ENERGY RELEASE CHARACTERISTICS OF SOLID WASTE DERIVED FUELS IN BOILER FURNACES

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In this session we are focusing on energy recovery from wastes by combustion in working boiler installations, some having boilers designed for the fuels being used, and others having existing boilers which may or may not have been modified for the purpose.

We will be reviewing the operating experience under these varied situations with emphasis on the relationship between types and degrees of solid fuel preparation and the resulting energy release characteristics in various boiler situations. We must also relate the techniques and problems of fuel preparation and feeding to plant performance and the relationship between percentage of waste to total fuel burned and boiler controllability.

These projects have been undertaken by highly innovative people who, while using conventional equipment and mainly tried and true components, have extended their use into unknown areas, at considerable risk, balanced by the hope of great benefits which justify the risk.

Somebody who recognized the need asked "What would happen if we try this?" A great deal of study was devoted toward anticipating the answers to these questions, and every effort made to minimize the risk by consulting experts, study of available knowledge, calculation and design.

Invaluable results have issued from these ventures: we now know more about what works and what doesn't work. Can we project this information into new projects? Sometimes yes, and sometimes no. A bad copy can be a disaster if sufficient care is not taken in studying all the conditions, requirements, and laws of nature we followed or failed to follow.

These projects are generally careful extensions of known technology. We could cite many projects called demonstration projects which have been expensive failures. Why were they failures? Did they extend too far from known technology? Did they result from excessive scaleup? Are they the result of our inability to make the leap from laboratory or pilot plant to a working plant? If so, why can't we make this leap? I venture that it is because the research people, the pilot plant people, the designers of the plant, the vendors, manufactureres and contractors have had communication failures.

We have heard a call for fundamental research that can be used by those who would build reliable and economic systems to convert wastes to energy. What research do we want? What kinds of research have been valuable so far? What areas should have priority?

Let us look at a single area as an example and see what we can learn: "combustion of solids." When coal was king a tremendous research effort was devoted to unraveling the mysteries of burning this highly variable material, and to methods of designing boilers to suit the coal. Can we use this information? Can we use the methods? Maybe.

There has been a recent rebirth of research in coal, using the latest available technology. A new generation is doing research much of it sponsored by ERDA, much of which will be filed and forgotten as a Doctor's thesis. We cannot afford this waste.

I offer the following illustration taken from a paper presented by Professor Essenhigh at the Combustion Institute this summer.

Figure I derives from a graph presented by J. B. Howard to the ASME in 1968, in an attempt to understand the combustion of Solid Refuse. It shows the entire range of particle sizes and combustion times based mainly on heat and mass transfer.

This graph shows where we are, and where we can go. A one-hour retention is needed for 2.54 cm (one-inch) diameter particle. This represents mass burning. A piece of newspaper takes three seconds to ignite, thirteen seconds to burn at 894°K (1150°F), but much less time if at 1644°K (2500°F), depending significantly on its moisture content.

Pulverized coal and powdered RDF (Eco-Fuel ^{TM}II) can be burned in .1 to 1 second if minus 200 microns. Thus the fuel size has a decisive control over furnace design and performance.

The time for combustion is greatly influenced by moisture content, differential velocity, temperature differential, and oxygen concentration.

Recent research at higher temperatures has shown that coal devolatilizes much more than at ASTM temperatures, and that cellulose (paper) can be burned without significant char formation.

