WHO SAYS THERE IS AN ENERGY CRISIS?

David W. Campbell
Moore Oregon
Portland, Oregon

Introduction

A little over three years ago, it became apparent that an energy shortage was imminent. Equipment used in the forest products industry that requires large quantities of heat energy would need additional methods of obtaining energy - preferably from unused wood residues.

An investigation of the technology available on equipment that had a potential of creating heat energy from wood residues was launched. The investigation showed there was equipment available that had good potential. It also showed that the problem was varied and complex. A single piece of equipment was not available to satisfy all of the different situations. Most importantly, it showed that research efforts should be spent in developing systems approaches, using the available equipment, to satisfy the needs of the industry.

Three years of work in developing systems approaches has seen much success. Systems have been installed and have performed at or above the levels that were predicted. Other applications are in various stages of engineering and installation. These will provide additional information that can be used for continued development.

A concerted effort must be maintained to continue the development of concepts that will keep the forest products industry abreast of its needs.

Looking at "Who says there's an energy crisis?"

A scientist speaking at a meeting in New York, sees the energy crisis in terms of two major concurrent symptoms. First, the enormous volumes of energy consumed are generating pollutants that may affect mankind in injurious ways. Second, is the depletion of our domestically most desirable fossil fuels. Regardless of the fact that only a small fraction of the total resources in place have been drawn upon, another century of low-cost domestic fossil fuels may not exist.

A utility company spokesman reported that in 1971, the electric utility industry used slightly more than 328 million tons of coal, 396 million barrels of oil, 3,993 trillion cubic feet of natural gas, and 900 tons of uranium for the generation of 1.5 trillion mega-watt-hours of electricity. Predictions are that during the next two decades, our use of electrical energy can be expected to quadruple.

A spokesman from the Federal Power Commission says the energy crisis is real. For four years running, we have consumed natural gas twice as fast as we have found new reserves. In the early 1960's, we had a reserve-life index of roughly 20 years. We were down to 11 years reserves at the end of 1971. In the winter of 1972, fifteen interstate pipe lines are expected to be short 1 trillion cubic feet of natural gas in fulfilling their contract obligations.

Another spokesman indicated that because we have been unable to get the nuclear-plant program operating on schedule, that as of

January 1, 1973, U.S. electrical generation will be behind by some 30,000 mega-watts of electricity. This represents an annual shortage of about 300 million barrels of oil, or nearly 1 million barrels per day that must be found and burned. If we are unable to import this much oil and gas, or supplement it from other sources, we will simply have to do without.

Energy Potential in the Forest Products Industry

Since 1953, significant changes have taken place in the manufacture of lumber from logs. Contrary to popular belief, more residues are developed now in the manufacture of a given volume of lumber in spite of improved sawing and surfacing methods. The increase is primarily in coarse residues. It is due to both decreasing log size and decreasing log quality. Decreasing log size results in an increase in the proportion of the log in slab wood, and decreasing log quality results in more loss in trimming and edging. One comparative survey made for western Oregon between 1953 and 1967 shows a 17% increase in the average residue generated in the manufacture of a thousand board feet of lumber.

Although this is based on data from different mills, there is considerable evidence that more residues are currently being generated in the manufacture of lumber.

The utilization of residues is increasing. Reports show that 94% of all wood residues and 79% of the bark produced are used. This still leaves us with a billion cubic feet of unused residues from primary manufacturing plants alone. This is roughly equivalent to 105 billion cubic feet of gas, or approximately 40 million barrels of oil annually.

Conclusion

This is strong evidence that we do, in fact, have an energy crisis. I'm sure that each of you here, in some way, has been made aware of this problem. The key, is in developing clean, efficient uses of the energy potential that is developed in the forest products industry.

The value of using wood residue as fuel is increasing. Because of rising fossil fuel costs and decreasing availability, the use of wood as fuel can begin to compete with the returns realized from other uses.

Objectives in the Burning of Wood

Lets set some objectives in burning wood:

1. To burn the wood fuel in an apparatus so that clean, usable heat energy is provided for use in: veneer dryers, lumber dry kilns, rotary process dryers and boilers.

2. To burn it all; venting no visible, gaseous hydrocarbons (smoke) and no carbonaceous fly ash.

3. Deal with the ash and dirt when necessary; although some applications, for instance, the veneer dryer and some rotary dryers do not need a perfectly clean outlet gas (with no ash) some applications, like the boiler, do require a clean, hot gas.

