

## USE OF CORN COBS FOR SEED DRYING THROUGH GASIFICATION

Stanley L. Bozdech

DEKALB AgResearch, Inc., Sycamore Rd., DeKalb, Illinois, 60115

Coupled with discoveries of the earliest uses of corn in the western hemisphere are indications that very early the cob was in general use as fuel for cooking, and firing pottery and brick kilns. Later the early farmers of the United States, especially those in the Plains where wood was scarce, found that cobs could cook their meals and heat their homes. The petroleum age came, harvest systems changed, the cob was left to rot in the field. Today I would like to talk about that old fuel which the seed industry is attempting to mate to an old technology. The seed industry generates enough by-products (cobs) to satisfy these needs for fuel for drying seed. Gasification promises to be the technology to efficiently convert cobs to clean, controllable, heat for that purpose.

I have been introduced. But let me introduce, very briefly, one company which creates the favorable environment and provides the support for a gasifier project, and many other developing technologies.

In 1936, with the marketing of DEKALB's first hybrid corn seed, came the winged-ear trademark, touting this new product as the mortgage lifter for the corn farmers. Genetic research is the soul of the business; the production and marketing of hybrids, its physical manifestation. Today the hybrids are not only corn, but sorghum, wheat, sunflower, chickens, hogs; - all of which are distributed world wide.

In later years DEKALB has diversified into the manufacture of irrigation equipment and electronics, into petroleum production, copper mining, commodity brokerage; but DEKALB has always kept close to its central theme of "Food and Energy."

The hybrid seed corn industry is unique. It's objectives, and therefore the seed conditioning procedures, are in no way similar to the grain handling industry.

Nowhere is this more apparent than in the harvesting and drying operations. Seed corn is harvested early and with high moisture content. It is also dried on the cob, in large batch bins. Temperature of the drying air must be maintained below 110 degrees Fahrenheit to preserve the vitality of the germ.

As early as 1972 DEKALB recognized cobs as a natural fuel for its seed drying operations. It took a therm to dry a bushel of seed, but the cobs from that bushel contained about 1.3 therms. Cobs are good fuel, and have been conditioned with the seed. The market value of the cobs, at that time, at the plant site, was about 72 cents a million Btu's. This since has gone down to about 34 cents. Natural gas costs are ten times that amount; propane twenty times. That spread would provide the capital for a conversion system for cobs, although driers are used only five weeks a year, each consuming 7,000 mcf of natural gas during that time. Readily available, good, cheap fuel is definitely an advantage. But the short season with low annual fuel consumption puts constraints on capital costs.

Marginal fuel supply dictated an equipment development plan which would make use of tempered combustion gases as the drying medium. Without heat exchangers, which are wasteful, the drying stream had to be relatively free of particulate matter and toxic gases. The batch drying system itself is a good filter for particulate, and it is soon apparent how clean a system is.

In 1973 because of the high price of fuel oil in Europe, DEKALB's French associate, RAGT, invested in an incineration system for cobs, and piped the combustion gases

to the driers. Today it is still used but with tubular heat exchangers which must be cleaned weekly. Its high particulate output without the heat exchanger is shown in Table 2.

DEKALB, in the U.S., felt that since the French had done so well with everything but particulate, surely some American technique could readily solve that problem. Two direct combustion units were installed in seed plants in 1976: - one a sophisticated incinerator with after-burners, which performed poorly; the other a toroidal unit for burning fine material in suspension, which in addition to high grinding costs, threw particulate as fast as the other units. Additionally, both units slagged badly. Both were complex, expensive, difficult to operate.

The advantage of the nadir is that the only way out is up. It was time to re-evaluate our needs.

In addition to the financial incentive, fuel interruption, therefore drying interruption, would expose a seed crop to frost and wipe it out completely. The machinations of bureaucracy in releasing emergency stocks are no match to the speed of the weather. We had to go ahead.

For some time, we had been following the work of Sweden with wood gasifiers. The elemental and physical similarity between wood and cobs to us became more apparent. During the spring of 1977 I made a quick tour of Europe, including Sweden, visited with all of the gasifier people available, including several people who had been practitioners of the art during the Second World War. Additionally DEKALB researched, heavily, technical libraries in the United States.

#### TYPICAL ELEMENTAL ANALYSIS

	Cobs	Oak
Carbon	44.96%	50.49%
Hydrogen	6.10%	6.59%
Nitrogen	2.42%	--
Oxygen	44.77%	42.77%
Chlorine	0.29%	--
Ash	1.46%	0.15%
Moisture	0.55%	Dry
Btu/lb.	7,215	8,810

Table 1

The result is a system specifically designed to dry grain with cobs, as seen in figures 1 and 2. It meets the criteria we had established at the outset. Although it requires more management than methane or oil fired equipment, the technology is attractive enough to be widely acceptable:

- Continuous operation
- Automated output control
- Five to one turn down ratio
- Simple and direct operating techniques
- Safe operation
- Clean, efficient, heat output

It also meets economic tests:

- Low capital costs
- Reasonable operating costs
- Serviceability
- Complete heat release
- Complete utilization of the heat
- No fuel preparation costs
- Favorable fuel prices

DEKALB's gasifier system is an atmospheric, up-draft, negative-pressured, system, powered by a single fan which discharges regulated, heated, gases to a seed drier. Starting at the right, a valve at the discharge of the fan modulates the complete system starting with the production of the gas in the gasifier.

