

FY02-XLIV-110
BIOMASS IMPACTS ON SCR PERFORMANCE

CONTRACTOR: Energy & Environmental Research Center

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PARTICIPANTS

<u>Sponsor</u>	<u>Cost Share</u>
U. S. Department of Energy	\$180,000
Xcel Energy	\$60,000
EPRI	\$60,000
Montana Dakota Utilities	\$30,000
ND Industrial Commission	<u>\$120,000</u>
Total	\$450,000

Project Schedule – 24 Months

Contract Date – 3-14-02
 Start Date – 2-26-03
 Completion Date – ~~12-31-04~~
 Extended to ~~12/31/05~~
 Extended to ~~3/31/06~~
 Extended to 5/31/06

Project Deliverables

Signed contract, industry
 DOE commitment 2-26-03 ✓
 Qrt'ly Reports: 4/30/03 ✓ ; 7/31/03 ✓ ;
 10/31/03 ✓ ; 1/31/04 ✓ ; 4/30/04 ✓ ;
 7/31/04 ✓ ; 11/30/04 ✓ ; 9/30/05 ✓
 Final Report 5/31/06 ✓

OBJECTIVE/STATEMENT OF WORK

The overall goal of this project is to determine the fundamental mechanisms of NO_x reduction and potential blinding of selective catalytic reduction (SCR) catalysts using biomass and low-rank (lignite) coal constituents. Specific objectives include 1) assessing candidate biomass fuels and coals for testing, 2) conducting bench or pilot scale and field testing to determine NO_x reduction mechanisms and SCR catalysts blinding during biomass-coal cofiring, 3) identifying SCR blinding mechanisms, and 4) developing a database. In addition, this project proposes the evaluation of biomass high in ammonium phosphates, such as poultry or turkey manure, as a reducing source for the NO_x.

STATUS

October – December, 2002 Status Report. Kickoff meetings were held with the project sponsors. It has been decided, with input from the sponsors, to focus on the blinding and poisoning aspects of cofiring biomass with coal and not to look at NO_x reduction mechanisms when cofiring

biomass. The biomass fuels for cofiring in bench- and pilot-scale testing were narrowed to the following tentative list: wood waste sawdust, urban wood waste, and switchgrass. This list does not preclude the use of other biomass fuels; however, sponsors believe it represents the most viable biomass fuels to be fired commercially in the near future. Southern Company has a program to look at full-scale catalyst testing, and it has expressed interest in collaborating on this project activity. This will be explored in more detail in the coming weeks. A revised scope of work reflecting the items listed here will be created in the coming weeks and sent to all project sponsors.

April – June 2003 Status Report. Project consortium sponsors have been finalized, followed by a kickoff meeting resulting in an approved project plan. A literature search will be conducted. Biomass fuels for bench-scale work will be identified and obtained followed by analytical analyses.

July 1 – September, 2003 A wood waste has been milled to a size representative for use in a commercial combustion plant. A Slip-stream catalyst rig will be charged with a catalyst material supplied by Haldor Topsoe.

Oct 1 – Dec 31, 2003 The catalyst will be installed in the fourth quarter at the Rapids Energy Center operated by Minnesota Power, using wood (80%) and coal (20%). The plant is a traveling grate stoker with a cyclone and an ESP for particulate control. Modifications to the plant will be made to support installation of the catalyst reactor.

Jan 1 – March 31, 2004. Installation of the reactor at the Rapids Energy Center continues. A presentation of the project was made to the EPRI Biomass Interest Group (a co-sponsor of the project).

Apr 1 – Jun 30, 2004. Installation and shakedown of the reactor and experimental equipment continues.

July 1 – Sept 30, 2004. The reactor was operated using 80% wood biomass and 20% coal. Operation was problematic and pressure drop across the catalyst became too high, resulting in reactor shutdown. Operation on only coal seemed to be acceptable. Operation with the biomass-coal mixture resulted in high unburned biomass char and ash, resulting in a high pressure drop leading to reactor shutdown.

Oct, 2004 – March, 2005. Numerous mechanical failures of reactors and boiler related operations have hampered test operations and procedures. Two months of run time was obtained with the SCR reactor. A continuing issue was plugging of the SCR reactor with ash material that included unburned carbon. After two months of run time, the catalyst loss approximately 25% of its reactivity. Future activity will include analytical to determine how the catalyst was poisoned. A contract extension was requested and approved, with the activity to be concluded in December, 2005.

April – June, 2005. Continued slipstream tests and collaborative laboratory-scale efforts to elucidate the deactivation of catalysts during biomass cofiring have produced initial results after

2 months that the SCR catalyst lost 25% of its activity to reduce NO_x emissions. The results appear to indicate that biomass use as a tool to reduce greenhouse gases may not be compatible with SCR systems.

July – September, 2005. Operations of the slipstream skid-mounted catalyst test rig were continued, but run time has been limited due to limited flue gas flow through the SCR reactor. It is believed that the high ash levels are causing plugging and increasing pressure drop, thus provide reactor flue-through at rates below the manufacturer's recommendation. Future work includes preparation of a final report.

Final Report – *Abstract*

A portable slipstream selective catalytic reduction (SCR) reactor was installed at a biomass cofired utility boiler to examine the rates and mechanisms of catalyst deactivation when exposed to biomass combustion products. The catalyst was found to deactivate at a much faster rate than typically found in a coal-fired boiler, although this may have been the result of high ash loading rather than a general property of biomass combustion. Deactivation was mainly the result of alkali and alkaline-earth sulfate formation and growth in catalyst pores, apparently caused by alkaline-earth ash deposition on or near the pore sites. The high proportion of biomass in the fuel contributed to elevated levels of alkali and alkaline-earth material in the ash when compared to coal ash, and these higher levels provided more opportunity for sulfate formation. Based on laboratory tests, neither catalyst material nor ammonia contributed measurably to ash mass gains via sulfation. A model constructed using both field and laboratory data was able to predict catalyst deactivation of catalysts, under subbituminous coal firing but performed poorly at predicting catalyst deactivation under cofiring conditions. Because of the typically higher-than-coal levels of alkali and alkaline-earth elements present in biomass fuels that are available for sulfation at typical SCR temperatures, the use of SCR technology and biomass cofiring needs to be carefully evaluated prior to implementation.