

An Attempt to Find a Suitable Source of Sodium Light to be used with the
Polariscope at the Virginia Polytechnic Institute.

Thesis

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Degree of Chemical Engineer by

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The work described in this paper was undertaken in order to construct a suitable source of sodium light to be used with the polariscope now in the Virginia Polytechnic^{institute} Laboratory. The polariscope in question is of the Schmidt and Haensch type with a Laurent polarizer, imported by the Arther H. Thomas Co.

The polariscope proper answers the purpose for which it was bought very well, but the sodium lamp supplied with the instrument is of little value. At present the source of illumination used is a wing-foot burner which is allowed to burn through a slite in a sheet of asbestos saturated with a sodium chloride solution. Such an apparatus is not desirable for several reasons. First, it requires two persons to take readings, second the light is not of constant intensity, and third, the burner has to be placed so near the instrument that the heat of the flame causes a very appreciable error in the reading of the instrument.

The writer first endeavored to obtain the required light from a source of white light by filtering the white light through various substances which would absorb all wave lengths except the one sought. In order to study the absorption spectra of these substances, a spectroscope was so placed that it was illuminated by the light after passage through the various solids and liquids tried. The source of light used was a nitrogen bulb of two hundred watts power on one hundred and ten volt circuit. This light was placed in one room in front of a small opening which permitted the light to pass into an adjoining room which contained the spectroscope. The latter room could be darkened, and as a further precaution against the entrance of stray light into the instrument a funnel shaped tube was constructed between the opening and the slite of the spectroscope. By placing the different substances used as filters in this opening the light was caused to pass through them before entering the spectroscope. The wave lengths absorbed could be easily determined.

e It was found that the wave lengths passed by most of these substances were not well defined; that is at some parts of the spectra part of the light was absorbed and part transmitted. Impure light of this nature can not be used in polariscopic determinations. The intensity of the light transmitted was also found to be insufficient for the purpose desired. Approximately thirty different substances were examined and in each case the above results were obtained; the conclusion to be drawn is that monochromatic light can not be obtained in this manner. Some of the results obtained are given in the chart attached hereto. A number of similar charts are at present published and in some cases these results do not correspond to those obtained by the writer of the present article; this discrepancy is explained however by the fact that the concentrations of the solutions were probably not the same.

The next attempt was to obtain the D line of sodium light by passing white light through a prism and by means of a slite allowing only the light of proper wave length to pass into the instrument. For this purpose a two hundred watt nitrogen bulb~~was~~ was used as the source of illumination. The light thus obtained was dispersed through a carbon disulphide prism, the dispersed light passed through a slit of variable width and by means of suitable focusing lenses, the light passing through this slit was focused on the spectro-scope.

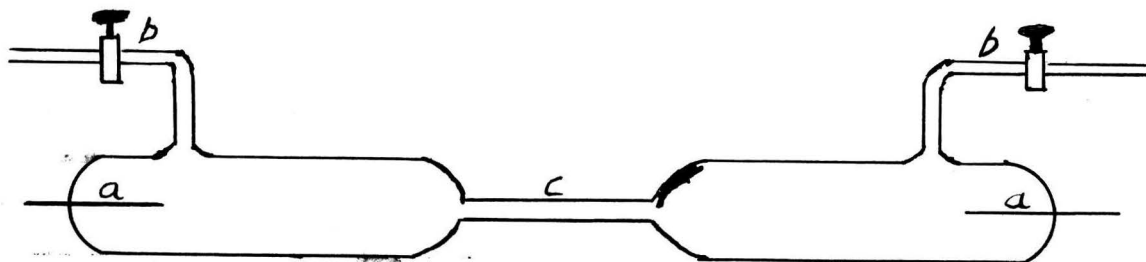
(2).

By turning the prism through an angle, any desired part of the spectrum could be focused upon the spectroscope. Because of overlapping the light thus obtained was not however of sufficient purity for the purpose. After dispersion the light was also found to be of low intensity, a condition which could possibly be remedied by using a more intense source of light. The results obtained up to this had indicated that overlapping of the lights of different wave lengths would not permit of the use of this method and consequently experiment along these lines were carried no further.