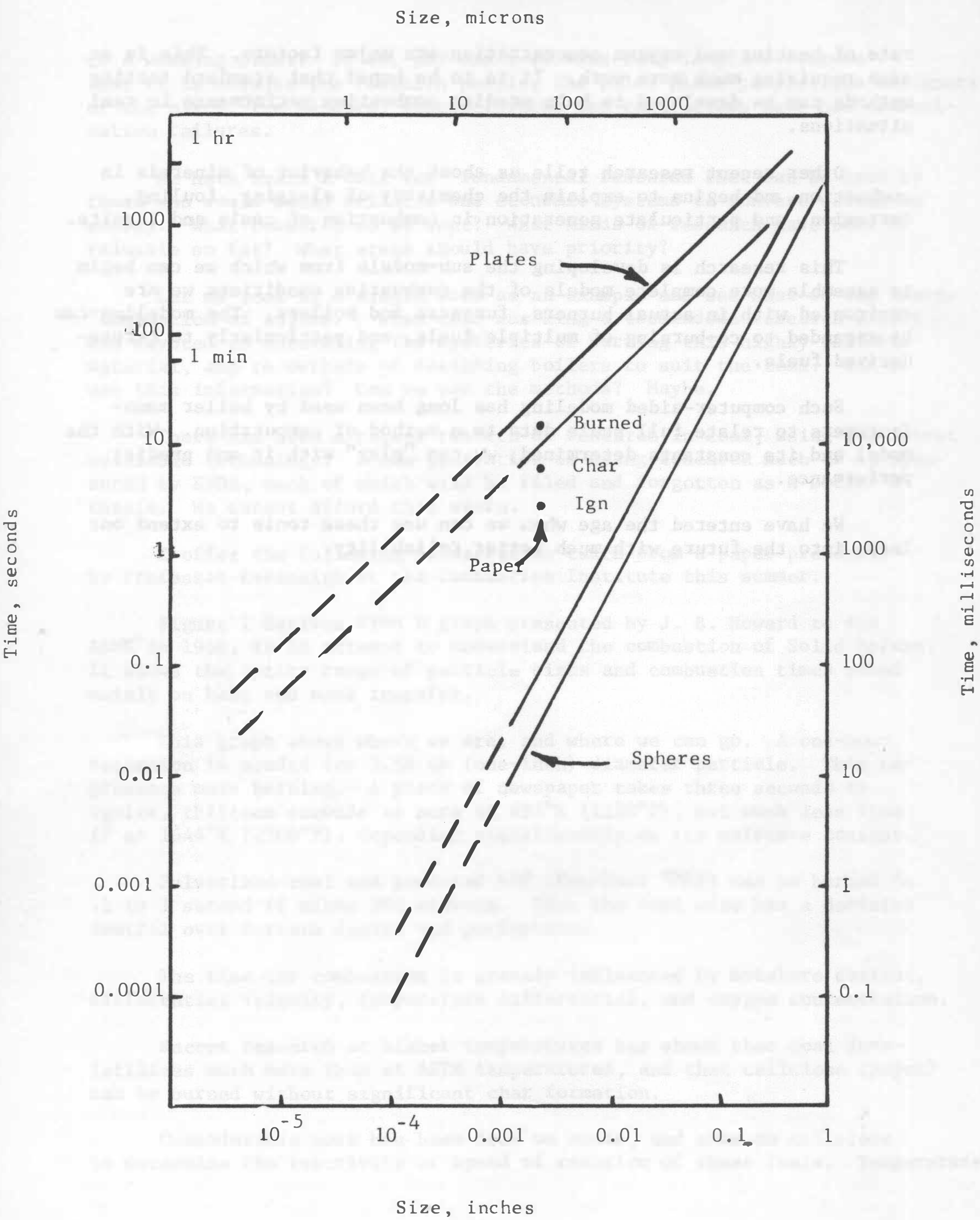
Considerable work has been done on coals, and some on cellulose to determine the reactivity or speed of reaction of these fuels. Temperature rate of heating and oxygen concentration are major factors. This is an area requiring much more work. It is to be hoped that standard testing methods can be developed to help predict combustion performance in real situations.

Other recent research tells us about the behavior of minerals in combustion, and begins to explain the chemistry of slagging, fouling, corrosion, and particulate generation in combustion of coals and lignite.

This research is developing the sub-models from which we can begin to assemble more complete models of the combustion conditions we are confronted with in actual burners, furnaces and boilers. The modeling can be expanded to co-burning of multiple fuels, and particularly to refuse-derived fuels.

Such computer-aided modeling has long been used by boiler manufacturers to relate full scale data to a method of computation. With the model and its constants determined, we can "play" with it and predict performance.

We have entered the age when we can use these tools to extend our leaps into the future with much better reliability.


Size, microns
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Plates
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Paper
Spheres
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Time, milliseconds
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1
Size, inches

Figure 1