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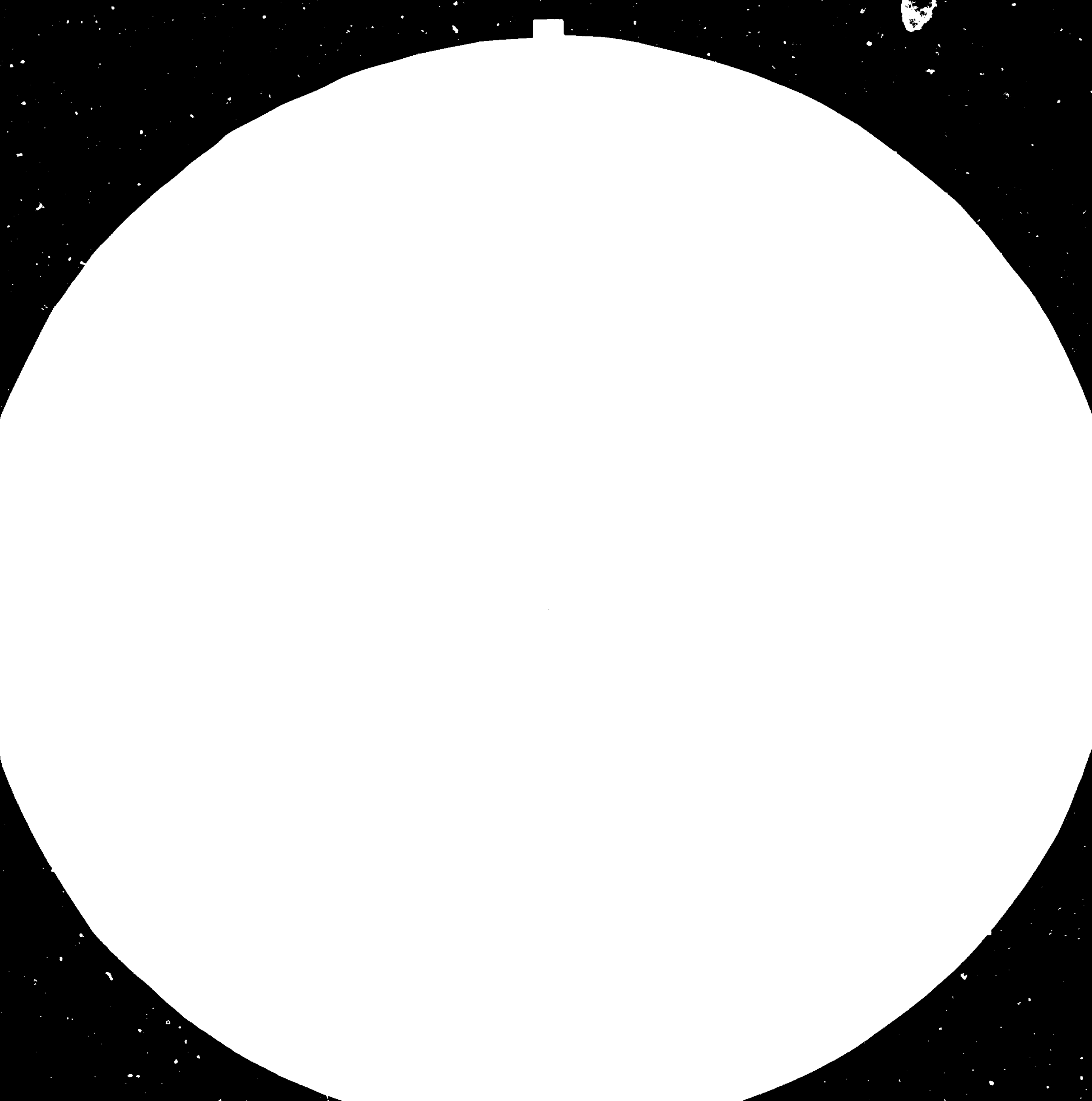

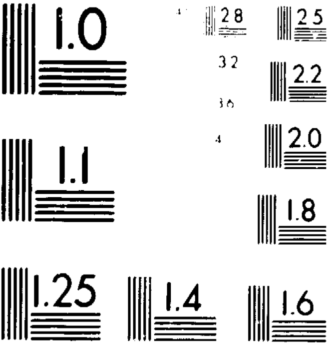

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GAS PRODUCERS TECHNOLOGY FOR RURAL APPLICATIONS*

by

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Producer gas technology is an old technology with a history that can be traced back more than 175 years ago.