SUSPENSION BURNER

(FORCED VORTEX)

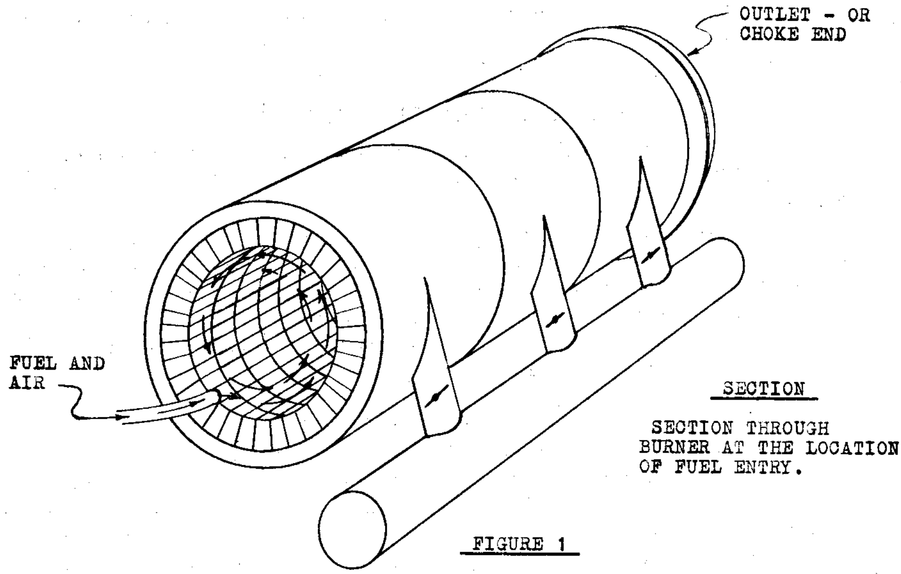

FIGURE 1

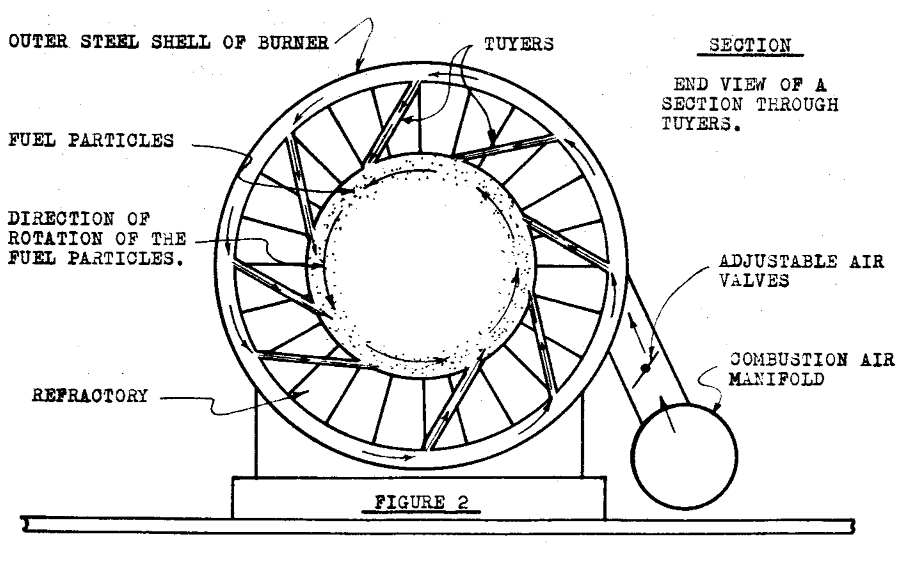

FIGURE 2

Suspension or Forced Vortex Burner

Our investigations show that a suspension, or forced vortex burner, that has the ability to operate in a slagging mode, best satisfies these objectives.

By slagging, ash and dirt can be removed from the hot gas stream and converted into an inert form that can be disposed of easily.

The space occupied by a suspension burner is very small in relation to its heat output. A nominal 30 million BTU burner is 58" in diameter by 92" long. Its cylindrical shape makes it easily adaptable to most equipment.

How do we get hot, useable gas by burning wood?

What is Required to Burn Wood?

"Combustion" requires: Time, temperature and turbulence, the so-called "3 T's." Perhaps a better term for turbulence is "Rate of Mixing."

The combustion process is a chemical reaction. Parts of the reaction absorb heat and parts give off heat. As in most chemical reactions, the rate at which the reaction takes place is determined by the temperature and the degree or "rate of mixing." The better the ingredients are mixed the faster the reaction will take place; and certainly, the higher the temperature, the faster the reaction will proceed.

Time and Turbulence

The fuel and the air carrying the fuel enter the burner tangentially (Figure 1). This sets the fuel in a path like a cyclone, or cyclonic motion. This motion is a forced vortex. The rotating motion imparts a centrifugal force on the fuel particles, which forces them radially outwards towards the cylindrical wall. At the same time, combustion air is introduced from tuyers in the wall. While doing this, the combustion air passes over the burning particles, more or less at right angles to the path of the particle. This is exactly the type of mixing that one would like for the maximum rate-of-combustion. The combustion air is not able to carry the particle towards the center because centrifugal force is driving it towards the wall.

The tuyers are "angled" in such a way that the "jet" of air enters the chamber in a tangential direction, and keeps the forced vortex rotating (Figure 2). At the same time, the whole mass moves axially towards the "choke" end. The "choke" provides a barrier that will allow only the center portion of the mass to leave the burner. Therefore, until the fuel particles have burned, the "choke" retains them within the burner.

Since the combustion of wood is essentially a gassification process, the fuel particle eventually converts into gas. The gas burns as it comes into contact with oxygen and becomes the same density as the rotating mass of gasses and ultimately emits out of the burner.

