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MECHANICAL ENGINEERING (MEC)

MEC 199501 ANTENOR, Rogelio A. (MS Mech. Eng'g)
Development of Modified Rice Husk Gasifier with Improved Gas Cleaning system. 1995

The potential of generating a tar free gas when gasifying rice husk was investigated using a modified downdraft gasifier with improved gas cleaning system.

The gasifier system was fabricated and tested at the Mechanical Engineering Laboratory, University of the Philippines, Diliman, Quezon City.

It consists of a gasifier with dry filter section located above the reactor. This filter section is separated from the feed and from the reactor by two swinging butterfly valve. The filter bed was made an integral part of the gas producer providing continuous operation.

The gas cleaning system consists of a water spray tower, cyclone water separator, oil bath and dry husk filter bed. The gas is sucked from the bottom of the gas producer through the water spray tower by a suction gas blower. It is blown to the upper portion of the filter bed, exit from the lower portion of the bed and then goes to the flare.

To enhance washing of the gas in the spray tower, a gas recirculation line was provided. This allow recirculation of the gas and increases its residence time in the spray tower.

Rice husk is pneumatically fed to the top of the gas producer by an air blower through a cyclone where it drops and is retained in the upper storage section.

Ash was removed from the grate by an ash wiper driven by a variable speed motor.

Experiments were performed with the gasifier operating in pure suction mode. A multipoint thermometer was used to measure the temperature of the gas at various points in the gasifier system.

At an average feed rate of 22.8 kg of rice husk per hour, the gasification rate (SGR) is 150 kg per hour per square meter of great area.

The charred ash is collected at an average rate of 6.1 kg per hour corresponding to 26.7% refuse. Laboratory test of selected sample of ash shows 51% unburnt carbon.

Performance testing of the water spray tower indicates that for a minimum water flow of 0.18 kg/sec, the product gas contains 4.4 mg per cu.m of gas. This is within the required maximum contamination in the product gas for engine application. At this optimum performance the water requirement was 10.7 liter per cu. m of gas.

Problems on the gasifier operation were identified. Bridging and slagging and ash removal were the major constraints on the continuous operation.

The available mathematical model developed for the calculation of gas composition and other performance parameters in biomass gasification with oxygen gave results (reactor diameter, gasification rate, and rice husk consumption) which are substantially consistent with experimental results.

Although results of the study show that the developed rice husk gas producer is suitable for 15-Kw Diesel engine, further testing of the product gas in an internal combustion engine is needed to determine its applicability to meet the engine power requirement for an extended period of time.

MEC 199902 BUENAVENTURA, Ramon M. (MS Mech. Eng'g)
The Performance of an Improved Gas Cleaning System for the Continuous Operation of a Rice Husk Downdraft Gasifier. 1999

This paper is an experimental study on the performance of an improved gas cleaning system for the continuous operation of a rice husk downdraft gasifier. This study also includes the gasification of rice husk, and the effects of the producer gas on the diesel engine. Producer gas-fueled system utilizing rice husk offers an attractive alternative to fossil-fueled power units due to its abundance in developing countries. This is especially useful to farmers and rice mills operating in the countryside where fossil fuel is not readily available.

In this study, the existing gasifier set-up of the Mechanical Engineering Laboratory of the University of the Philippines was used and modified to provide producer gas for the diesel engine-generator. Particular emphasis was given to the practical aspects of the gasifier-engine-generator system operations and maintenance procedure. Engine speed settings of 800 to 1800 revolutions per minute and load settings of 10 to 60 Amperes were used.

The results showed that the gasifier-engine-generator system is a viable alternative power source. It was able to operate continuously for 4 hours, limited only by the capacity of the ash bin. It accumulated a total of 105 hours of operation with no harmful effects on the diesel engine as shown by the results of its engine oil analysis. It also showed that the designed gas cleaning system, including the oil bath, is effective in cleaning the producer gas as evidence by its tar and particulate contents of less than 2 mg per m^3 of product gas.

MEC 199303 CAILIPAN, Napoleon C. (MS Mech. Eng'g)
Vapor Compression Refrigeration for Cold Testing in Semiconductor. 1993

The purpose of this experimental model was to investigate the effectiveness and reliability of a vapor compression system in maintaining cold test environment for semiconductor testing. Operating characteristic of a two stage vapor compression refrigeration system was analyzed and investigated. The experiment was made on an integrated circuit (IC) test handler with its environmental chamber fitted with an evaporator coil. Using refrigerant 12 (R12) vapor compression system, the handler was maintained at low temperature condition.

From the experiment, the speed of the low stage compressor was varied from 600 to 1400 rpm and the high stage compressor maintained at 1700 rpm. The results achieved were: (1) low side pressure dropped from 54.2 to 30.5 kPa, and (2) the highest and lowest evaporator temperatures were -20^o and -28^oC, respectively.

A computer simulation using the low stage compressor speed variation was performed to estimate two stage vapor system compressor characteristics which were: (1) variations in mass flowrate ratio as low stage compressor speed was changed and (2) variations of compressor conditions (piston displacement, volumetric efficiency and shaft power) at different evaporator and intermediate stage temperatures.

MEC 200304 DE LARA, Dennis Noel G. (MS Mech. Eng'g)
An Alternative Undamped, Free Vibration Analysis of Duffing's Equation. 2003

An undamped, freely vibrating spring-mass system with a nonlinear symmetric restoring force of the Duffing-type is considered. The problem is to determine the displacement response, which reduces to the mathematical problem of solving an undamped, free Duffing's equation. This preliminary study of nonlinear undamped, free vibration is important because it initially brings out nonlinear features of the system, like the possibility of resonance in the forced vibration case and stability, which appear in the more realistic cases of undamped, forced; damped, free; and damped forced vibration. Duffing's equation also manifests itself in many engineering problems.

