3

STUDY OF THE ABSORPTION SPECTRA OF MERCURY VAPOUR WITH VARYING TEMPERATURE AND PRESSURE

By D. K BHATTACHARYYA and JAGAT MURARI

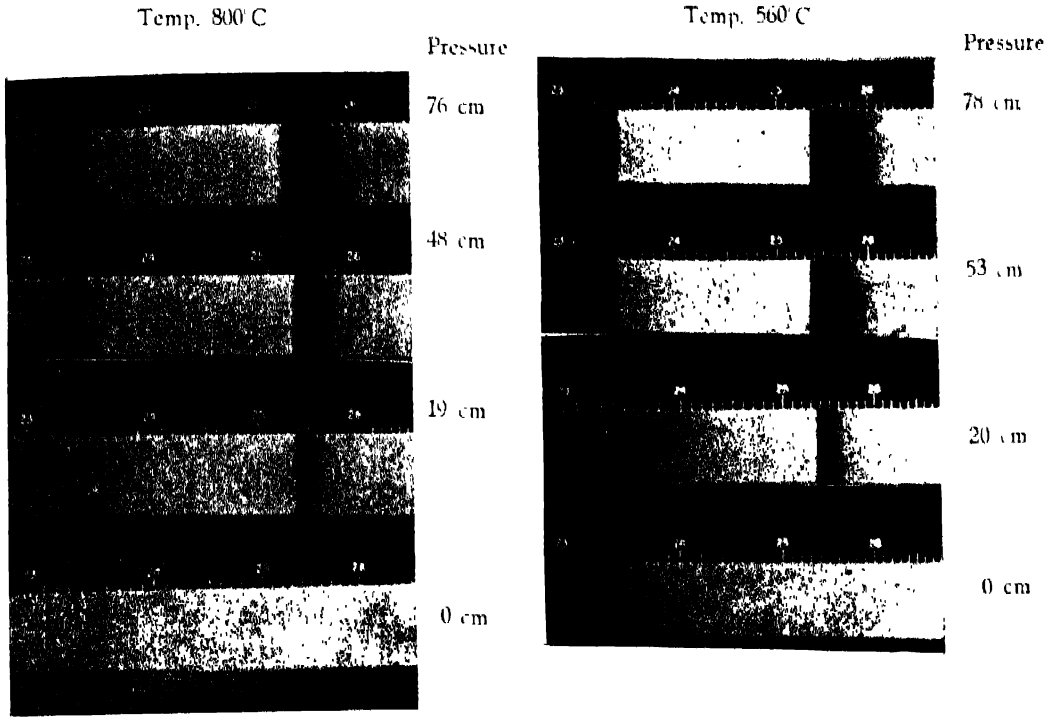
(Plate II)

ABSTRACT. The absorption spectra of mercury vapour with varying conditions of temperature and pressure were studied using an absorption chamber of fused quartz and a hydrogen continuum as the background. Progressive broadening of the absorption line λ2537Å both with increasing temperature and pressure was observed. Also a few new bands near the absorption line λ 2537 Å were observed. The absorption bands between 2311 Å and λ 2341 Å were observed to develop and grow clearer with increasing pressure at 560° C and 800° C, while they did not appear at all at 250°C.

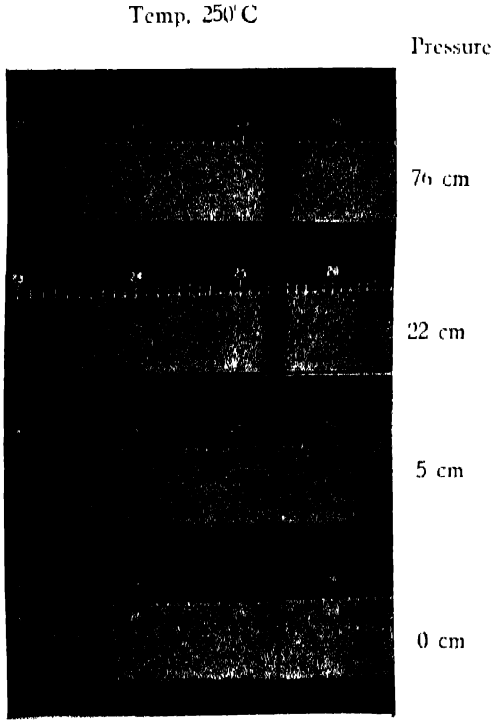
INTRODUCTION

The spectrum of mercury vapour both in emission and absorption has been studied in detail by Rayleigh (1927) and by Walter and Barrat (1929). They have ascribed quite extensive band systems to the spectrum of mercury vapour in absorption and the troublesome task of photographing them has been accomplished by Rayleigh in his excellent spectrograms published in his paper quoted above.

The origin of these spectra in absorption, however, is a bit controversial point. They do not appear if mercury is heated in a carefully evacuated sealed quartz tube at any temperature. Rayleigh used an arrangement in which mercury boiled under imposed air pressure which could be varied from about three atmospheres to any fraction of one atmosphere. The significant point is that the bands appear only in the presence of air. In the present investigation arrangements were made for varying the imposed pressure from zero to one atmosphere. A series of spectrograms were taken with gradually varying pressures at any particular room temperature. The superimposed pressures were due to the gases nitrogen and oxygen. No marked change, however, was observed in the spectrograms with nitrogen and with oxygen, pointing to the conclusion that the spectrum is probably due to diatomic mercury molecules and not due to association of a mercury atom with a gas atom. The presence of gas merely favours the formation of mercury molecules.



