regulatory activity), and 14 (Tube failures [corrosion and erosion]) were among the top five concern issues for all three groups that used PC combustion technology as their reference in their responses.

The last table in Attachment 1 (Table 4) considers whether referencing stoker-fired combustion technology in the responses would impact which items in the survey would be of greatest concern. As observed, Items 3 (Combustion and plant control systems), 7 (Impact of environmental regulatory activity), 9 (Material handling, preparation, transport, and injection or removal [fuel, ash, sorbant]), and 14 (Tube failures [corrosion and erosion]) were among the top five concern issues for both groups that used stoker-fired combustion technology as the reference point in their responses.

An additional concern issue expressed by FBC technology vendors related to the impact of deregulation on existing power purchase agreements. There were two additional vendor comments, which were received, that did not seem to reflect one type of combustion technology reference over another:

1. *"We believe there are a growing number of cases where plant owners are foregoing efficiency improvements through control improvement to avoid the current regulatory climate of Prevention of Significant Deterioration (PSD) / New Source Review (NSR) triggered by control improvement. For example, if you improve efficiency, you have the ability to increase pollution. We are concerned that plant owners are being pushed to do things that are politically correct, and not defensible scientifically."*

2. *"Many plants have combustion controls and instruments that are aging and / or obsolete. The modernization of these plants is an item of concern. PSD / NSR also impacts on this as well."*

Summary and Conclusions

The primary focus of this survey was to collect and analyze data, which pertain to forced outage causes and operating and maintenance concerns being experienced by energy generating boiler owners and operators, and as perceived by energy system technology vendors. From the data collected and analyzed, a trend of common concerns can clearly be observed. The items presented in the top five boiler operating and maintenance concerns were shared by all six responding groups. However, the middle five and lowest five concerns were distributed without any noticeable pattern in the rankings.

One of the greatest common concerns, which was shared by all six responders, is the impact of environmental regulatory activity imposed on the energy generating combustion boiler systems. This concern may be attributed both to present, as well as anticipated, more stringent environmental regulatory activity. In order to ease this concern, research and development in multi-pollution control processes and devices for in-situ or post emission controls are urgently needed in this area.

The survey results provide rather clear direction for future research and development efforts to address these concerns as expressed by the owners, operators, and vendors. Addressing these technical concerns should greatly improve the reliability and availability of these energy generating combustion systems. Furthermore, the improvements will certainly help to make coal-fired energy generating systems more competitive with gas- and oil-fired energy generating systems.

The results of this survey also pose a future challenge to researchers to provide an energy generating combustion system, which will combine advanced energy and multi-pollution-control technologies into customizable packages that offer higher net energy efficiency than stand-alone technologies. These advanced systems are currently being developed at the National Energy Technology Laboratory of the U. S. Department of Energy.

References

1. Abdually, I. and R. Navazo (1993). "Update of Waste Fuel Firing Experience in Foster Wheeler Circulating Fluidized Bed Boilers." *Proceedings of the 1993 International Joint Power Conference*: 95-112.
2. Anthony, E., D. Lu, and J. Zhang (2002). "Combustion Characteristics of Heavy Liquid Fuels in a Bubbling Fluidized Bed." *Journal of Energy Resources Technology*, 124 (1): 40-47.
3. Basu, P. and S. Fraser (1991). *Circulating Fluidized Bed Boilers: Design and Operations*, Butterworth-Heinemann.
4. Capuano, L. (1992). "Circulating Fluidized Bed Combustion: Past, Present, and Future." *Proceedings of the Council of Industrial Boiler Owners' Eighth Annual Fluidized Bed Conference*: 97-122.
5. Carson, W. and M. Hill (1992). "TVA's 160 Mwe Atmospheric Fluidized-Bed Combustion (AFBC) Demonstration Unit." *Proceedings of the 1992 Conference on the Application of Fluidized-Bed Combustion for Power Generation*: 4-1 to 4-11.
6. "Clean Coal Technology Demonstration Program: Program Update 2001." U.S. Department of Energy, Washington, D.C., 2002.
7. "Clean Electric Power From Dirty Coal." *USA Today Magazine* 2002, vol.130 (2685): 14.
8. *Combustion: Fossil Power Systems*, Combustion Engineering, Inc., 1981.
9. Considine, T. (2000). "Cost Structures of Fossil Fuel Fired Electric Power Generation." *The Energy Journal*, 21 (2): 83-104.
10. Cuenca, M. and E. Anthony (1995). *Pressurized Fluidized Bed Combustion*, Blackie Academic & Professional.
11. Geffken, J. and D. Huber (1993). "A Programmatic Look at the Role of Fluidized-Bed Technology in the Clean Coal Technology Program." *Proceedings of the 1993 International Conference on Fluidized Bed Combustion*: 327-333.
12. Hahn, B. (1994). "CFB Cogeneration Project: An Economic Discussion." *Proceedings of Comparative Economics of Emerging Clean Coal Technologies III: Advanced Power and Environmental Control*.
13. Hoskins, W., R. Keeth, and P. Russell (1989). "Assessment of Circulating Atmospheric Fluidized-Bed Combustion Technology for Utility Applications." Report on Research Project GS-6621, Prepared for the Electric Power Research Institute, Palo Alto, California.
14. Levendis, Y. and A. Atal (1996). "Comparative Study on the Combustion and Emissions of Waste Tire Crumb and Pulverized Coal." *Environmental Science and Technology*, 30 (9): 2742-2754.
15. Levendis, Y. and A. Atal (1998). "On the Correlation of CO and PAH Emissions from the Combustion of Pulverized Coal and Waste Tires." *Environmental Science and* Technology, 32 (23): 3767-3777.
16. Nair, R. and S. Yavuzkurt, S (1997). "Modeling Sulphur Dioxide Capture in a Pulverized Coal Combustor." *Journal of Engineering for Gas Turbines and Power*, 119 (2): 291-297.
17. O'Connor, L.(1994). "Less Waste From Fluidized Beds." *Mechanical* Engineering, 116 (2): 26.
18. Office of Fossil Energy, Office of Combustion and Control Systems (1987). "Technology Assessment of Atmospheric Fluidized Bed Combustion."
19. Peltier, R. (2003)"A Pollution Free Coal Plant?" *Power*, 147 (4): 52.
20. Scherr, F. and J. Fuller (2002). "Costs of Atmospheric Fluidized-Bed Combustors for Electric Power Generation." *Energy Journal*, 23 (1): 117-132.

