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ENERGY ENGINEERING (EGY)

EGY 199701 ALDAS, Rizaldo E. (MS Energy Eng'g)
Air Preheating Systems for Low-Temperature Drying. 1997

Low temperature drying is a slow drying process but an economical and energy efficient method resulting to quality grain as it utilizes ambient air or slightly preheated air. Its operation requires knowledge of the ambient condition to know when to operate the air preheating system. It also requires an appropriate air preheating system which can endure long hour of operation and with controllable temperature to protect the grain. Thus some heating systems which may be tapped for low temperature drying were evaluated and a more appropriate rice hull furnace was designed and evaluated. Drying tests were conducted to assess the performance of the pot type kerosene burner which is widely used for flatbed dryers. The use of kerosene burner resulted to fuel consumption of 0.68 to 0.90 li/hr and drying air efficiency of 36 to 50%. It also resulted to milled grain quality which is comparable with sundried and shade dried samples, however, controlling the temperature was still difficult and it produced high amount of combustion product that went into the bulk of grain. On the other hand, the potentials of utilizing the waste heat from an internal combustion engine were explored by using a 6 hp gasoline engine to run a blower in the test duct that simulated the dryer's plenum. The potential waste heat energy was directly proportional with the fuel consumption and engine brake horsepower while the fuel consumption was directly related with the airflow rate and static pressure. A temperature difference of around 6.4 K was possible with bare engine and around 8.6 K for an engine with housing. Meanwhile, a compact, lightweight and low-cost semi-automatic rice hull furnace for low temperature drying was designed and evaluated. The furnace which weigh around 35 kg used a piston type mechanism to provide feeding rate of around 3 to 7 kg/hr. It has a burning efficiency of 90 to 95% and drying air efficiency of 40 to 80%. The ash was discharged through the cyclonic compartment and air-sweep floor. Conducted drying tests resulted to excellent milled grain quality, an almost theoretical moisture reduction process, and clean dried grain which indicated that the furnace was effective in separating the ashes from the heated air.

EGY 199302 CABANILLA, Brenda V.G. (MS Energy Eng'g)
Performance and Evaluation of an Improved Design of a Rice Hull Gasifier/Igniter. 1993

This study aimed to evaluate the performance of the NRCP Rice Hull Gasifier/Igniter, make design modifications, and evaluate the performance of the "improved" unit, the Modified Updraft Gasifier.

Evaluation of the NRCP Gasifier/Igniter included actual observations on its performance, gas combustibility and composition. Experiments conducted revealed problems like warping and melting of metal parts, caking and bridging of rice hulls; also the gas generated was non-combustible. Design modifications were introduced on the unit in an attempt to improve its operation and gas quality but, to no avail although, a slight increase in CO content was achieved. Further design improvements were made and a new gasifier unit was fabricated – the Modified Updraft Gasifier. In this unit, the rectangular shape of the NRCP Gasifier/Igniter was shelved in favor of the cylindrical geometry which allowed expansion of metal in all directions when subjected to heat thus eliminating warping and melting problems. The area of the fuel column was likewise increased to eliminate bridging of rice hulls. Indeed, these improvements solved warping and melting problems, however, caking and bridging remained unsolved. Poking and agitating the fuel column was the only solution adapted to break the cakes and bridges formed. Despite the operational problems encountered, the Modified Updraft Gasifier generated combustible gas in all its runs. At optimum gasification rate of 25.3 kg/hr-m^2 of grate area, the producer gas contained 16.18 percent CO, 11.59 percent CO_2, 0.99 percent CH_4, 6.39 percent H_2, and 64.85 percent N_2, with a calorific value of 2596 kJ/kg. Cold gas thermal efficiency and percent decomposition of combined water were low at 48.2 percent and 54.56 percent, respectively.

This thesis paper also included a review of the physical and chemical properties of rice hulls and some works on gasification and utilization of rice hulls and other agricultural wastes.

EGY 199403 CLAR, Jose D. (PhD Energy Eng'g)
Performance Evaluation of a Direct Water-Injected Gasifier Utilizing Low-Grade Philippine Coals. 1994

This study was conducted to determine the feasibility of utilizing low-grade Philippine coals as substitute or augmentation fuel in an experimental set-up consisting of a direct water-injected gasifier which was close-coupled to an oil-fired furnace by means of a producer gas burner. The study focused on the effects of the use of liquid water, instead of steam, in the gasification of low-grade coals. The study included the formulation of a mathematical model and computer simulation procedures which could be used to predict the performance of the experimental set-up using the regular coal analysis and a few operational parameters.

The experiments have shown that liquid water could be used instead of steam to prevent clinkering of the ash and also to improve gas quality.

EGY 199904 HERRERA, Alice B. (PhD Energy Eng'g)
Upgrading of Philippine Coals with Emphasis on the Application of the Oil Agglomeration Technology. 1999.

Coal has the advantage of being an abundant energy resource in the Philippines. However, the uncontrolled utilization of coal, particularly low grade coal, using existing conventional technologies can have adverse effects on the environment on a local, regional and global scale. These adverse environmental effects of coal use, if not properly addressed, could hamper expanded coal utilization in the Philippines which is in line with the government's thrust on sustainable development. Aside from this, the Philippines is becoming more and more concerned with its environment just like the rest of the world.

One of the promising techniques for handling very fine coal and recovering most of the carbonaceous material is called "oil agglomeration". Aside from being an efficient and effective technique to selectively separate coal from mineral matter and beneficiate the coal to a higher grade, oil agglomeration produce agglomerates which have very

good storage and handling properties and have low and consistent level of impurities.

