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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:October 09, 2005

Report for the Monthly period:
Starting Date: September 1, 2005 Ending Date: September 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 CO_2 and other benefits of using animal wastes (alternately known as feedlot biomass, FB) as fuels.

Task 1: The PC FB fuel analyses were obtained from Hazen Research Lab. The full analyses are listed in Appendix A. Appendix B presents a list of sub-tasks performed in fuel preparation, grinding and fuel analyses.

Task 1: The PC FB is currently being ground for firing. Small amount of samples has been shipped for test firing.

Task 1: Training and preliminary testing were completed on the TGA. Data on FB and Wyoming coal were generated and are being interpreted in terms of kinetics.

Task 2 deals with small scale reburn experiments for NOx reduction. The test setup was modified to allow for vitiated air. The ground fuel was shipped recently from Amarillo. TXU was contacted for supply of Texas lignite coal.

Another aspect of Task 2 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. The design of the new combustor was completed and sent to local fabricators for bids. One bid was received. We are waiting for another bid. Order for Hg analyzer has been placed.

Task 3: Pilot scale studies: There are several reasons for the delay in scheduling the pilot scale studies. 1) We wish to generate TAMU experimental data on Hg reduction studies with FB as reburn fuel prior to any pilot scale studies. As we informed you earlier, there was untimely accidental death of an experienced senior PhD graduate Student (Mr. Soyuz Priyadarsan) who was responsible for a part of Task 2 dealing with Hg experiments. Hence the Hg part of task 2 has been delayed. 2) The investigators were working with DOE and TAMU contract personnel in satisfying all required formalities in setting up the new DOE Grant in Oct 2005. It has been recently awarded for energy conversion studies on Dairy biomass (DB) and FB. Total Project amount: $ 1,240,000 with DOE Contribution: $ 992,000 (DOE) and cost sharing from TAMU and TCEQ: $ 248,000 (20 % of total amount as required by DOE for the award). TCEQ's Cost share toward DOE Project is a total of $ 26,280 (= $ 20,000 of equipment cost from TCEQ + graduate student tuition of $ 6280) since same equipment will be used for TGA of dairy biomass and student will

also contribute to DOE project.3) The DOE project will also involve pilot scale studies. Thus we wish to select the best possible site through competitive bidding for both pilot tests.

Task 4: As a part of overall Hg modeling, single particle Mercury modeling has been performed. Simulations were done for different concentrations of chlorine, varying from low to high (50ppm, 100ppm, 175ppm). The data is taken from the US Coal data base and done for different ambient temperatures (1000K and 1500K). Two different global reactions were considered separately:

$Hg + Cl_2 \rightarrow HgCl_2$
$Hg + 2HCl \rightarrow HgCl_2 + H_2$

Modeling the Release of Chlorine:

For reaction i, it was assumed that the pyrolysis product of chlorine is atomic chlorine (Cl). Since the reaction has Cl_2, one more reaction, the formation of molecular chlorine, was included.
$Cl + Cl \rightarrow Cl_2$
For reaction ii, it was assumed that the pyrolysis product of chlorine is HCl.

Task 4 also deals with a zero dimensional reburn model for predicting the NOx and Hg capture by biomass fuels. The Hg part of Task 4 modeling program has been retrieved from the computer of deceased student.

Task 5: Further work was completed on the economic analysis.

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.

Section II: Problems/Solutions

Problem(s) Identified (Please report anticipated or unanticipated problem(s) encountered and its effect on the progress of the project)	Task 1: i. The grinding of the manure takes longer than once anticipated. Task 2: i. Fabricators are slow to respond to quotes for materials and fabrication of new burner setup. ii. All the fuel required for the NOx reduction experiments has not arrived due to feeding problems in the grinder. iii. As we informed you earlier, there was untimely accidental death of an experienced PhD graduate Student who was responsible for a part of Task 2 dealing with Hg experiments and We have not yet hired qualified replacement for him. Task 4 While zero dimensional modeling has been developed by Mr. Soyuz Priyadarsan prior to his death, he has not yet been replaced by qualified PhD student. Task 5: i. None

Proposed Solution(s) (Please report any possible solution(s) to the problem(s) that were considered/encountered)	Task1: i. A feeder system was designed and is being installed to speed up the grinding process Task 2: i. Limited amount has been recently shipped. We are continuing to contact the suppliers for the material and fabrication of the new combustor. We may also contact other companies. ii. The grinding process is underway and should be completed in the first part of October. Once operational, fuel will be ground and sent to TAMU. This should provide sufficient time to complete required experiments. Task 4: A new PhD student will be recruited in Spring 2005 to deal with Hg aspects of Task 2 and Hg modeling of Task 4. The Hg part of Task 4 modeling program has been retrieved from the computer of deceased student.
Action(s) Conducted and Results (Please describe the action(s) taken to resolve the problem(s) and its effect)	Task 1: Task 2: Task 3: Task 4: Task 5:

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 3 (10/01/2005 – 10/31/2005)

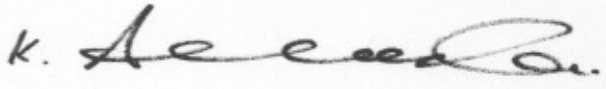
General:

Task 1:
Complete 75 % of TGA/DSC tests and begin analysis.

Task 2:
Begin furnace fabrication.
Use fuel data from Task 1 to calculate operating conditions for experiments.
Begin small scale reburn experiments on NOx reduction once fuel arrives.
Hire part time student to set up the Hg analyzer and calibrate the unit.

Task 3:
If Hg analyzer performs satisfactorily, take Hg data with existing facility when NOx reduction experiments are being performed.

Task 4:
Present results show that not much of mercury is oxidized for the chlorine concentration considered (50ppm, 100ppm, 175ppm). For the future simulations, the chlorine concentration is increased by steps to a maximum amount available in US Coals and FB. When this is done, the code will be run on different conditions. We are going to consider the chlorine concentration present in Animal waste and mercury concentration in free stream. And we are going to run the code to check out how much of mercury is oxidized.
Task 5:
Submit a report based on economic analysis conducted so far.



Date: 10/09/05

Authorized Project Representative's Signature

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.

Table of 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
CO_2: Carbon Dioxide
DAF: Dry Ash Free
DB: Dairy Biomass
DOE: Department of Energy
DSC: Differential Scanning Calorimeter
EER; Energy and Environmental research Corporation
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
AHP: 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 Laboratory
N2: Nitrogen
NOx: Oxides of Nitrogen
O2: Oxygen
PAC: powdered activated carbon
PC: Partially composted (45 days)
PCD: particulate control devices
PM: particulate matter
RM; Raw Manure
S: Sulfur
SCR: Selective catalytic reduction
SR: Stoichiometric ratio, Air: Fuel/ (Air: Fuel) $_{stoich}$
SS: Soil surfaced or high ash feedlot biomass
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