The original gas producer is the blast furnace stove which used coke to smelt iron, and in the process produced combustible gases. These combustible gases could be fired to heat the molds into which molten iron was poured, or to preheat the air used for the combustion and gasification of coke to attain the high temperatures necessary in the processing of steel. My paper today, however, is not aimed at discussing the steel or industrial applications of producer gas, but rather to present the case of producer gas technology as used presently for rural energy requirements and its future potential.

The two main ways of using producer gas are: (1) for direct heat production as in boiler furnaces and in crop drying; and (2) as fuel for internal combustion engines (diesel and gasoline engines) to provide shaft power.

Producer gas must not be confused with biogas. This confusion can happen since biogas is more commonly known to be used also for direct heat application and shaft power production.

Raw producer gas which is produced by the incomplete combustion of carbonaceous and cellulosic solid fuels,is a dirty hot gas, compared to biogas which is a clean, cold gas produced from the bio-digestion by microbes of solid and liquid wastes. Therefore,producer gas needs to be cooled and cleaned before it can be used reliably as fuel for internal combustion engines.

Of course, there can be no need for cleaning, and cooling if producer gas is burned directly in a furnace for direct heat production since tar, the major impurity in the gas, can also be burned. But this same tar, when not removed from gas used in a gasoline or a diesel engine, can collect in the valves and piston rings of the engines and cause it to stop running.

Aside from cleaning, cooling the gas is desirable so that it becomes more dense and more gas in terms of weight per unit volume can be admitted into the cylinders of the engine. Thus, power de-rating of the engine is minimized. Power de-rating when using producer gas is inevitable because the gas contains less energy per unit volume compared to either gasoline or diesel.

In promoting the use of a new technology, or in this case the re-introduction of an old technology which has not been in used for decades, it is important that the technology should be reliable and economic. It is with this end in view that initial R & D concentrated on very simple systems that would not require costly materials and which would gasify a fuel that would not require too complicated gas cleaning equipment. One such fuel is charcoal. Good quality charcoal should contain no tar at all since this ought to have been removed during the charcoaling process. It should contain very little ash if the starting material contains very little ash. Coconut shell charcoal and that from ipil-ipil wood (leucena Leucocephala) contain very little ash and are commonly available in the Philippines.

A very simple gas producer system hooked-up to a gasoline engine is shown in this illustration (shown in slides). The gas producer reactor is a constant-diameter down-draft reactor, the size of a 55-gallon drum. There are two major types of fixed bed reactors: the up-draft reactor and the down-draft reactor, classified by virtue of the direction of flow of air and gas through the fixed bed of solid fuels. In the down-draft flow, the air enters from the top of the reactor, and as it flows downwards, reacts with the fixed bed of fuel to form producer gas which exits from the bottom of the bed. Down-draft reactors are reported to produce less tar in the gas compared to up-draft reactors. The efficiency of gasification however is somewhat lower in the down-draft than in the up-draft.

This size of reactor could be good for a capacity of 10KW. Automotive gasoline engines could of course deliver much more than 10KW, but because of the 50% reduction in power capacity when using gas (with no gas cooling) and the need to operate at a lower RPM compatible to the speed of the electric generator (1800 RPM), then 10KW would be a reasonable output that could be expected from such a system.

Figure 1 and 2 (shown on slides) represent the simplest workable gasifier-engine system which in fact worked reliably well so long as the charcoal used was of good quality (85% fixed carbon).

