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Texas Commission on Environmental Quality  
New Technology Research & Development (NTRD) Program  
Monthly Project Status Report

Title: FEEDLOT BIOMASS: A REBURN FUEL FOR “MAXIMUM NOX” REDUCTION IN  
COAL-FIRED POWER PLANTS

Contract Number: TCEQ Grant # 582-5-65591 0015

Grantee: Texas Engineering Experiment Station, Texas A&M University

Date Submitted: November 09, 2005

Report for the Monthly period:  
Starting Date: October 1, 2005 Ending Date: October 31, 2005

Section I. Accomplishments (Please provide a bulleted list of project accomplishments as well as a description of their importance to the project.)

The overall objectives of the project are i) to develop a retrofit technology of using processed low-ash feedlot biomass (FB) as reburn fuel for potential reduction of the NOx in coal-fired power plants by 80-90% and ii) determine the possible capture of Hg for low rank coals, reduction of CO2 and other benefits of using animal wastes (alternately known as feedlot biomass, FB) as fuels.

1. Task 1: All fuel for the small scale study ground and shipped to small scale burner facility in College Station, TX.
2. Task 1: 25 % of testing is completed and analyzed on the TGA.
3. Task 2 deals with small scale reburn experiments for NOx reduction. Preliminary results were obtained for LAPC FB. These results show very high reduction in NOx under certain operating conditions.
4. Task 2: Fuel data from Task 1 was used to calculate operating conditions for NOx experiments.
5. Task 2 also deals with Hg studies. In light of safety concerns, it was decided that a new combustor setup will be fabricated exclusively for conducting mercury experiments. Bids were received for fabrication of the metal portions of the burner and fabrication has begun.
6. Task 2: An order for mercury analyzer was placed and should be delivered to TAMU in November. Also, research has been done on how to properly perform the Hg measurements.
7. Task 4 deals with a zero dimensional reburn model for predicting the NOx capture by biomass fuels. The subroutines for calculations in the main burner section have been completed, and currently subroutines are being written to determine the volatile matter composition of coal and feedlot biomass fuels. This is being done using the Gibbs Minimization Method. Mr. Soyuz Priyadarson (now deceased) was responsible for the most part of and NOx and Hg modeling. A MS student has recently been hired (Oct, 2005) as a part time student worker to continue the modeling.
8. Task 4: Simulations were done for different concentrations of chlorine, varying from low to high (50ppm, 100ppm, 200ppm, 500ppm, 1000ppm). The data is taken from the US Coal data base.
   a. Global reaction considered:
Hg + 2HCl $\rightarrow$ HgCl$_2$ + H$_2$  

b. Pyrolysis of Chlorine:
   For the reaction above, it was assumed that the pyrolysis product of chlorine is HCl.

c. The above simulations were done for different ambient temperatures (900K and 1500K) to calculate the amount of mercury oxidized to mercury chloride, for varying concentrations of chlorine and temperature.

9. Task 5: The economic analysis was continued and more information regarding the cost of selective non catalytic reduction (SNCR) and selective catalytic reduction (SCR) for NOx reduction in coal fired power plants was obtained.

Indicate which part of the Grant Activities as defined in the grant agreement, the above accomplishments are related to:

Task 1: Fuel characteristics
Task 2: Small Scale Reburn Experiments for NOx reduction
Task 4: Reburn modeling to predict NOx and Mercury capture by biomass fuels
Task 5: Perform the economics of the use of FB as reburn fuel in coal fired power plants and cost of NOx reduction compared to other technologies.
| Problem(s) Identified | Task 1:  
| i. There were delays in getting materials (e.g. lignite coal) for testing.  
Task 2:  
i. Air leaks into the furnace through the seals.  
ii. The cooling water sump stopped operating.  
iii. The filter on the gas probe frequently clogs due to the high temperature in the stack.  
Task 3:  
i. NO progress has been on Task 3 due to two reasons: 1) we were waiting for arrival of DOE funds; the DOE research plan includes pilot scale tests on cofiring and reburn with dairy biomass; ii) The TAMU plans to get preliminary Hg data using TAMU reactors prior to testing in large scale units. The experiments require Hg instruments. The purchase order and the construction of new furnace have been delayed due to untimely death of a PhD student.  
Task 4:  
i. Mercury modeling: encountered, coding errors while running the numerical code.  
Task 5:  
i. None |
| Proposed Solution(s) | Task 1:  
i. Work extra hours to make up for any lost time; lignite coal has been shipped by TXU to Amarillo for grinding. The ground lignite coal has arrived in College Station  
Task 2:  
i. Additional sealant should be added to all seals.  
ii. A pipe directly to a drain should be added so that the need for a sump is eliminated.  
iii. A separate gas sampling probe and an additional large particle filter should be added to prevent instrument filter from clogging.  
Task 3: The DOE grant just started. Funds are in place to call for combined bids on pilot scale testing. A graduate student worker has been hired recently to proceed with order. An undergraduate Engineer Scholar is working on the construction of new reactor.  
Task 4:  
I. Hg modeling: The possible solution to the above mentioned problem is to make proper implementation of the changes to the present numerical code and time to fix the problems.  
Task 5:  
i. N/A |
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<tr>
<th>Action(s) Conducted and Results</th>
<th>Task1:</th>
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<tr>
<td>(Please describe the action(s) taken to resolve the problem(s) and its effect)</td>
<td>Task 2:</td>
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<tr>
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<td>i. Additional sealant was added to all seals and the problem was resolved.</td>
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<td>ii. A pipe directly to a drain was added, thus eliminating the need for a sump.</td>
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<td>iii. A separate gas sampling probe was added to the stack and an additional large particle filter was added.</td>
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<td>iv. Preliminary reburn NOx data indicated a large reduction in NOx with the new injection system for reburn. However the data requires re-conformation.</td>
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<td>Task 3:</td>
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<td>Task 5:</td>
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Section III. Goals and Issues for Succeeding Period: (Please provide a brief description of the goal(s) you hope to realize in the coming period and identify any notable challenges that can be foreseen)

