References #6

Control of Emissions from Batch-Type Charcoal Kilns

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Abstract

Design of a relatively simple and inexpensive "home-made" smoke burner is described for control of emissions from batch-type charcoal kilns. Installed cost was approximately $4,000 per burner but it was found that one burner was sufficient for two 30-cord capacity kilns. Burners installed at sites in Wisconsin and Minnesota have reduced kiln smoke emissions 80 to 90 percent and have been approved by pollution control officials of both states.

CHARCOAL PRODUCERS using batch kilns (Missouri, Beehive, *etc.*) are, or soon will be, faced with the need to control kiln smoke emissions. Operators in remote or thinly populated areas may be able to operate for a limited time with little or no emission control, depending on prevailing air pollution control laws for their area. Husky Briquetting, however, operates Missouri kilns at two sites close to residential areas and to heavily travelled highways. These kiln operations are located at Hixton, Wisconsin (5 kilns) and Isanti, Minnesota (6 kilns). Because of the recent enactment of strict air pollution laws, local complaints and, at times, obstruction of visibility on adjacent highways, it became necessary to take immediate action for emission control, or to shut down operations.

Time was not available for an intensive engineering study of kiln emissions to characterize emission quantities and qualities, or to develop a sophisticated kiln smoke control system. Furthermore the economics of kiln charcoal production could not support extensive research or expensive control systems such as can be purchased from various pollution control equipment manufacturers.

Therefore, it was decided to design and construct our own system for one or two kilns at the Isanti plant. If this control system proved to be effective, it was then to be installed on all kilns.

Initially, consideration was given to condensing and scrubbing the kiln "smoke." This approach would have produced a calculated 9,650 gallons of water, tar, and pyroligneous acid per kiln burn. Disposal of this mixture was a problem that did not appear to have any immediate solution. Further, the cooling and scrubbing water needed was not available at either kiln site.

Because of this, incineration was chosen as the only practical means quickly available to clean up the kiln emissions. Data available in literature on the products from the destructive distillation of wood were used as the criteria for the design of an experimental "home-made" smoke burner, such burner to be of simple but rugged construction for minimal maintenance and ease of operation. Two thousand dollars was allotted for the experimental burner. Eventually about $3,500 was spent in the development and construction of the first experimental burner. Final installed cost of additional burners built following the experimental tests ran close to $4,000 per burner.

Kilns at both sites are 22 by 38 by 9 feet, with arched roofs (30 cord capacity Missouri kilns). Originally each kiln had four 12-inch exhaust stacks, two on each

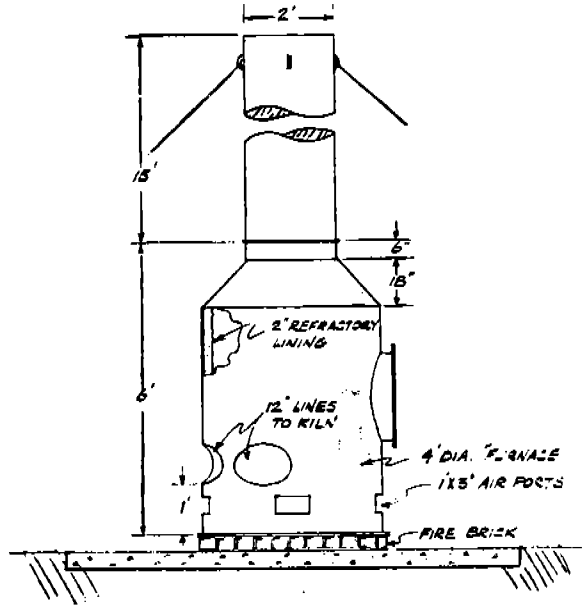

Figure 1. — Details of experimental furnace. Stack height was increased to 21 feet and air port area was increased following the experimental tests.

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side. These four side-stacks were eliminated during installation of the burners and were replaced with two 12-inch exhaust ports on the back of each kiln at ground level. Burner details and burner-kiln layout are shown in Figures 1 and 2.

At first it was planned to use one burner per kiln. However, it was found that one burner was sufficient for two kilns. This was done by installing butterfly valves in the lines from kiln to burner, and scheduling kiln firing to run only one kiln burn to a burner at a time during the period of heaviest smoke emission (Fig. 3).