The third attempt, which was partially successful, was to heat the vapors of a sodium salt to incandescence by the passage of an electric current through an evacuated tube containing the salt of sodium. ~~KXXXXXX~~
~~XXXX~~ The pump used for evacuating the tubes for this purpose was of the Langmuir Mercury Condensation type, one of the latest pumps upon the market. The pump is capable of producing a very low vacuum. The current through the tubes was supplied from the secondary of an ordinary laboratory induction coil; ~~XXXX~~ the primary of the coil was supplied from a twenty volt direct current circuit.

A number of vacuum tubes of different shapes and sizes were used and different amounts of the salt used with each type. The shape of the tube used first is shown in the drawing below.

- (aa) straight platinum wire electrodes
- (bb) stopcocks for evacuating the tube and adding the salt
- (c) capillary tube through which current passes



(3).

A small amount of sodium chloride was first forced into the tube and the tube attached in a horizontal position to the pump. While the pump was still running, the current from the secondary was passed through the tube and the result noted. The light obtained was the light of an ordinary vacuum tube, but when the tube was heated a faint sodium line was obtained. As there was danger of breaking the tube, the temperature which could be obtained was not high enough to vaporize a sufficient quantity of the salt. The tube was then placed in a vertical position and enough salt added to completely cover the bottom electrode. Upon evacuating and heating the tube after this had been done, a sodium line somewhat brighter than the first was obtained. There were also in addition a number of other lines, the probable result of impurities. This experiment showed that the point of vaporization of sodium chloride is at too high a temperature for the desired results.

The above experiment was then repeated using sodium acetate in the tube. The point of vaporization of sodium acetate is much lower than that of sodium chloride and consequently, it vaporizes much more readily in a vacuum. When the tube was attached to the pump and the pump started, some of the very fine ~~salt~~ particles were drawn over; the current in its passage through the tube impinged upon these small particles and in this way a very strong sodium light was obtained. However in a short time after the pump was stopped, the particles settled out and consequently the light was no longer produced. Upon the application of heat, enough of the acetate was evaporated to give a strong light of the desired wave length.

The results of this experiment indicate that the D line can be obtained by passing an electric current through vapors of a sodium salt. Since the tube must be heated in order to vaporize the salt, two persons would be required to take readings and for this reason such a method of illuminating a polariscope would have little advantage over that at present used in the laboratory.

For the purpose of determining whether or not the shape of the tube has any effect upon the vaporization of the salt, a number of tubes of different shapes were tried. All of these tubes were blown in the laboratory; ~~the~~ the electrodes were sealed in with cement in order to overcome the usual difficulty of sealing with glass. Three of the shapes used are shown in the sketch attached to this paper. None of these types showed any advantage over the type used in the first trial; in fact, the strongest light obtained was obtained in the tube which has already been described.

The conclusion to be drawn from this limited search is that the use of a salt of sodium in a vacuum tube has no advantages over the apparatus at present in use in the V. P. I. laboratory. There are however several solutions of the problem which the writer did not have sufficient time to investigate. Metallic sodium used in the tube would probably produce better results; since it is an element the vapor would probably give a more intense light and there is of course no substance present to give other lines than the D line. Probably the sodium would act upon the glass of the tube however and for this reason the tube would be very short-lived.

