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GRAIN DRIER FUELED WITH A BIOMASS GASIFIER

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INTRODUCTION:

The basic concept of this agricultural crop dryer is to use a biomass gasifier to energize the drying equipment for agricultural crop drying. A blast of heated air is forced through the commodity that is to be dried and this carries off moisture that can cause spoilage and deterioration. Typically, crop driers are fueled with natural gas, LP gas or fuel oil and the fan is powered with an electric motor or tractor engine. In this research project, the objective was to determine if an engine fueled with producer gas from a gasifier could be utilized to operate a fan and if all of the waste heat from the gasifier, gas filtering equipment and the internal combustion engine could be utilized to heat the air. About seventy-five percent of the fuel energy going into an internal combustion engine is wasted in the cooling air and through the exhaust and it was proposed that a very efficient crop drier could be developed if most of this energy could be reclaimed. The waste heat from the air cooled engine, the gas coolers and filters and the gasifier can be used to heat the drying air if these components are placed in a tunnel leading to the drier fan as shown in Figure 1.

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EQUIPMENT DESIGN:

The drier unit was designed to batch dry grain or other agricultural commodities in small bins or bulk wagons such as peanut wagons. The power unit is a twin cylinder Wisconsin spark ignition, air cooled engine of 53.9 cubic inch displacement. The gasifier is a downdraft type designed especially for the engine and it has a hearth diameter of 2.63 inches and has 5 air tuyeres. (Figure 2) It is fueled with an injection type feeder, and equipped with an electrically powered reciprocating shaker. A cyclone gas cleaner is used to remove ash and other large contaminants in the gas stream. A glass fiber cartridge type filter is used as a final filter. The specifications on the final filter state that it is 98% efficient for removing all particles larger than three microns. The cleaned producer gas is mixed with an almost equal amount of air for a stoichiometric mixture in a specially designed carburetor that replaces the gasoline carburetor on the air cooled engine. The only other engine modification was to advance the ignition timing about 20° over a factory setting for gasoline or to about 40° BTC.

The engine powers the fan through an alternator and electric motor on the fan. The electric drive was selected instead of a direct mechanical drive so that it would be easier to control the engine load and any extra power over that needed to drive the fan could be used to heat air with electric resistance heaters. Gasifier-engine systems operate best when they are fully loaded so the electric drive gives more flexibility in the operation of the system. The fan is an inline duct blower and is rated at 4950 cfm at 1250 rpm with free air delivery. It is capable of developing a pressure of 2 inches of water. The outlet of the fan is a fabric duct that is connected to the drier wagon or bin. The wagon or bin must have a

false perforated floor to allow the heated drying air to travel upward through the commodity to remove the moisture.

EQUIPMENT FABRICATION AND ASSEMBLY:

The gasifier and gas cleanup equipment were fabricated and tested. The gasifier was first blown with a high pressure blower and gas quality was tested.

The engine was tested on a dynamometer to make sure it developed rated power on gasoline. It satisfactorily met manufacturers rating. The producer gas carburetor was installed and the engine was re-tested on the dynamometer to determine the performance on producer gas. It was found to be about 60% of that with gasoline fuel. This is slightly less than the power output of producer gas engines as reported in the literature but most of the reports are on engines that are 4 - 5 times as large as this particular engine. It was concluded that the performance of this engine was satisfactory and acceptable on producer gas.

The fan, gasifier, gas filters, engine and generator were installed on a steel base which would also serve as the bottom of the duct of the completed drier unit. (Figure 3.) The whole unit was enclosed with an inlet on the end opposite the fan so air could be pulled past all of the components. The engine exhaust is discharged into the air stream without use of a heat exchanger because it is felt that there are no components in the gas that would cause deterioration of the quality of an agricultural commodity.

PERFORMANCE:

Preliminary tests of the unit showed that it would operate for up to 6 hours without any maintenance other than refueling. A short test was designed with the unit connected to the drier wagon where approximately twelve inches of green wood chips were to be dried. (Figure 4.) These

Fig. 1. SELF-CONTAINED BIOMASS FUELED GRAIN DRIER

green wood chips of approximately 40% moisture (w.b.) were dried down to about 7% moisture in five hours of operating time. After this preliminary test a long term test was designed where 5,825 lbs. of green oak wood chips of 39% moisture (w.b.) were dried in 17.83 hours of operating time over three days to 7.76% moisture (w.b.) while the unit consumed 260 lbs. of dried wood chips. The energy content of the wood is about 8,000 BTU's per pound and this operation utilized 1,142 BTU's of energy per pound of moisture removed from the commodity. This compares very favorably with the typical oil fueled crop drier which can utilize about 2980 BTU's per pound of water removed and a typical gas drier that can use nearly 2400 BTU's of energy per pound of water removed. The air flow through the unit during this test was just over 3000 cfm and the temperature rise was between 24 and 27°F. The air flow was measured in a long duct with a differential pressure flow element and an inclined manometer.

Wood chips were dried in these experiments because there was no grain such as corn or peanuts available at this time of the year. Tests on soybeans, peanuts and corn are planned for late Summer and Fall of 1982 and will be reported in a paper submitted for presentation to ASAE.

Fig. 2. Wood gasifier with cyclone cleaner, final filter, and engine.

Fig. 3 Wood energized crop drier without shroud. From left to right are shown the generator, engine, gas filter, gasifier and fan.

Fig. 4. Wood energized crop drier connected to drying wagon.

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