Dry cobs, as they come from the sheller, whole or in bits and pieces, are fed, on demand, into the system through alternating slide grates which keep the system sealed. At the reactive zone, with the reduction in cob size, channeling has a tendency to occur. The agitator, in an adjustable cycle, keeps the bed packed. The grates are perforated stainless steel, and in operation are generally protected

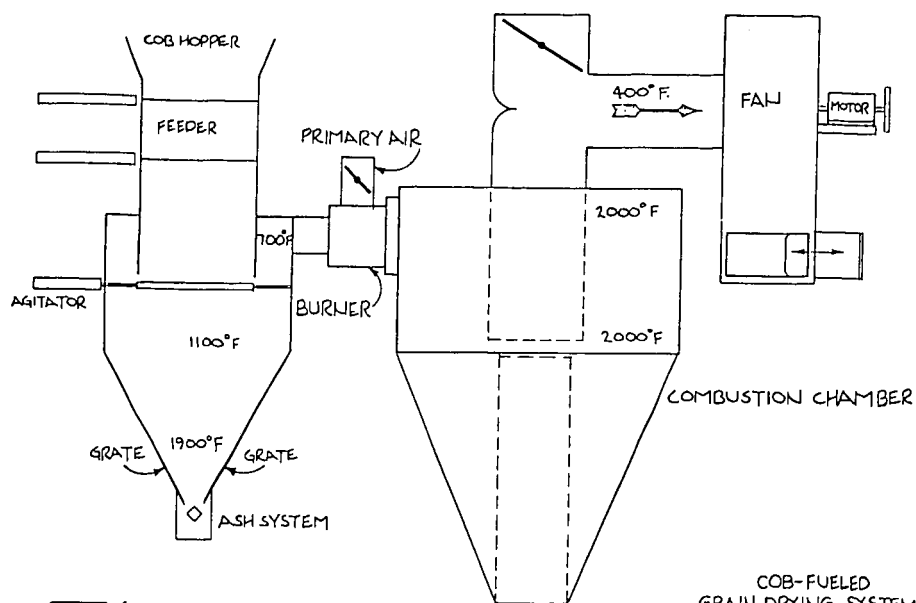


Fig. 1

COB-FUELED  
GRAIN DRYING SYSTEM  
DEKALB AGRESEARCH INC.  
DEKALB IL. 3-28-80

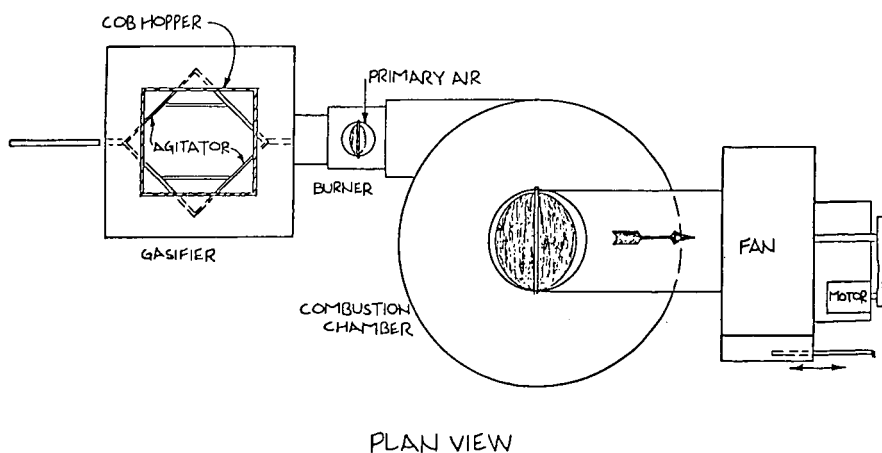


Fig. 2

COB-FUELED  
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DEKALB IL. 3-28-80

by layer of ash. At 1,900 degrees there is usually some indication of slagging which appears as soft clumps of ash and carbon. While slagging is not completely eliminated, the horizontal, rotary, powered, ash removal system breaks up and removes most slagged materials.

Producer gas leaves the system at 700 degrees, carrying, as a vapor, tars that often cause serious problems in updraft units. In some earlier tests, tars going through the burner as droplets were not totally consumed and left a sticky coating on fans and drying equipment. The tars are in the gas stream; - the challenge is to burn them.

On extremely cold days, primary air at the burner has a tendency to condense the tars in the burner head. This can be overcome by feed back from the combustion chamber to heat the ambient. The primary air adjustment is manual. Once set, it responds with the pressure variations in the system and maintains a constant ratio.