But charcoal supply could be of variable quality and frequently charcoal still contains volatile matter and tar. For this reason, there is still a need, for a more reliable operation to clean and cool the gas.

Such a gasifier system, hooked up to a 7.5 KW diesel engine, is shown in Figure 3 & 4 (shown on slides), this is the same design adopted by GEMCOR for diesel-engine irrigation systems.

GEMCOR (which is the acronym for Gasifier and Equipment Manufacturing Corporation) is a government corporation that is now mass-producing gasifier equipment for the country. Presently, the equipment is designed to use charcoal mainly as the input fuel. It was established in 1981 and as of June, 1983 has fabricated a total of 1661 units. It has adopted a 7-year program, from 1983 to 1989 which targets a production and installation of 500,000 gasifier units. To support these gasifiers with fuel, 750,000 hectares of land will be planted to fast-growing trees. The total market potential for stationary engine applications is about 30,000 units while the bulk of the potential applications is for land transport vehicles and other mobile applications at around 750,000 units.

The potential for irrigation applications is estimated at 5000 units.

For electricity generation and for small power supplies such as a 2-ton per day ice plant, the potential market is estimated at 3000 untis.

For other small engine driven processing equipment, such as portable rice threshers, but not including rice mills, the estimate of potential market is 8000 units.

For motorized bancas (native fisherman's boat) and small trawlers, the estimated market is 150,000 units.

And for land transport vehicles, jeepneys, buses, trucks, and cars, the potential market estimate is 750,000 units. Although the potential for gasifier-retrofitting of land transport vehicles is very high, acceptance of the technology by which vehicle owners may be long in coming. Operating a vehicle to run on producer gas is not a simple matter, and vehicle drivers may not presently be willing to exchange the convenience of running their jeepneys or buses on diesel or gasoline with the mess, and the inconvenience of running them on producer gas, even though the economics may be quite attractive. For jeepneys which are kept on the road for 12 hours or more daily, GEMCOR's calculations indicate that retrofitting those with gasoline engines with charcoal gasifiers costing US $65/KW capacity of the gasoline engine, would enable the owner to recover his capital investment in less than 6 months.

Small rural rice mills represent a special case. There are 16,000 of these in the Philippines. The operation of these are seasonal, during harvest time. Payback period for a US $70/KW charcoal gasifier retro-fitted to a 25hp diesel engine in a rural rice mill is about 2 1/2 years. The question is why use charcoal: why not use rice-husks. In rice mills, rice husk is a waste and a nuisance. Using them as fuel offers two potential advantages: (1) increased savings in operating costs; (2) elimination of the waste as an environmental problem.

Research work on utilizing rice husk as gasifier fuel is on-going in at least two Philippine institutions - at the University of the Philippines College of Engineering and at the PNOC-ERDC.

CONCLUSION

In conclusion, let me summarize the case for gas producer technology and its application to supply the small energy requirements in the rural areas. An old technology has been reviewed, re-studied, and re-tested in laboratories. Innovations and modifications were made to make the technology more workable and practical for use in the rural areas of developing nations. Low cost and simplicity in operation are the primary objectives to make technology useful and acceptable. An effective collaboration among several government agencies ensued. Research and developmental work at two government instutions, the University of the Philippines and the Energy Research Development Center of the Philippines, National Oil Co., established that simplified designs using charcoal as fuel would be the most practical approach to introduce the technology for widespread use in the rural areas. Proto-type systems for irrigation application were set up and tested by the Farm Systems Development Corporation, another government corporation. The tests lasted for two years at a demonstration farm to establish the durability and reliability of the system. Then GEMCOR, a government corporation was created in 1981 to mass produce the equipment. Acceptability of the technology was gradually established after users experienced cost benefits during the first year of operation. Monitoring the operations during succeeding years would tell us if this economic advantage will continue.

Finally, continued research on the use of the more abundant and cheap fuels such as agricultural residues should be vigorously pursued to increase the technical and economic advantages of the technology. This is a particular activity that I, as a representative of a Philippine research institution,would be most interested to undertake on a regional cooperative basis.