LRC-IX-34
DEVELOPMENT OF METHODS TO PREDICT AGGLOMERATION AND DEPOSITION IN FBCS

CONTRACTOR: Energy & Environmental Research Center

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PARTICIPANTS

Sponsor	Cost Share
Northern States Power	$100,000
Ahlstrom Pyrpower	100,000
Riley Stoker Corporation	100,000
U.S. Department of Energy/EERC JSR Program	600,000
Electric Power Research Institute	100,000
ND Industrial Commission	200,000
Total	$1,200,000

Project Schedule - 3 Years
Contract Date - 8/19/92
Start Date - 3/1/93
Completion Date - 12/31/95

Project Deliverables
Bimonthly Project Reports ✓
Semiannual Review Meetings ✓
Annual Report - 3/15/94 ✓
Annual Report - 6/5/95 ✓
Final Report - 2/28/96 ✓

OBJECTIVE / STATEMENT OF WORK

Successful operation of advanced combustion systems requires control and mitigation of ash-related problems. Major ash-related problems are slag flow control, slag attack on the refractory, ash deposition on heat-transfer surfaces, bed agglomeration, corrosion and erosion of equipment and materials, and emissions control. These problems are the result of physical and chemical interactions of the fuels, bed materials, and system components. The abundance and association of the inorganic components in coal determine the interactions that occur in fluidized-bed combustion (FBC) systems.

Major project objectives are:

1. To develop advanced ash and deposit characterization techniques to quantify the effects of the liquid-phase components in terms of agglomerate formation and ash deposits;

2. To determine the mechanisms of inorganic transformations that lead to bed agglomeration and ash deposition in FBC systems; and

3. To develop a better means to predict the behavior of inorganic components as a function of coal composition, bed material characteristics, and combustion conditions.

Overall project objectives are to advance knowledge of ash behavior so methods can be generated to predict and, ultimately, mitigate ash-related problems in FBCs.

STATUS

Intensive sampling was done at the Montana-Dakota Utilities Company's Heskett Station, an 80 MWe atmospheric bubbling-bed, which is located in Mandan, North Dakota. Lignite from Knife River Corporation's mine near Beulah, North Dakota, is fired in the Heskett Station.

Analyses and evaluation of agglomerates formed in fluidized beds indicate a five-step mechanism describing formation of an eggshell-shaped agglomerate.

1. Bed particles become coated with ash as they rub against sticky coal particles;
2. Bed particles stick to the surface of the coal particle;
3. As the coal burns, ash is left at the surface and interacts with the coated bed particles;
4. The ash and bed coatings melt on the surface of the burning coal; and
5. The coal burns out, leaving a hollow center.

Results of the program include a sampling protocol to assist FBC operators in determining the source of ash-related problems. Two types of predictive models were developed. Pictorial models were developed, which visually represent mechanisms of ash formation and bed material agglomeration in the fluidized bed. One of the models involves the formation of a Na-Ca-S-based sticky matrix on the bed material. Another model involves the sticky surface of the coal matrix serving as a surface initiating agglomerate formation. In addition, a computer model was developed to predict agglomeration.

Proper selection of bed material was identified as one factor for mitigation of agglomeration. Operating conditions impacting agglomeration are local reducing conditions, high temperature, increased pressure, and the presence of fluxing agents.

The computer model enables the plant operators to predict agglomeration behavior in the fluidized bed and take action before agglomerates form. Currently, the operators are evaluating the use of alternate bed materials in the Heskett Station (Project FY97-XXVII-76).