The design of the combustion chamber offers the gas dwell time in high temperature environment to promote complete combustion. We are striving for stoichiometric conditions. Additionally the combustion enclosure offers the first chance to blend ambient air with combustion gases. Final tempering to 400 degrees is accomplished by a modulating Valve controlled by a sensor at the fan inlet.

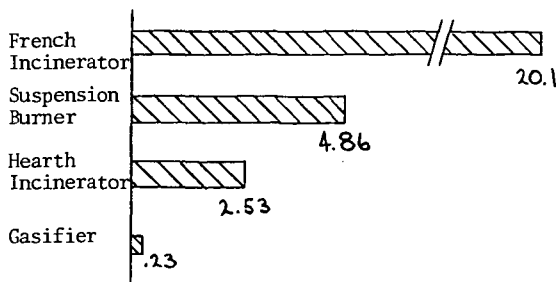
This fan discharges to a mixing chamber at the intake of the fan that supplies drying air to the corn bins. A thermostat in this final air stream controls the damper in the discharge of the fan, in the sketch, to provide a constant, correct, amount of heat.

After one thousand hours running time on a 1.6 mm Btu pilot unit and many hours on a full size 6 mm Btu unit, we have enough answers for a strong positive program.

The particulate emissions are now controllable without a heat exchanger. That expense is eliminated. The cobs produced from the dried seed will now satisfy fuel needs for drying the seed.

Gas quality is good and burns well. Gas samples are taken just ahead of the burner. Analyses of the gases from two typical runs show some variations, but Btu content stays within a range of 122 to 143, which provides satisfactory ignition and combustion.

Although the system satisfies, in many aspects, the definition of attractive technology, it is not a push button unit. One man can operate two units, if close together. Fuel is bulky and cannot



PARTICULATE EMISSIONS IN POUNDS/TON OF FUEL CONSUMED

Table 2

PRODUCTION GAS COMPOSITION  
PERCENTAGE BY VOLUME

	Tests	
	1	2
N2	56+	54+
O2	1.61	0.66
CO2	8.00	7.40
H2	7.50	8.00
CO	24.72	27.10
CH4	1.99	2.80
Cob		
Moisture	11%	
Btu's/SCF	122	to 143

Table 3

be piped from a tank. Special handling equipment is necessary.

The system does utilize all the thermal potential of the cob; sensible heat from the gasifying process, which in some systems can escape to the atmosphere, is captured by placing the unit in the inlet air stream to the drying fan. Mechanically, the gasifier is simple. Most of the annual maintenance problems will probably come from deterioration of refractory during the 47 weeks of down time.

The fuel, as it comes from the seed dryer, requires no further drying, nor does it need classification by size, or grinding. We expect cob prices to stay low since demand for cob products has been severely depressed by substitutes with lower collection and processing costs. Electrical power consumption is low.

The final table is an indication of comparative costs of the gasifier system over a petroleum-fueled system already installed. Cob handling equipment is included in capital outlay.

#### SEED DRYING COSTS PER BUSHEL-ANNUAL BASIS

	Methane	Propane	Gasifier
Capital			141,000
Depreciation charge			11,280
Operating days	34	35	35
Operating labor	960	960	3,200
Operation electrical	116	116	1,920
Cobs (\$0.34/mm Btu's)			2,500
Propane (\$5.45/mm Btu's)		38,150	
Methane (\$3.50/mm Btu's)	24,500		
Maintenance	400	400	1,100
Bushels dried	70,000	70,000	70,000
\$/Bushel	\$0.371	\$0.566	\$0.286
	29.7%	97.9%	

Table 4

The additional cost of using petroleum fuels is high and will probably advance at a fast pace. On new installations, where the capital cost for propane storage and firing equipment, or for methane transportation and firing equipment, must be considered, the figures are much more favorable.

Finally, gasifiers for cobs protect the seed industry from sudden interruptions of drying fuel supplies. These interruptions, if they occur at certain times, could wipe out a complete year's work.

DEKALB intends to start equipping its seed corn plants with gasifiers. Our system is not perfect, but in actual use, development will come faster.

This gasifier system is particularly adapted to retro-fitting grain driers. Purdue is developing a cob separator for a combine which may solve the mechanical problems, but the economics of collection and transportation of cobs must be tested. In the Midwest, on-farm drying of grain uses 20 gallons of propane per acre to dry the 140 bushels of corn from that acre.

If cobs are an available fuel, the gasifier concept can be used to provide fuel for internal combustion engines. Gas clean-up and efficiency become a problem. Energy lost in tars must somehow be recaptured. There is a need for this energy. The average irrigation pump in this country uses the equivalent of 50 gallons of diesel per year per acre.

In addition, with the right fuel, the gasifier is an excellent biomass combustion

system for heat exchangers. Properly designed, emissions stay below EPA levels; cost is competitive with other systems; couplings are simple.

We are excited about gasifiers. It will help DEKALB and its customers control rising costs. It may provide, under the right conditions, energy conversion hardware to the agricultural community. Above all, conservation and the divorce from the dependency of petroleum must start at the energy consumer. By the wise use of biomass in agriculture, substantial amounts of petroleum fuels and their transportation costs can be dislocated for other uses.