

### XXXIX.—*The Effect of Heating on the Absorptive Power of Sugar-charcoal for Sulphur Dioxide.*

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DURING the later stages of the war the absorptive power of charcoal for poisonous gases and lachrymatory vapours was of the greatest importance. In the earlier types of box respirators animal-charcoal was employed, but when the use of this type of respirator was extended to all troops, it became necessary to investigate other kinds of charcoal, of which an unlimited amount would be available. Experiments carried on at the Imperial College, chiefly by Prof. Philip, showed that, contrary to the earlier belief, wood-charcoal which had been subjected to long-continued heating gained so much in absorptive power that, in this respect, it was in no way inferior to animal-charcoal.

It was thought worth while to investigate this question further, using the purest charcoal obtainable, and incidentally to find out whether this increase in absorptive power was associated with any other changes in the physical properties of the charcoal.

The sugar-charcoal was prepared by heating the finest crystallised sugar until no fumes or odour were perceptible. After roughly powdering the mass, it was placed in a hard-glass flask, in which it was heated in a vacuum. Chlorine was then admitted and allowed to remain all night. The flask was next heated to redness for half an hour, a vacuum being maintained in it by means of a good water-pump. The charcoal on boiling with water gave no indication of the presence of chlorine or hydrochloric acid. It was heated in a muffle furnace for half an hour, powdered, and sieved. The particles between 0.4 and 0.8 mm. in diameter were used in the experiments.

The ash from different samples showed a very uniform percentage, 0.113 being the mean value.

*Specific Gravity of the Charcoal.*—The material which had been heated to about 900° in a muffle furnace for four hours had a specific gravity of 1.76, mean of six samples.

That which had been heated for forty hours had a specific gravity of 1.84, mean of two samples.

*Absorptive Power of the Charcoal.*—Sulphur dioxide was chosen for the first experiments, since the gas is easily obtained in a fairly pure state from the liquefied substance, and also because the amount absorbed is very considerable.

The gas was contained in a gas-burette over mercury, which, with its accompanying barometer tube, was surrounded by a jacket

## 320 WINTER AND BAKER: THE EFFECT OF HEATING, ETC.

through which water at a constant temperature was circulated. Sealed on to its exit-tube a long capillary tube communicated, by means of a mercury-protected ground joint, with the thick hard-glass bulb in which the charcoal was placed. It was found impossible to weigh the charcoal in an open weighing tube, so rapid was its absorption of water vapour from the air. No lubricator was used for the ground joint. By means of a screw clamp on each side the parts of the joint were kept in close contact, and no leakage occurred when, as sometimes happened, there was a considerable internal pressure. Before admitting the sulphur dioxide, the bulb containing the weighed charcoal was exhausted by means of a Gaede pump, and heated to redness for two hours. It was then cooled in a bath containing melting ice, the same water, at  $0^{\circ}$ , being circulated through the jacket of the gas-burette. The latter, which had a volume of about 100 c.c., had been carefully calibrated, and the volume of the bulb had been determined by weighing its volume of mercury. It was feared that the volume of the bulb might change on heating when exhausted. This was not found to be the case when the bulb was of sufficient thickness.

On admission of the sulphur dioxide the absorption was very rapid for the first hour. It then became extremely slow, but in seventy-two hours no further absorption could be measured. The results obtained were, with 1 gram of charcoal which had been heated previously for the times stated:

Hours .....	4	40	42½	45½
C.c. ....	97	195	241	288

Saussure (*Ann. Physik.* [Gilbert], 1814, **47**, 113) found that one volume of charcoal of sp. gr. 1.57 absorbed sixty-five volumes of sulphur dioxide, or 1 gram of charcoal absorbed 38 c.c. of sulphur dioxide.

Favre (*Ann. Chim. Phys.*, 1871, [iv], **24**, 247), with charcoal of the same specific gravity, found that 1 gram absorbed 105 c.c. of the gas.

#### Conclusion.

Charcoal, in a very pure form, has its specific gravity increased by forty hours' heating to  $900^{\circ}$  from 1.76 to 1.84. By the same treatment the amount of sulphur dioxide absorbed is increased from 97 c.c. to 288 c.c.

It is proposed to extend this investigation to the cases of other gases, and also to find if other physical properties of charcoal are affected by prolonged heating.

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