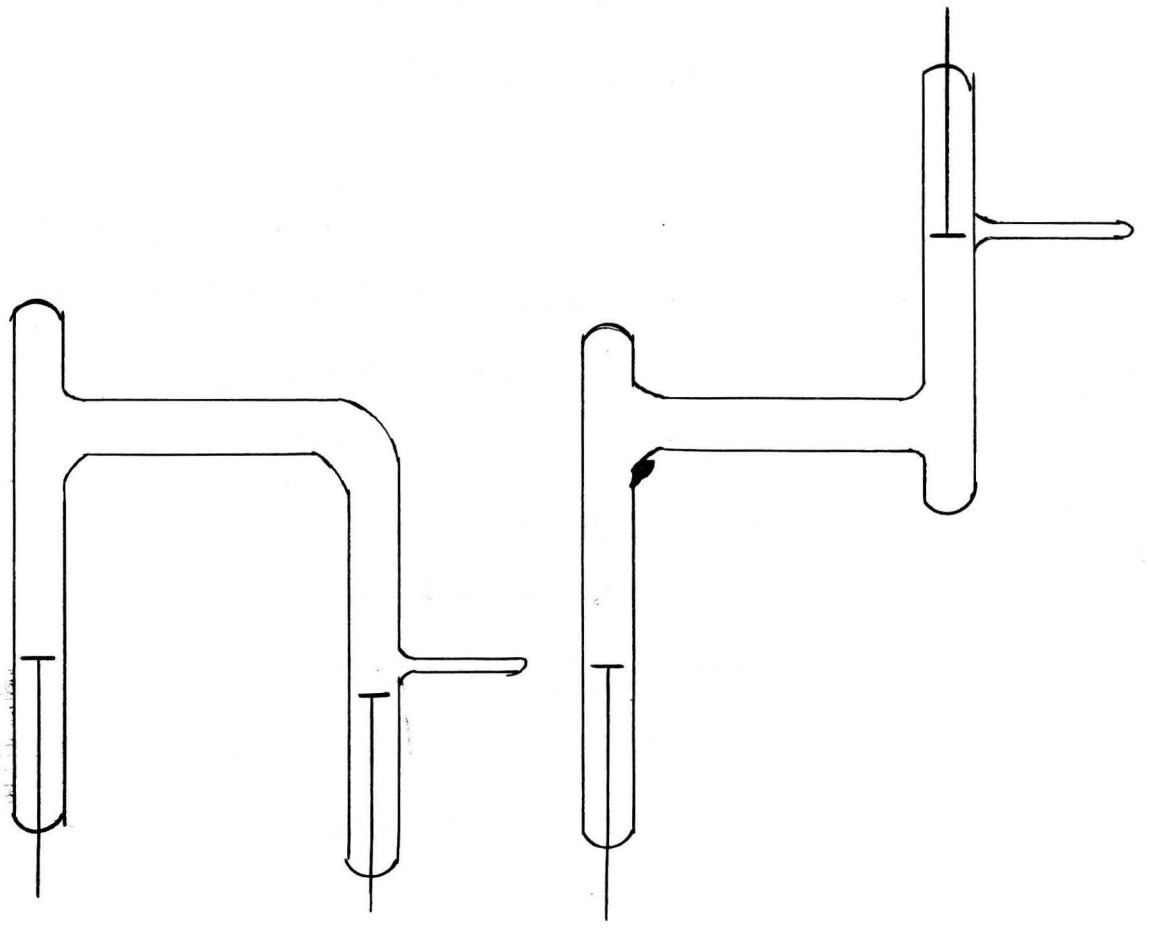
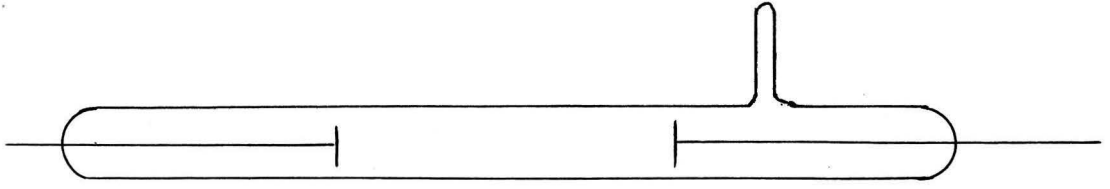
One other possibility has suggested itself to the writer. If some compound of sodium or the metal itself be added to a mercury vapor lamp, the vaporization of the mercury will doubtless aid the vaporization of

