

For kiln burning, the general practice in the United States is to cut to 4 ft. lengths. Formerly the cutting to lengths as well as the felling was done with the axe, but latterly the saw has been brought into general use, with a view not only to quicker work, but to prevent waste. The value of the saw in cutting the cordwood to length is considerable, for the axe chips represent a very material loss. The axe seldom makes a cut at an angle less than 45 degrees, so that in practice as much wood is cut away as remains in the two adjacent points, and the loss of chips in cutting to four foot lengths with the axe, amounts to fully from 8% to 10% according to the size of wood cut.

In the Province of Quebec, when we first took up the charcoal iron industry, we found that the practice was to work wholly with the axe, and to cut to 3 ft. lengths, and we saw that this must be changed, as the loss was considerable in labor through cutting to such short lengths, and as already pointed out the loss in chips also was naturally very great. We had a great deal of prejudice to overcome, but we are now making for kiln purposes solely 4 ft. wood, and our men are using the saw for cutting to length. And we find that not only do we effect economy for reasons given, but our men are able to earn, working in pairs, with the saw, better wages than they formerly could, working singly, with the axe.

In burning into coal two systems are generally followed, viz., pit or meiler burning and kiln burning, and in the United States "retort" burning has been attempted. This is carried on, I believe, on a small scale at present, but I do not think it has ever proven to be a commercial success although perhaps if given full trial it might be found to be more economical than it has so far proven to be.

KILN BURNING.

Two styles of kilns are generally used,—the "rectangular" and the "bee-hive." The latter has been found to be the most satisfactory, and has practically superseded the "rectangular" kiln. In our own experience the "rectangular" kilns have given us good results both as to durability and the making of coal, but we have found them more difficult to keep air-tight than the "bee-hive," and that they also require more experience and care in handling, being more subject to cracking and opening through being effected to a greater extent by expansion and contraction. They have also to be well bound with heavy frames of wood, which are affected by weather and time and require replacing.

Our present battery of "rectangular" kilns is, however, in first class condition, although it has been in operation about twenty-four or twenty-five years. This is perhaps mostly due to the fact that they have been carefully looked after, and repairs promptly made when necessary.

When in operation, it is necessary that the burner watch the "rectangular" kilns very closely, owing to there being a greater liability to burn down to the centre than in the "bee-hive" kilns. The form of the latter giving solidity while the action of expansion and contraction from heat and cold is not so great, and the "bee-hive" kiln is therefore easier to keep air-tight, and for these reasons the coal produced in the "bee-hive" is more uniform.

Apart from the question of coal, the "bee-hive" kiln is much easier to keep in repair, as it is not necessary to have any wood frames or binding. The wood can also be handled somewhat cheaper and faster in the "bee-hive" than in the "rectangular" and owing to their greater liability to straining from expansion and contraction already referred to, the "rectangular" kilns require about two or three days longer to cool, and therefore cannot be "turned over" as often as the "bee-hive," and for general results the latter has been found to be the most suitable.

PRINCIPLE OF MANUFACTURING IN KILNS.

In our "rectangular" kilns, an opening is left from the front door to the centre of the kiln. This is made by piling the cordwood in such a manner that a canal of say 12 inches square is left in the middle of the kiln leading from the door to the centre. At this point a sort of crib work is built, known as a "chimney," leading to the top of the kiln. On all sides of this dry wood, or brands, is piled so as to fire easily. A small quantity of split brands is then placed in the hole in the centre. The wood on all sides is ranked in the same manner as cord wood and is piled as closely as possible. Along the top of the kiln the lighter wood is laid, and this for two reasons. First, it is easier to handle, and secondly, the fire will run through it quicker than through the heavy timber which is left in the centre of the kiln, then a fair quantity of light wood (or brands) is placed along the bottom and at the ends. When the kiln is closed and ready for firing, the top door is opened, and a piece of oily waste is inserted by means of a long pole to the centre of the "chimney." The draft to the top of the kiln carries the fire upward and along the top, and once fairly started, the top door is closed and the air is allowed to draw down to the lower vents, three rows of which are open around the base of the kiln. These vents are operated by the burner in such a manner as to draw the heat from point to point of the kiln, and thus to "cook" the whole mass. The direction and force of the wind have a large bearing on the manipulating of the heat, and will drive it from one side of the kiln to the other,—hence the hole—have to be closed and the windward side protected to prevent combustion, as otherwise the wood would become over-heated and be reduced to ashes. The condition of the coal in the kiln when approaching the finishing point is generally determined by the color of the smoke and sometimes by the insertion of an iron rod at various points to ascertain by feeling the condition of the wood or coal. This latter mode is only occasionally resorted to.