There are many existing approximate methods to solve the problem, many of which are perturbation methods applicable to weakly nonlinear systems. A general exact solution to the problem is also possible using the appropriate definitions of elliptic functions and integrals. This study, however, offers an alternative method of analysis to the system using the concepts of an exact implicit solution, instantaneous amplitude, instantaneous frequency, and instantaneous phase angle.

The alternative method of analysis initially resulted in the derivation of an exact implicit solution that highlights the presence of the instantaneous amplitude, the instantaneous frequency, and the instantaneous phase angle in the pertinent equations. This exact implicit solution, however, used numerical methods in generating a table of values between the displacement and the time.

Relaxing the rules a little bit resulted in the derivation of the first and second approximate solutions (analogous to the exact implicit solution) that use only elementary functions like the sine and cosine and avoids elliptic functions and integrals.

The first and second approximate solutions can be expressed both implicitly and explicitly. The implicit forms are analogous to the original exact implicit solution. The explicit forms are derived by performing algebraic rearrangements of the corresponding implicit forms.

The first and second approximate solutions were found to be very accurate, quantitatively and qualitatively, with respect to the exact solution using elliptic functions and integrals. In addition, the first and second approximate solutions were also found to be more accurate, quantitatively and qualitatively, than existing approximate methods of analysis.

It is concluded that the first and second approximate solutions are accurate representations of the system displacement response of Duffing's equation. The alternative method of analysis also demonstrated the validity of using implicit relationships to express the solution to Duffing's equation. Furthermore, it is found that the new definition of strength of nonlinearity is a better parameter in determining whether a system is weakly nonlinear or strongly nonlinear. It is recommended that the alternative method of analysis be also applied in other related nonlinear systems.

MEC 199705 GALINDO, Ronald M. (MS Mech. Eng'g)
Studies on Fluidized Bed Gasification of Corncobs. 1997

Obtaining energy from agricultural wastes has enjoyed renewed public interest and an increasingly widespread use as the prices of fuels rise.

Conrncobs as one of the abundant agricultural wastes in the country has been used in this study as a fuel to the fluidized bed gasifier for gas production. It is of great interest to use this waste being considered as one of the low-grade fuels to investigate its feasibility and determine some of the limiting factors and operating conditions when gasifying this granular solid fuel.

The process of obtaining energy from corncobs may be extremely simple or very complex. Regardless of the system, there are still three components to consider to obtain energy from this type of agriwaste: 1) growing this agriwaste (corncobs) 2.) transporting it to the conversion site. 3.) preparing and converting it into a form of energy for possible application.

In this study, a 6 inch. fluidized bed gasifier was used and tested at the DOST-ITDI Fuels Energy Division Laboratory, DOST Compound. The reactor uses corncobs as fuel for gas production and black river sand as bed material. The producer gas passed thru series of cyclones, a gas cleaning system for the removal of char carry over, tar and other elutriated particles which also includes the ash.

The method of testing the performance of the fluidized bed gasifier was done by setting air flow, the air-fuel ratio and bed depth at different levels. It was found out that corncobs proved to be a good biomass for this type of gas producer.

Initial tests were done on the fuels and the inert bed material. This includes, the cold fluidization to determine the minimum fluidizing velocity, the size analysis, proximate and ultimate analyses and samples of the gas produced during experimental runs were taken for gas analysis. The results showed that the gas has fairly high calorific value of 5667 KJ/n m^3. The analysis of the amount of tar present in the producer gas was not made available due to lack of tar content analyzer.

The thesis covered an extensive survey of combustion, gasification and fluidization of corncobs.

MEC 199306 TADULAN, Edilberto L. (MS Mech. Eng'g)
Combustion of Biomass Fuels With Applications to the Energy Requirements of the Philippines. 1993

The aim of this research programme was to investigate the problems and potential for biomass combustion with reference to the particular techno/socio/economic circumstances of the Philippines. Four work phases were involved (i) assembly of an initial data base for the

properties of some Philippine woods; (ii) review of air pollution problems associated with wood combustion taking particular emphasis on nitrogen oxides (NOx) emission; (iii) acquisition of data on pollutant emissions form plant trials; (iv) application of computer software (COMBUST) to the design of a wood fired process air heater.

Five kilograms of biomass species were brought to England for analysis. Proximate analysis and ultimate analysis were carried out on the samples. The results of the analysis were used to model a wood fired air heater simulated by COMBUST software.

Plant trials were carried out on a 450 kW wood fired air heater located at the Natural Resources Institute, Chatham, Kent, U.K. Using a cross-flow heat exchanger system, it was predicted that the flue gases would increase the process air temperature from 25^{o}C to 140^{o}C. Results showed that the average flue gas temperature was about 624^{o}C at 104% excess air whilst COMBUST provided 781^{o}C at the same operating conditions. This temperature difference can be accounted for by inadequate modeling of the combustion process, particularly with regard to volatile evolution. Actual results also showed that there was about 6% of carbon in the ash. Combustion efficiency, however was adequate at 99%. Heat exchanger effectiveness was found to be 0.683, which is reasonable for an economic design of cross flow unit. Thermal efficiency was found to be 52% based on the Gross Calorific Value of the fuel used and the Direct Method of calculation. NOx values for both plants were in the range 60 – 110 ppm for excess air levels of 100 – 120%.

Environmental implications and policies were reviewed and parameters for the control of pollution due to the combustion of biomass were identified. Outcomes suggest that further work is necessary to investigate sustainable wood fuel sources, pollution control and the associated costs for specific plant and process applications.