To summarize: The forced vortex keeps the particles in suspension and the "choke" retains them within the burner. This allows them the "Time" for combustion and coupled with the entry of combustion air through the tuyers, creates an extremely well-mixed reaction. So much for "Time and Turbulence"; now for "Temperature" and the third "T."

Temperature

The whole combustion process takes place within the burner; it is not simply a mixer of fuel and air; it is the combustor: thus all the BTU's available are released within the chamber. The chamber is small and thus the energy release per unit volume is very high. In the range of 600,000 BTU's per cubic foot. This develops temperatures in the range of 2200° F. to 2700° F.

Coupled with its small internal size is the fact that the burner creates high "Turbulence" and with these two qualities "Temperature and Turbulence" it can operate on minimal excess air, which again allows for high temperature operation.

Maintenance

The high temperature operation would "wipe" the refractory out of such a small burner if it were not cooled. A tuyer layout has been developed which tends to cool the brick by using the combustion air. Thus, the combustion air is used for three purposes: (a) to react with the fuel in the "burning process", (b) to keep the "forced vortex" going, and (c) to cool the inside surface of the refractory. However, the brick is allowed to heat up so it can re-ignite the burner without using the pilot-gas-burner should there be an interruption in the fuel supply. Incidentally, no gas is required after the initial heat-up cycle, (say 30 minutes, although 10 minutes is a good average).

As to Applications

The "choke" outlet can be viewed in somewhat the same way as the outlet of a natural gas burner; the vortex burner is simply a gas burner, starting with solid, rather than gaseous, fuel. In fact, the forced vortex burner affords an advantage in that its combustion takes place within the burner (e.g. the burner is the mixer and the furnace) whereas a flame, and the majority of the combustion occurs outside, a gas or oil burner (which could be more accurately described as a "mixer" of fuel and air).

Therefore, the burner offers all the qualities required for combustion: "Time", "Temperature" and "Turbulence", plus the ability to provide clean heat energy.

Summary

Natural gas prices have risen sharply within the past 12 months. Increases in propane costs have been reported; ranging from 25% to nearly 100%. Uninterruptable service and firm price, service contracts are becoming more and more difficult to obtain. Many plants this last winter experienced shut-downs because of shortages in supply. The rising energy costs and increased shortages indicate that we are, in fact, faced with an energy crisis.

The forest products industry has the potential to off-set its energy demands, by using the energy available in the wood residues it creates. This is not to imply that the industry has been slack in this area. Far from it. The point is: The portion of wood residues that are now being used for fuel to create energy could possibly be utilized more efficiently; and that the portion of wood residues that remain unused, represent a large amount of energy that can be put to work.

Finally, in our opinion, the suspension or forced vortex burner offers an advanced method of utilizing wood residues. It is efficient and produces readily useable energy. It offers solutions to problems that have plagued other attempts to use wood and bark as fuel. And in so doing, it also helps in our effort to control the pollution of our atmosphere.

Bibliography

1. "1972 Directory of the Forest Products Industry" Miller Freeman Publications.
2. U. S.. Department of Commerce, Domestic and International Business Administration "U. S. Industrial Outlook 1973 with projections to 1980" U.S. Government Printing Office.
3. James T. Bones and Teresa M. Bowers "Wood Residues How Much Are We Recovering?" Northeast Forest Experiment Station, Forest Service, U. S. Department of Agriculture, Upper Darby, Pa., Sept. 1971.
4. Peter Neild "Burning Wood to Obtain Usable Heat (BTU's)." Research paper - April 9, 1973.
5. F. W. Guernsey "Utilization of Sawmill Residue in the Southern Coast Region of British Columbia" Canada, Department of Resources and Development Forestry Branch Bulletin No. 109, 1953.
6. S. E. Corder, T. L. Scroggins, W. E. Meade, G. D. Everson "Wood and Bark Residues in Oregon - Trends in their Use" Oregon State University, Forest Research Laboratory, Research Paper 11, March 1972.
7. "Conversion Factors for Pacific Northwest Forest Products" Institute of Forest Products; College of Forest Resources; University of Washington.
8. John A. Bergvall and Ronald J. Holtcamp "Washington Mill Survey; Wood Consumptions and Mill Characteristics 1970" State of Washington Department of Natural Resources; Report No. 2, Sept. 1971.
9. James O. Howard "Volume of residues from logging" Forest Industries, November 1971.
10. Donald R. Gedney "Residues from primary manufacturing" Forest Industries, November 1971.
11. Thomas E. Hamilton "Prices of primary manufacturing residues" Forest Industries, Nov. 1971.
12. Brian R. Wall "Residues from secondary manufacturing" Forest Industries, Nov. 1971.
13. L. G. Desmond "On particulate emissions using wood as fuel" Paper presented at the annual meeting of the PNISAPCA Eugene, Oregon, November 1972.
14. "The Energy Crisis" Mechanical Engineering, January 1973.
15. U. S. Dept. of Agriculture, Forest Service. "Table 24 - Volume of Unused Residues at Primary Manufacturing Plants in the United States by Industrial Source" June 1972.