Proposed activities for month 11/01/2005 – 11/30/2005

General:

Task 1:
- Complete 100 % of TGA/DSC tests and analyses.
- Get proximate and ultimate analyses of Lignite coal/FB including Hg.

Task 2:
- Begin furnace fabrication.
- Use fuel data from Task 1 to calculate operating conditions for experiments.
- Begin small scale experiments once fuel arrives.

Task 3:

Task 4:
- Present results show that not much of mercury is oxidized for the chlorine concentration considered (50ppm, 100ppm, 200ppm, 500ppm, 1000ppm) when global oxidation reaction is used. A three step oxidation is being considered for the future simulation.
  - HCl + OH → Cl + H₂O
  - Hg + Cl → HgCl
  - HgCl + Cl → HgCl₂

Task 5:
- Continue to research the limitations of SNCR and SCR for coal fire power plants.
- Compare NOx reductions and cost of SNCR and SCR to those obtained or predicted from using feedlot biomass (FB) as a reburn fuel.

Implémentation Grants Section
Texas Commission on Environmentnal Quality
NOTE: Please attach any additional information that you feel should be a part of your report or that may be required to meet the deliverable requirements for tasks completed during this reporting period.
LIST OF ACRONYMS

AB: Agricultural Biomass
AC: Activated Carbon
ACI: activated carbon injection
APCD: Air Pollution Control Devices
APH: Air Pre-heater
AW: Agricultural Wastes
ARS: Agricultural Research Station
ATP: Texas Advanced Technology Program
AWDF: Animal Waste Derived Biomass Fuels
CAFO: Concentrated Animal Feeding Operations
CAIR: Clean air Interstate Rule
CAMR: Clean Air Mercury Rule
CB: Cattle biomass
CO₂: Carbon Dioxide
DAF: Dry Ash Free
DB: Dairy Biomass
DOE: Department of Energy
DSC: Differential Scanning Calorimeter
EER: Energy and Environmental research Corp.
EGR: Exhaust Gas Recirculation
EPA: Environmental Protection Agency
ESP: electrostatic Precipitator
FB: Feedlot biomass (Cattle manure or Cattle Biomass CB)
FC: Fixed Carbon
FGD: flue gas Desulfurizer
FR: Feed Ration
GRA: Graduate Research Assistant
HA-FB-Raw: High Ash Feedlot Biomass Raw form
HA-FB-PC: High Ash Feedlot Biomass Partially Composted
HAFP: high ash/High Phosphorus feedlot biomass
HP: High Phosphorus
HHV: Higher Heating Value
HV: Heating value
LA-FB-Raw: Low Ash Feedlot Biomass
LA-FB-PC: Low Ash Feedlot Biomass Partially Composted
LALP: Low ash/Low Phosphorus feedlot biomass
LAHP: Low ash/High Phosphorus feedlot biomass
LOI: Loss on ignition or % carbon in bottom and fly ash
LP: Low Phosphorus
MAF: Moisture Ash Free, Dry Ash Free

mmBTU: million BTU
MMF: Mineral Matter Free
NETL: National Energy Technology Lab.
N₂: Nitrogen
NOₓ: Oxides of Nitrogen
O₂: Oxygen
PAC: powdered activated carbon
PCD: particulate control devices
PM: particulate matter
RM: Raw Manure
S: Sulfur
SCR: Selective catalytic reduction
SR: Stoichiometric ratio, AF/AFstoich
TAMU: Texas A&M University
TAES: Texas Agricultural Extension Service
TGA: Thermo-Gravimetric Analysis
TMPA: Texas Municipal Power Agency
TXU: Texas Utilities
USDA: US Dept of Agriculture
VM: Volatile matter

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