

"UPGRADING PYROLYSIS PRODUCTS"

by

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Mister Rivero, I thank you for giving me the opportunity to speak here; and, gentlemen, I am pleased to participate particularly in the informal afternoon sessions. I find them invaluable in my data collection and growth.

You have already heard this morning from men speaking on several forms of acquiring fuels from waste. For the first few minutes of my remarks I would like to tie those separate elements together and to explain the overall Energy Research and Development Administration's Waste to Energy Program.

My strategy is a microcosm of the overall ERDA energy strategy. Most simply stated that strategy is to recognize that no one energy source is the panacea of the future and therefore, choices must be developed. In the broad context those choices are nuclear, fossil, solar, geothermal, advanced and conservation including improved building, community, industry, electrical energy, transportation and storage systems and last but not least my bread and butter, garbage; or better, wastes.

This slide indicates the overall waste program. On your left are the sources of waste. I am part of the Division of Buildings and Community Systems and am responsible for the urban sector. Jerry Collins is part of the Division of Industrial Energy Conservation and is responsible for the industrial sector. Incidentally responsibility for waste heat is also in that division.

The agricultural and forestry wastes are in the Solar Division in the Fuels from Biomass program. I happen to believe that the overall waste program would be better managed if all these sources were in a single organization be it at assistant director or division level. However, the current organization is plausible - it just requires much more coordination and cooperation.

In the center are the conversion processes. I'll focus on the pyrolysis area in a bit; but if we are to consider the beneficiation of waste as an energy source we cannot ignore the development of refuse derived fuels not only to feed combustion processes as noted but also to feed pyrolysis, bioconversion and other processes.

Finally the section of the chart on your right is perhaps the most important; the product and the end use. Incidentally the end uses are by



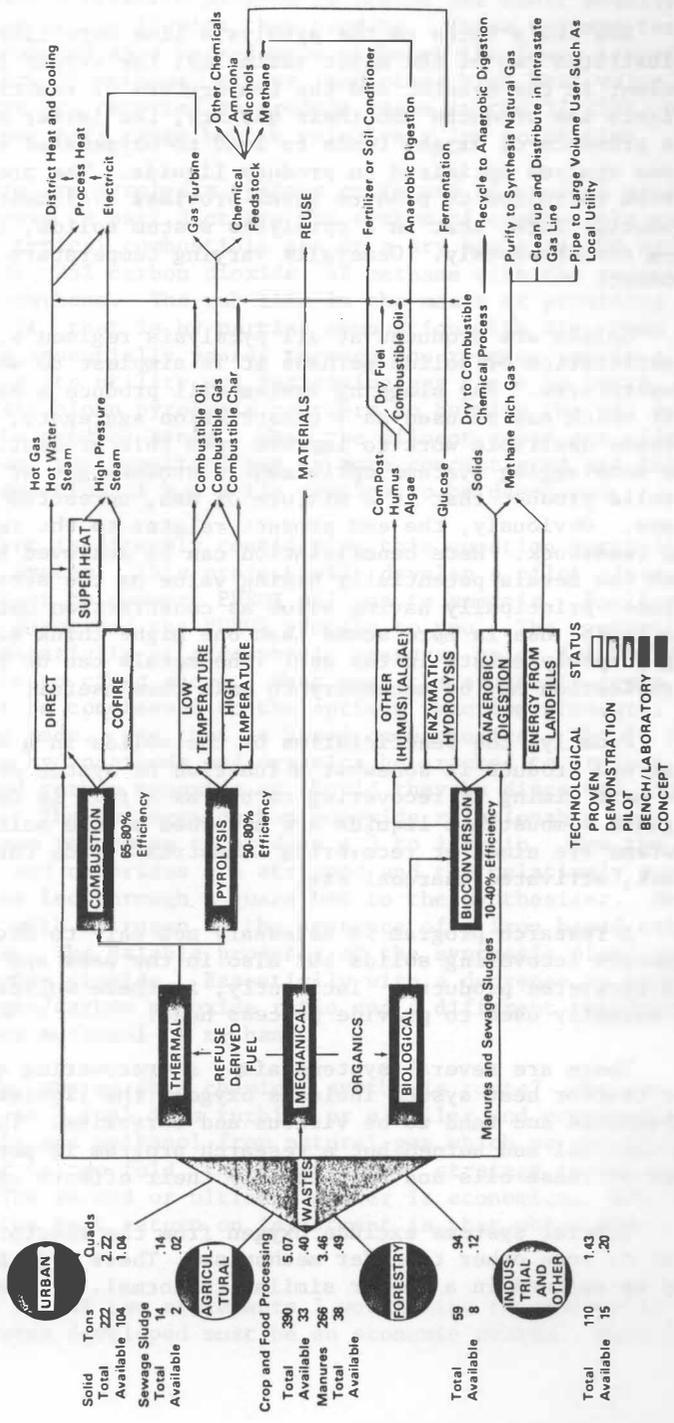
OPTIONS WASTE UTILIZATION

WASTE SOURCE
(1980 Estimate Millions of Dry Tons) Per Bu of Mines 1972 and EPA 1975

CONVERSION PROCESS

PRODUCT

END USE



no means all the options that are available. They are only the most visible of the available options.