Furnace size and stack height were calculated based on the following:

1) Kiln charge 40 bundles (slab wood), @ 3,500 lb./bundle, total 140,000 lbs.
2) Three-day burn.
3) Assumption of a constant gas rate and gas composition.
4) Slab wood "seasoned" oak and birch, analysis:
   Moisture Content: 30-50%
   Volatile Matter: 74-78% (dry wood basis)
   Ash: 2-4% (dry wood basis)
   Fixed Carbon: 19-24% (dry wood basis)
5) Wood distillation yield per 4,000 lb. charge:

	Lb. Yield
Charcoal	960
Tar	200
Pyro-Acids	190
Water	1,870
Gas-CO_2	523
CO	172
CH_4 - METHANE	55
C_2H_6 - ETHANE	30
	4,000

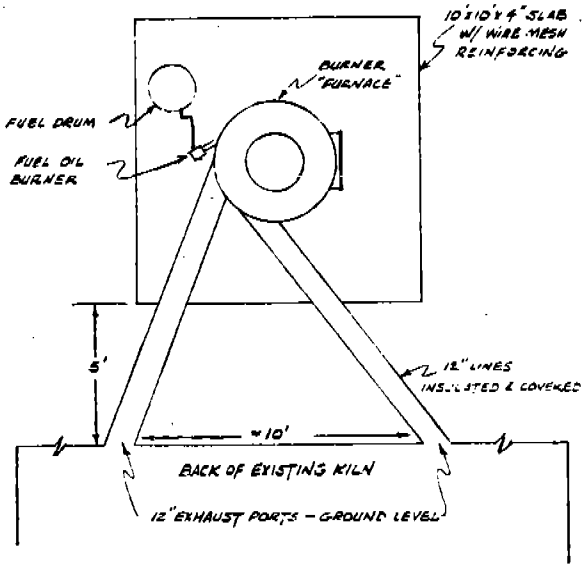

Figure 2. — Original plan of burner location showing 12 inch lines to back of kiln. After testing it was discovered that one burner was sufficient for two kilns, and four lines (two to each kiln) were attached to each burner (see Fig. 3).

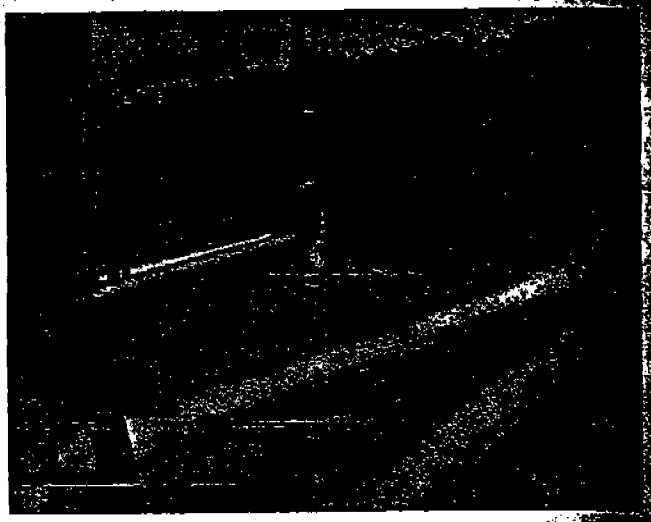

Figure 3. — Photograph of the final installation of burners at the Hixton, Wisconsin site. Note that each burner serves two kilns. Butterfly valves are located at point of flange connection in line.

The kiln off-gas (furnace fuel) characteristics derived from these data were a gas rate of 8,450 [illegible] which, when burned, would release 3.39 MM BTU/[illegible]. From this, furnace and stack dimensions were selected as follows:

Furnace: 6 feet high by 4 feet in diameter.
Stack: 15 feet high by 2 feet in diameter.

Each furnace is equipped with two oil or natural gas burners which are used only during the first 24 hours of a kiln burn cycle. After this, most of the charge wood moisture has been driven off and the smoke burning fire is self-sustaining. Fuel costs (natural gas or oil) average $2 to $3 per ton of charcoal product.

Kiln smoke emissions have been reduced by 80 to 90 percent. Most of the emissions remaining occur during the first 24 hours; this is a very white emission which dissipates quickly. The kiln smoke burners at both the Wisconsin and Minnesota sites have been approved by state pollution control officials.

Recently a 6-foot length has been added to each burner stack (making a total of 21 feet) and the area of the air ports increased at the bottom of each burner. This has resulted in a further emission reduction because of improved burner operation. If additional kilns and burners are added to either kiln site, a larger furnace will be used, sized 5-foot diameter by 10-foot height.

There has been practically no maintenance required except for stack replacement. The original stacks were mild steel only; the new stacks have a 2-inch Cast-Set refractory lining. Since replacement, no further maintenance has been necessary.

This relatively simple and inexpensive system for controlling air pollution is certainly not the only answer to this specific problem; however, it works and our neighbors are satisfied.