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SUBJECT: TESTING OF ADSORPTIVE CAPACITY OF CHARCOAL BEDS
HRT Test No. II-A 10 b

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TESTING OF ADSORPTIVE CAPACITY OF CHARCOAL BEDS
HRT Test No. II-A 10 b

During the pre-startup phase of the HRT operations, moisture was accidentally introduced into the charcoal bed adsorbers in the off-gas system. Tests have been made to determine the effect of wetting upon the adsorptive properties of the charcoal. The work was divided into two phases, testing of fresh charcoal in the laboratory and testing of the HRT charcoal beds in situ.

Laboratory Charcoal Tests

The purpose of these tests was to obtain a standard of performance against which the behavior of the large charcoal beds could be judged. The charcoal used in these tests was from the same shipment as that used in the large beds, 8-14 mesh, Columbia Grade G activated coconut charcoal.

The test procedure was to introduce measured increments of gas with a gas burette into the previously evacuated charcoal bed and measure the pressure after each addition. Isothermal conditions were maintained with a water bath.

The adsorption isotherms for nitrogen and for oxygen are shown in Figs. 1 and 2.¹ The nitrogen isotherms were run to see if the method being used in the laboratory test gave results that would agree with published data. If agreement was obtained, then confidence could be placed in the oxygen measurements for which no literature values were available at the test conditions of the HRT charcoal beds. The 30°C isotherm for nitrogen agrees reasonably well with the findings of McBain and Britton.² Two runs were made at each temperature for each gas. The agreement between runs was good except in a few cases when there was difficulty in holding a constant temperature. The isobars shown in Fig. 3 are cross plots of Figs. 1 and 2.

HRT Charcoal Beds

In December 1956, an oxygen adsorption isotherm was run for each bed (prior to the laboratory scale tests) by adding increments of gas from a cylinder to the bed, previously evacuated to 0.3 to 0.4 inches Hg absolute. The amount of oxygen added was calculated from the changes in cylinder pressure and the cylinder volume. The beds were at ambient air temperature, and therefore temperatures varied over a range of 16°F during a run. Each bed contains 520 lb (2.36×10^5 g) of charcoal.

¹Original data on pages 165-174 of HRT Data Log.

²J. W. McBain and G. T. Britton, J. Am. Chem. Soc. 52, 2198 (1930).

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Fig. 1. Adsorption of H_2 on Charcoal

(lab test)

Volume Adsorbed, cc (STP)/g Charcoal

Absolute Pressure, mm Hg

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Fig. 2 Adsorption of O_2 on Charcoal

(lab test)

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Fig. 3 Absorption of N_2 and O_2 on Tharcoal

(lab test)

Isobars

The results are shown in Fig. 4.³ Also shown are the isotherms for fresh charcoal, derived from Fig. 3. A comparison shows that bed 10C is satisfactory, but that bed 10A probably contains moisture. Comparative data were not available for bed 10B.

Drying the Beds

In August 1956, it was discovered that the charcoal adsorber beds contained water from an unknown source. Drying of the beds was begun by passing relatively dry instrument air through the saturated charcoal until equilibrium was reached (i.e., inlet and outlet moisture content the same). It was noted that the exit air velocity and the moisture content of the exit air both increased during the day when the beds were warmed by the sun. Next, a Henry drier was placed in the air line so that the air passed through three 113 in.³ silica-gel cartridges before reaching the charcoal. The drying operation was stopped when the inlet and outlet moisture contents were the same. The final relative humidity was about 3% (dew point about 55°F) and the total drying time was about five days.

In laboratory work with wet charcoal, it was noted that drying by evacuation with the bed at room temperature proceeded very slowly but that heating to 40°C speeded up the drying considerably.

Therefore, it is recommended that the beds be dried by heating them to about 40°C and purging each with one to two liters/min of dry instrument air. The beds can be conveniently heated by flooding the pit with water and sparging with steam. Drying should be continued until the dew points of the entering and leaving air are both about 55°F. If the dew point of the instrument air is above 55°F, the Henry drier should be used toward the end of the drying.

R. Van Winkle

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³Original data on pages 151, 156, and 157 of ERT Data Log.

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Fig. 4 Absorption of O_2 in HT Charcoal Beds on Dec. 13-15, 1956

and Comparison with Lab Data

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