21. Siebenthal, C, W. Hoskins, and S. Tavoulareas (1991). "AFB Cost: A Program for Estimating Costs for AFBC Power Plants." *Proceedings of the 1991 international Conference on Fluidized Bed Combustion*: 1035-1045.
22. Smith, Douglas J. (2000). "Fluidized-Bed Upgrade Improves Efficiency and Reliability at University Power Plant." *Power Engineering*, 104 (4): 56-57.
23. Smith, D. (1995). "Fluidized Beds Competitive With Conventional Coal-Fired Units in Electric Power Generation." *Power Engineering*, 99 (1): 12.
24. Smock, Robert. (1995) "Pulverized Coal Combustion Readied for 21st Century." *Power Engineering*, Vol. 99 Issue 9: 27.
25. Weirauch, W. (1995). "Used Tires Become Fuel Supplement." *Hydrocarbon Processing*, 74 (11): 25-26.
26. Weth, G., J. Geffken, and D. Huber (1991). "The Relationship of Fluidized Bed Technology to the US Clean Coal Technology Demonstration Program." *Proceedings of the 1991 International Conference on Fluidized Bed Combustion*: 1425-1430.
27. Wilhelm, D., D. Simbeck, and H. Johnson (1993). "FBC's Future Role in Solid Fuel Firing." *Proceedings of the Council of Industrial Boiler Owners Ninth Annual Fluidized-Bed Conference*: 125-138.

Table 1

Comparison of Boiler O/M Concerns By Responding Group

Group	Top five	Middle five	Lowest five
1	9,14,7,3,10	1,12,5,6,8	2,11,13,4,15
2	7,14,9,10,6	15,5,1,11,13	3,8,12,2,4
3	7,14,9,10,3	6,8,1,11,12	13,15,5,2,4
4	14,10,7,13,3	6,1,9,2,8	11,5,15,12,4
5	14,9,7,12,4	3,15,6,8,10	2,1,11,13,5
6	7,14,3,6,9	10,11,13,8,1	2,4,15,5,12

Note: Group 1 is FBC owners and operators.
Group 2 is industrial PC owners and operators.
Group 3 is industrial stoker-fired owners and operators.
Group 4 is PC utility owners and operators.
Group 5 is FBC technology vendors.
Group 6 is PC & stoker-fired technology vendors.

Table 2

Comparison of Boiler O/M Concerns By FBC Responding Group

Group	Top five	Middle five	Lowest five
1	9,14,7,3,10	1,12,5,6,8	2,11,13,4,15
2	14,9,7,12,4	3,15,6,8,10	2,1,11,13,5

Note: Group 1 is FBC owners and operators.
Group 2 is FBC technology vendors.

Table 3

Comparison of Boiler O/M Concerns By PC Responding Group

Group	Top five	Middle five	Lowest five
1	7,14,9,10,6	15,5,1,11,13	3,8,12,2,4
2	14,10,7,13,3	6,1,9,2,8	11,5,15,12,4
3	7,14,3,6,9	10,11,13,8,1	2,4,15,5,12

Note: Group 1 is industrial PC owners and operators.
Group 2 is PC utility owners and operators.
Group 3 is PC technology vendors.

Table 4

Comparison of Boiler O/M Concerns By Stoker-Fired Responding Group

Group	Top five	Middle five	Lowest five
1	7,14,9,10,3	6,8,1,11,12	13,15,5,2,4
2	7,14,3,6,9	10,11,13,8,1	2,4,15,5,12

Note: Group 1 is industrial stoker-fired owners and operators.
Group 2 is stoker fired technology vendors.