BEE HIVE KILNS.—The same mode of piling and firing applies to the "bee-hive" kilns as described in regard to the "rectangular." The fire is started at the bottom and allowed to burn upwards. Once fairly started among the light or dry wood, the kiln is closed, and as the gases escape from the wood they practically supply sufficient heat to "cook" the entire mass. Care must be taken at all times to prevent too great a supply of air to the kiln, and thus cause combustion.

The properly cooked kiln should contain only the ashes made by the wood that surrounds the "chimney" with a little from the dry or light wood on the top, the combustion of which has supplied sufficient fuel to heat the mass and cause the drying and evaporation of water and gas in the whole.

What a charcoal burner must keep before him all the time is, that the wood is to be "cooked" and not burned, so that every care must be taken to prevent combustion, and sufficient heat must be introduced into the kiln or the "chimney" or canal leading to it, or by the combustion of a small quantity of light or dry wood on top to "cook" the whole mass. The light wood, of course, will be consumed, but in the meantime it should have imparted sufficient heat to the rest to draw off the water and the lighter gases.

The burning of charcoal is more or less a process which distils or throws out the undesirable gas leaving the mass of wood charred to the centre. If this could be carried out to perfection, the coal should be solid without any breaks or cracks or tendency to fall to pieces.

Both our "bee-hive" and "rectangular" kilns have a capacity of about 55 cords, and they generally take from ten to fourteen hours to fill, according to the class of wood handled, and from five to six days to burn, which is again largely

governed by the class of wood. The "bee-hive" kilns take about eight days to cool and can be easily discharged in one day. The "rectangular" kilns generally take two or three days longer to cool, as already stated, owing to their being more affected by expansion and contraction. In our kiln work we use cord wood all the way from a limb of 2½ inches in diameter up to the trunk of the heaviest tree that is too solid or knotty to be split with the axe, so that in our practice there is practically no waste wood, as we use tops, lops and everything.

THE MANUFACTURE OF COAL IN PITS OR MEILERS.

In Sweden the coal is very largely manufactured in pits and this has been carried on on quite a large scale also in the United States. One advantage of the pit system is that farmers and others can do coal burning on their own lands and obtain the results of the labor, and at the same time the cost of transportation is naturally greatly lessened as forty bushels of charcoal can be transported for considerably less than a cord of wood, of which it is an average equivalent. In general results throughout the United States it would seem that the quantity of coal per cord obtained by pit burning has not been equal to the quantity obtained in the kilns. The general average seems to be about thirty-five bushels per cord from pit burning as against about forty bushels from the kilns. In my opinion, this is very largely due to lack of care or knowledge on the part of the pit burner, as with the same care and attention, and with a thorough knowledge of the work, there does not seem to be any good and valid reason why the results as to quantity should not be about equal. Apart from this, however, in our own experience of pit burning, the coal produced was of a better quality than that obtained in the kilns, (i.e., where the work was well done.) We found the coal dense and close, and practically solid to the centre, and this class of coal develops at least 15% to 20% more gas than the ordinary coal obtained in kiln practice. It will not consume as rapidly, and gives a greater and more enduring heat, and has proved itself as economical even where an equal quantity per cord was not obtained, as compared with kiln practice.

In manufacturing coal in pits, the process of firing is practically the same as that practised in kilns, a canal being made to the centre in which to insert the fire and a "chimney" built to the top along which light wood (or brands) is placed.