Now let's focus on the pyrolysis line more closely. This slide illustrates two of the major variables: the oxygen level and its source, present in the reactor and the temperature of reaction. The former affects the products and their quality, the latter sets the product level. The presence of oxygen tends to lead to oxygenated organic liquids in those systems optimized to produce liquids. The presence of air in a system optimized to produce gases provides a diluent to the end gas product. Note, that in a pyrolysis system solids, liquids and gases form simultaneously. Generally varying temperature varies the principal product.

Solids are produced at all pyrolysis regimen's. In speaking of beneficiation of solids perhaps it is simplest to work down from high temperatures. Any slagging system will produce a hard, glass like fused frit which may be used as a construction aggregate. However, I can foresee desirable work to improve upon this product. As we retreat into the nonslagging systems optimized to produce gas or liquids we move into a solid product that is a mixture of ash, unreacted carbon, metals and glass. Obviously, the end product relates to the reaction temperature and feedstock. Here beneficiation can be achieved by separation techniques with the metals potentially having value on the scrap market and the remainder principally having value as construction materials. Incidentally, the latter use is more sound than one might think since a natural cementing properly exists in the ash. The metals can be recaptured however, purification may be necessary to make them useful.

Finally, the beneficiation of the solids in a system designed for that end product is somewhat a function of system design. As an example, one unit aiming at recovering carbon as a fuel is designed such that the organic combustible liquids are absorbed by the solid product. Other systems are aimed at recovering industrial grade carbons i.e., carbon black, activated charcoal etc.

A research program is necessary not only to develop the pyrolysis reactors recovering solids but also in the uses and specifications for the recovered products. Incidentally, in these solids systems the gas is normally used to provide process heat.

There are several systems aimed at recovering organic liquids. When the reactor heat system includes oxygen, the liquids or oils produced are oxygenated and tend to be viscous and corrosive. They can be emulsified in fuel oil and burned but a research program is necessary to develop the uses of these oils and particularly their effects on combustion equipment.

Several systems exclude oxygen from the reactor using either radiant heat or some other transfer mechanism. These tend to produce oils that may be refined in a manner similar to normal. Petrochemicals or burned

similarly to fuel oils. Since, these systems are basically in the pilot stage of development a research program is needed for their development and one for the use of the liquids they produce. These systems tend to recycle the gas produced as a heat source although the lower temperatures favor the production of methane, ethane, and other high heat value gaseous hydrocarbons. They are reported to produce gases in the 37,257KJ per cubic meter (1,000 BTU per scf) range but in relatively low quantities.

Finally, there are pyrolysis systems optimized to produce gases. In these, the process in part dictates the system of combustible gas beneficiation. A typical combustible gas on a dry basis is 25% hydrogen, 40% carbon monoxide, 25% carbon dioxide, 5% methane with the remainder (15%) higher hydrocarbons. The rub lies in the means of providing heat to the reaction. If that is by partial combustion with air, then 70% of that gas stream essentially passes through the reactor and is a diluent to the gas reducing its utility and increasing gas clean up costs. This generally limits air blown pyrolysis reactors to burning the off gas as soon as feasible to produce steam. When the diluent gases are eliminated from the gas stream, the resultant gas is more concentrated and therefore more utile. The question of how utile remains to be developed.

One ERDA effort is directly considering this question partially in support of a full system. This project will develop a pilot clean up train and synthesizer to convert PUROX off gas to ammonia. Earlier this morning Kai Young described the PUROX process to you. The combustible gas produced is essentially at atmospheric pressure below 100°C (212°F) and of the composition cited above. What must the synthesis train do. First the gas must be compressed to the optimum reaction pressure. Now a decision must be made. One that is based on economics. Should the methane and higher hydrocarbons and organics be cracked to produce additional hydrogen and carbon monoxide or should they be discarded from the synthesis process. The hydrogen/carbon monoxide relationship must then be adjusted by steam reforming to produce a 3 to 1 ratio. Now the carbon dioxide, sulfides and chlorides are stripped and the relatively pure carbon monoxide gas led through a guard bed to the synthesizer. Here the hydrogen combines with nitrogen in the presence of a iron based catalyst to produce ammonia. The salable products of the synthesis plant would be ammonia and carbon dioxide. Essentially with a decrease in pressure a change in hydrogen/carbon monoxide ratio and a different catalyst the system will produce methanol or methane.

One might ask, why go this chemical synthesis route? Why not use the pyrolysis gas as a fuel in a turbine or a boiler and continue to manufacture ammonia and methanol from natural gas which we now know how to do. The answer is two fold, the first is our strategy to match waste to end product. The second or ultimate answer is economics. Whichever product provides the best return on investment is that which should be produced.

This then is one of two statements I would like to address in closing. Each system developed must be an economic system. When this

is achieved there is little need for direct federal involvement in financing although other economic incentives may be valuable. Market forces will drive the systems. These comments, however, deserve some clarification. A system is not developed until it has been successfully demonstrated at the full scale. This step will require federal incentive if only to speed the process. As an example, while I applaud the construction of a major waterfall incinerator at Saugus completely with private capital, I also recognize that the studies that led finally to that plant were initiated in the sixties. At this stage of the energy crisis, can we afford ten additional years?

The final statement concerns the intra-federal interface. I am firmly committed to a policy of ERDA, other federal agency cooperation in waste to energy systems and I will permit little to stand in my way of attaining this goal. An ERDA-EPA interagency agreement is in effect and committees are meeting to develop a national research and development and implementation plan. However, cooperation demands a two way street and no one should mistake my statement. I will fight to have the program carried out where it and its discrete elements can best be managed.

Thank you