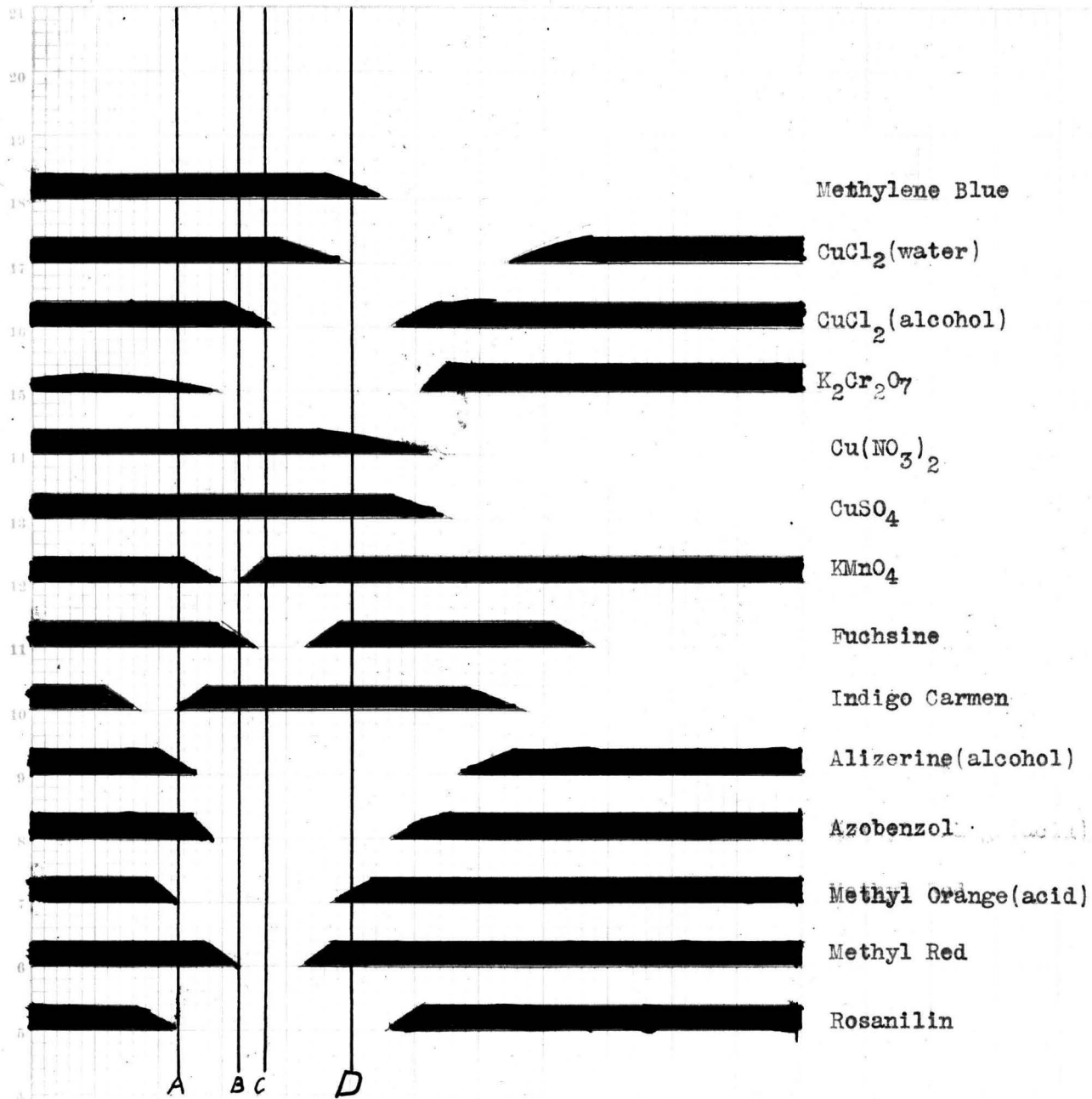
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of the sodium compound. The resultant light may be passed through proper solutions which will absorb the wave lengths not desired: i.e. the red lines of mercury

References:

Watson's A Text-book of Practical Physics
Wood's Physical Optics
Bulletin no. 44 Bureau of Standards 1916.





2 4 6 8 10 12 14 16 18 20 22 24
 Scale readings (V. P. I. Spectroscope)