The main objective of the research is to determine whether the oil agglomeration process is an effective technique for lowering the ash content of Philippine coal fines and for recovering most of the combustible carbonaceous material. The study involved process optimization varying oil dosage, pulp density and agglomeration period and determining their effects of percentage recovery of clean agglomerates and percentage ash removal. It also involved modeling of the recovery and ash removal phenomena.

The recovery of carbonaceous materials ranged from 67 to 92% while the percentage ash removal ranged from 16 to 62%. Process variables such as pulp density, the amount of agglomerating oil and the agglomeration period affect significantly the recovery of clean agglomerates and the percentage ash removal.

High percentage recovery of agglomerates of about 89.36% and high percentage ash removal of 41% can be obtained when using the optimum values of 21.11 to 23.78% oil dosage, 22.09% pulp density at an agglomeration period of 3 minutes.

EGY 199305 NWOKE, Felix I. (PhD Energy Eng'g)
Geothermal Steam Pretreatment of Coconut Coir Dust Using the Modified Rapid Steam Hydrolysis (M-RASH). 1993

A pretreatment process for treatment of biomass waste materials, known as Modified Rapid Steam Hydrolysis (M-RASH), was designed and fabricated. Experiments were conducted at Mak-Ban geothermal power plant in Bay, Laguna. The M-RASH process was found to be an efficient pretreatment method for biomass waste materials fractionation and separation of the three major constituents; cellulose, hemicellulose and Lignin with minimum degradation of sugar content.

Coconut coir dust (waste product of Coconuciferioa Linn) waste materials were reduced to different mesh sizes, ranging from mesh 20 to mesh 100. Cellulose content of 57.83 percent was observed in mesh 20 from geothermal steam pretreated samples at 155^{o}C, and 57.40 percent from generated boiler steam pretreated samples at 200^{o}C and one minute reaction time. The lignin content dropped quickly at temperatures above 155^{o}C, as observed in mesh 20, from generated boiler steam pretreated samples with lignin content of 16.02 percent at 200^{o}C. The hemicellulose's

content ranges from 4.96 to 6.68 percent for all mesh sizes. At a longer pretreatment reaction time of 5 minutes, the cellulose content was 82.80 percent for mesh 20 geothermally pretreated samples, and 95 percent reduction of the lignin content observed ranges from 1.35 to 2.88 percent for all mesh sizes. However, degradation of hemicelluloses content was observed at longer pretreatment reaction time (above 5 minutes) and mesh 20 had the greatest loss of polymer fragments.

The cellulose conversion to glucose of prehydrolysis samples of mesh 20 had the highest glucose yield of 53.19 percent at 155^{o}C temperature and one minute reaction time. The acid hydrolysis of geothermally pretreated samples for mesh 20 gave a glucose yield of 75.45 percent, based on the original available glucose of untreated samples.

A mathematical model that was formulated based on the volume reaction model (Homogenous model) predicted a cellulose fractional conversion of 59.88 percent at 155^{o}C, and lignin fractional conversion of 33.4 percent at 200^{o}C, corresponding to lignin content of 8.72 percent. The model used the effectiveness factor, thiele modulus and performance factor to account for the rate of change of conversion and the progress of reaction occurring in a solid (Coir dust) – gas/fluid (Geothermal steam) non-catalytic reaction. The effectiveness factor (EF) of lignin and hemicellulose components gave rise to effectiveness values greater than unity, while the cellulose component did not exceed the effectiveness value of unity at higher isothermal temperature runs. The critical Thiele modulus (Q_{crit}) predicted by the model was 1.25 and at Thiele modulus of ø≥ 5.0, a shorter reaction time is required to delignify the coir dust waste materials. The assumption of zeroth order (m=0) with respect to geothermal steam and first order (n=1) with respect to coir dust was considered as a valid assumption, based on the performance parameter.

The numerical algorithm of the orthogonal collocation method overestimated the cellulose values at high temperatures, while the Runge Kutta – Simpson's technique gave values that were very close to the experimental results. However, the predicted values of lignin from both numerical methods were good and close to the experimental results.

The activation energy of the cellulose and hemicellulose components were a bit low compared to the activation energy reported by other investigators on some biomass waste materials. A statistics analysis gave a good correlation of R-square equal to or greater than 90 ($R^2 \geq 90$) for all constituents of coir dust.

EGY 199306 PHAN HIEU HIEN (PhD, Energy Eng'g)
Rice Husk Combustion Systems for Crop Drying. 1993

An experimental conical grate rice husk furnace was designed, fabricated, and tested in Los Baños at the Agricultural Engineering Division of the International Rice Research Institute. Experiments were performed with the furnace under suction from an axial-flow fan. Drying air efficiency of the furnace was found to lie in the range 60-80%. At a rice husk burning rate of 32-38 kg/hr, the furnace was compatible with flat-bed dryer demand of 4-6 tons/batch for 6-8 hr continuous operation. The furnace has a simple cable-type transmission which provides synchronized fuel feeding and ash discharge, and is lightweight relative to its heat load.

The charred ash from the furnace contained from 6 to 15% unburnt carbon and was amorphous, as examined by the X-ray diffraction method.

Problems in continuous operation of the gasifier-combustor were identified, the major constraint being rice husk feeding flow at high temperature.

A rice husk gasification equilibrium (RHGE) model was developed to predict gasifier performance. The model used a reactivity factor R_f to account for biomass reactivity relative to that of graphite, and took account of the ash content and the % Uburnt carbon of rice husk in the mass and heat balance equation. Comparison between RHGE model-generated data and published experimental data showed that the model adequately predicted gasifier performance.