Absorption Spectra of Mercury Vapour with Varying Temperature and Pressure



The present investigations differ from that of Rayleigh inasmuch as that the investigations of Rayleigh were made at higher pressures of imposed gas and with much longer absorption chamber. Observations with smaller pressures, however, have revealed a few new bands near the absorption line $\lambda = 2537$ Å, while the extensive spectrum observed by Rayleigh between $\lambda = 2943$ Å and $\lambda = 2614$ Å did not appear at all. This is due to the fact that with increasing external pressures the absorption spreads to longer wavelength side.

Further a systematic study of the absorption with varying pressures and temperatures as described in this paper has revealed certain behaviour of the absorption spectrum, which does not appear to have been recorded before.

EXPERIMENT

Figure 1 shows the experimental arrangement. A tube of fused quartz T with windows of fused quartz sealed on to it was used as the absorption cham-

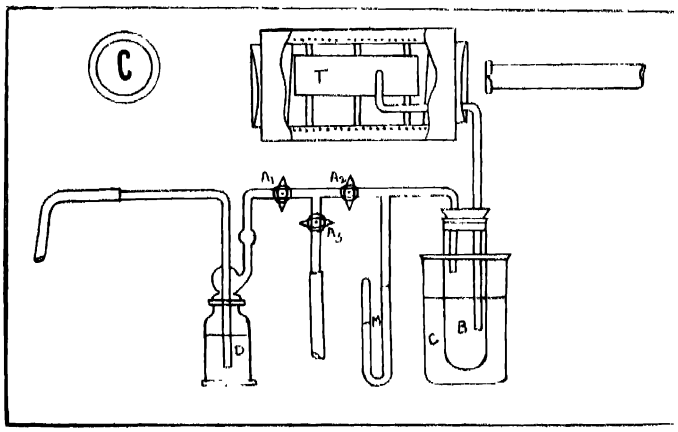


FIG. 1

ber. The length of the tube was 25 cms and diameter 4 cms. The tube communicated with a large test tube B which was cooled with water in a beaker C, and served to condense any vapourised mercury. The chamber could be evacuated and dry nitrogen introduced with the help of three stopcocks A_1, A_2, A_3. The pressure was recorded by the manometer M. The chamber was surrounded by a silica tube wound with nichrome wire and covered with asbestos. This served as a furnace and different temperatures up to 1000° C could be obtained by varying the heating current. Hydrogen continuum run by a Foster transformer giving a maximum voltage of 2000 volts was used as a continuous source. An Adam Hilger Intermediate spectrograph was used for recording the spectrum. The chamber was made completely leak-tight, so that on evacuation the manometer remained perfectly steady for 24 hours.

The experimental procedure consisted in heating the chamber containing mercury to a definite temperature and then photographing the spectrum. Now some nitrogen, dried by passing through a sulphuric acid tower D, was introduced and the spectrum photographed with varying pressures of nitrogen.

EXPERIMENTAL RESULTS

Absorption spectra for the temperatures of 250° C, 560° C and 800° C are reproduced. The widening of the absorption line with increasing temperature and pressure is very clearly seen. Let us consider the photographs (Plate II) one by one.

Lowest Temperature 250° C. This photograph shows banded structure near the resonance line very clearly. With zero pressure the absorption line is very sharp. As the pressure is increased to 10 cms. another thin line appears at $\lambda = 2540$ Å. With further increase of pressure increasing number of diffuse bands appears and the extent of absorption increases. A noteworthy point is that the longer wavelength edge of the absorption at $\lambda = 2540$ Å remains practically fixed and only the shorter wavelength edge is extended towards still shorter wavelengths with increasing pressure. This behaviour is altered at higher temperature.

Temperature 560° C. This photograph shows the same general behaviour as the last, absorption line getting wider with increasing pressure of nitrogen. But a remarkable difference is that at this temperature the structure is practically absent and another very important difference is that in this case it is the short wavelength edge at $\lambda = 2333$ Å nearly, which remains fixed and very sharp with increasing pressure of nitrogen. The widening with increasing pressure takes place with forcing the longer wavelength edge towards still longer wavelength side.

Temperature 800° C. This photograph also does not show so much structure as the first one and is more akin to the second photograph. But a difference appears at the maximum pressure where the short wave length edge which was so far very sharp, becomes diffuse and some bands appear.

Some of the absorption edges read from the plate are recorded below.

Temp 250° C	Temp 800° C
$\lambda = 2538.5$ Å	
$\lambda = 2533$ Å	$\lambda = 2533$ Å
$\lambda = 2526$ Å	$\lambda = 2527$ Å
	$\lambda = 2524$ Å
	$\lambda = 2522$ Å
	$\lambda = 2519$ Å
	$\lambda = 2514$ Å

Besides the behaviour of the absorption about the resonance line the absorption between $\lambda = 2311$ Å and $\lambda = 2341$ Å also shows some peculiarity. They do not appear at all at the temperature of 250° C. They appear at the temperature of 560°C but here also only when the pressure is increased to 20 cms. of Hg and becomes clearer with increasing pressure of nitrogen. Similar behaviour is observed at the still higher temperature of 800° C.

Our thanks are due to Professor S. P. Prasad for giving us every facility in conducting this piece of work.

Department of Physics,
Science College, Patna,
16th April, 1945.

REFERENCES

Finkelnburg (1933), *Phys. Zeits.*, **34**, 529.

Rayleigh (1927), *Proc. Roy. Soc.*, **116**, 702.

Walter and Barrat (1929), *Proc. Roy. Soc.*, **122**, 201.