XXII.—*On the Spontaneous Combustibility of Charcoal.*

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(Abstract.)

THE kinds of wood generally used for the manufacture of gunpowder charcoal are the black dogwood (*Rhamnus frangula*), the willow, and the alder. They are all well adapted for the manufacture of charcoal, although the dogwood is always used for the best sporting gunpowder. The wood is converted into charcoal by heating it in iron cylinders, and the combustible gases pass underneath the cylinders of an adjoining set, and constitute the greatest part of the fuel. Great advancement has been made in economising these gases, especially in the cylinder house of Messrs. John Hall and Sons; and the method they have originated brings the use of coal down to a minimum point. In 1869 one cwt. of coal was required for every burning, whilst at present, with proper care and management, 50 burnings can be effected with 56 lbs. of coal.

The amount of charcoal produced is generally about 20 per cent. of the wood employed, and depends to a great extent on the state of the wood; if the wood contains a large quantity of moisture, the amount of charcoal is of course much less; but the decrease is greater than the proportion of moisture present, for the latter, at the high temperature to which it is subjected, becomes decomposed, liberating oxygen gas, and this unites with the charcoal, forming carbonic oxide.

In order that the charcoal should play its intended part, it should be able to undergo a thorough and quick combustion, leaving but a small percentage of ash; and its hygroscopic power should be as low as possible. The fulfilment of these conditions demands great attention to the regulation of the temperature. If the charcoal is heated too highly, it has small hygroscopic power, but is also slow in combustion; whilst if heated at too low a temperature, it is quick in combustion, but has great power of absorbing moisture.

The following experiments show the difference in three differently burnt charcoals:—

	Velocity in feet with Snider rifle (charge 70 grains).	Moisture absorbed in a hygrometric box.
No. 1.—Sample of R.F.G., made from dogwood charred at a very high temperature	1229	1.19 per cent.
No. 2.—Sample of R.F.G., made from dogwood charred at a very low temperature	1296	2.40 per cent.
No. 3.—Sample of R.F.G., made from dogwood charred at the ordinary temperature	1262	1.65 per cent.

After the charcoal is taken from the cylinders, it is placed in iron coolers provided with tightly fitting lids, and allowed to stand for 24 hours, by which time it is quite cold, and it is then shot into store bins. The following experiments will show the time after burning when it is safe to send it to the charcoal mill to be ground, and afterwards to be mixed with the other ingredients for gunpowder. In order to distinguish them they were marked as follows:—A. B. C. D. E. F.

A. consisted of charcoal ground one day after burning.

B. " " two days "

C. " " three " "

D. " " four " "

E. " " five " "

F. " " six " "

They were all ground on the same day, immediately after each other, and placed in large iron coolers, the lids being taken off, and a centigrade thermometer placed in each cooler.

Time.	Temperature of room.	A. 1 day old.	B. 2 days old.	C. 3 days old.	D. 4 days old.	E. 5 days old.	F. 6 days old.
Immediately after grinding ..	20.0	25.0	24.0	23.3	23.3	22.5	23.0
12 hours after.....	21.0	57.7	30.0	24.3	24.0	23.0	22.0
24 hours after.....	21.2	90.0	32.0	24.9	24.6	24.0	22.9
36 hours after	19.0	on fire.	31.0	24.7	24.5	23.5	22.7
48 hours after	20.4	—	30.0	23.6	23.5	23.7	22.6

It will be seen that the charcoal one day old took fire, and that after two days no increase of heat took place, any more than the temperature of the room might occasion; this increase during one and two days is owing to the fact that charcoal absorbs mechanically within its pores a large quantity of oxygen gas from the atmosphere, and the condensation of all gases liberates heat, and charcoal being a bad conductor, the heat cannot escape.

The combustion was not attended with any flame, in fact it was scarcely apparent.

The amount of oxygen absorbed by the charcoal also varies with the degree of carbonization; the higher the heat the more gases will it absorb. The absorption of the ordinary charcoal will be seen from the following experiment. The charcoal was taken direct from the cylinder, in a glass globe provided with stopcocks which were closed after the admission of the charcoal, to allow it to cool; oxygen gas, freed from carbonic anhydride and moisture by passing it over potash hydrate and sulphuric acid, was then allowed to enter, and the increase in weight of the globe taken every six hours.

After being subjected to oxygen 6 hours it absorbed 1·80 per cent.

"	"	"	12	"	"	1·95	"
"	"	"	36	"	"	2·16	"
"	"	"	48	"	"	2·16	"

The absorption with the sticks of charcoal is not so quick as with ground charcoal: hence the spontaneous combustion of stick charcoal does not occur so often.

Charcoal also absorbs a large quantity of moisture from the atmosphere, which will be seen from the following:—

						Per cent.
Charcoal after being exposed to the atmosphere 12 hours gained						2·40
"	"	"	24	"	"	3·90
"	"	"	36	"	"	5·10
"	"	"	48	"	"	5·70
"	"	"	60	"	"	6·60
"	"	"	72	"	"	6·70
"	"	"	84	"	"	6·70
"	"	"	2 weeks	"	"	6·90
"	"	"	1 month	"	"	6·92
"	"	"	2 months	"	"	6·89
"	"	"	3	"	"	6·91
"	"	"	4	"	"	6·90
"	"	"	5	"	"	6·93
"	"	"	6	"	"	6·90
"	"	"	7	"	"	6·89

From the above we may draw the conclusion concerning the use and storage of charcoal in gunpowder and other works: that the charcoal absorbs its maximum amount of oxygen from the atmosphere within three days after carbonization, and, that after that time no danger need be apprehended by using it, whilst up to that time its use may be attended with danger. The maximum amount of moisture is also absorbed within the first two weeks, and after this no change takes place, any more than atmospheric agencies might occasion.