The whole is then covered with eight or ten inches of evergreen branches, leaves and sand or earth. After the fire is thoroughly started, the top or the centre over the chimney will fall in, owing to the total consumption of the wood at that point, and a supply of hard wood is kept on hand, which is driven into this hole as soon as the covering shows a tendency to fall in. After it is thoroughly re-filled, a fresh covering is put on, then vents are opened along the sides towards the base. The condition of the coal inside is ascertained by feeling with an iron rod, and as the burner finds it at any point properly "cooked" he can open it and withdraw a portion of the coal, covering the balance rapidly and carefully again in the same manner as at first. This process is kept up until he knows by the color of the smoke and by the inserting of his "try rod" that the whole is properly "cooked." It is all then carefully covered in and allowed to cool and die out.

This mode of burning coal requires very careful and constant watching, owing to the liability to fire. As I have already said, the practice in Sweden is to use wood for pit purposes in nine or ten foot lengths, and when we took up the question of getting the farmers and others in our district to make coal in this manner, we had them follow the usual Swedish process in cutting, but from various reasons, principally owing to the density of our woods, the burning of shorter lengths has proved more satisfactory, and our best results have been obtained from wood cut in four or five foot lengths, and a portion of it split, and also by using smaller pits.

The pits which we first operated contained as much as forty-seven to fifty cords, but the results were unsatisfactory, the process proving too slow and too many brands being made. The coal obtained, however, was fairly good. Our burners then resorted to smaller pits containing from 20 to 25 cords of 4 ft. wood. These burned faster and gave better coal. Where our men had had experience in the work, the coal was clean and solid, and as pointed out, gave better results in the furnace than ordinary kiln coal.

In pit and kiln practice, we have used the following woods:—maple, birch, beech, soft maple, white birch, tamarac, hemlock, balsam, and in point of value they can be reckoned in the order named. Our principle consumption has been in maple, birch and beech, with which our district abounds. In practice in kilns and in pits both, we have found it possible to use 25% to 30% of soft wood, but for furnace purposes we prefer not to go above that as the coal made from the softer woods is more friable and will not carry a heavy burden of ore.

RETORTS.

In the United States attempts have been made to manufacture charcoal in retorts or closed vessels in which the wood is placed, and the charring done by external heat. In a report on this system, made by a prominent expert, he mentions that one system is to erect a furnace, and supply it with a number of vertical cylindrical vessels, which are handled with a crane. These vessels are filled with wood, tightly sealed, lifted into the furnace and connected by means of nozzles with conduits leading to condensers. After the fire has been maintained a sufficient length of time to properly char the wood the vessel is lifted out and allowed to cool, another taking its place in the furnace. In this method the retorts serve also as cooling vessels, but they must be handled, and the outlets for gases must be disconnected and closed at each change.

Another plan consists of a cylindrical retort hung from trunnions over a furnace. It is raised to a vertical position to receive the charge of wood, and reversed to discharge the charcoal into the cooling vessel, where the process is completed. The difficulty of filling these retorts and maintaining them, makes this plan undesirable.

A system largely employed in North Pennsylvania and South New York, consists of a series of cylindrical vessels set permanently in a horizontal position over furnaces. These retorts are filled with wood either thrown in, or in improved retorts, placed in a crib which has been previously loaded. When the carbonization has proceeded sufficiently, the coal is withdrawn into a cooling tank, which is hermetically sealed, until such time when the danger of the mass taking fire is greatly reduced.

Other forms have also been followed, but as far as I can ascertain, none of them have ever proved commercially successful, and the old-fashioned kiln and pit system still seems to be for general charcoal purposes the economical, and, in fact, the only systems by which charcoal can be successfully manufactured for general commercial purposes, or at least for the manufacture of iron.

BY PRODUCTS.

Of late years considerable attention has been given to by-products obtainable in the manufacture of charcoal, and it has been found that with a chemical plant attached to a battery of kilns, that every cord of wood can be so handled that the exact weight that went into the kiln will practically be taken out, when everything is taken into consideration. What by-products can be drawn from a charcoal kiln would be too numerous to mention. In fact there seems to be very little that cannot be taken out of the wood in this way, but for commercial purposes the principal by-products, and