

### III. A "REMOVABLE" YELLOW INK

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(Introduced by F. T. Gardner)

As long as the oil industry lasts, there will be a need for maps. And as long as there are maps, men will devise means for making them more easily read. The most common method now employed is the use of colored ink, or paint, to denote acreage held by various firms. But, unfortunately, every lease does not become a producing lease; lease renewals are not always possible; and often nearby developments cause acreage to be condemned for oil purposes. Therefore, when a lease expires or is canceled, all the maps containing this lease must have the ink removed to keep them up to date. At present the chief method of removal is a mechanical eraser, a device which sounds like a cross between a dentist's grindstone and a planing mill. It was to develop an ink which in itself was permanent, yet which could be completely removed easily if the occasion demanded, that this research was begun. Of all the colors, yellow was chosen with which to work, because at present it is used by several major oil companies, and because it can be photostated without obliterating any lettering which may be under it.

When yellow inks which change their color are mentioned, the immediate thought is of indicators which change from yellow to colorless. Clark, in his book, "The Determination of Hydrogen Ions," lists two general classes of indicators which go through the desired color change. The first group are nitro compounds, of which paranitrophenol is representative. The second is Alizarin Yellow GG (metanitrobenzeneazosalicylic acid).

The sodium salt of p-nitrophenol in alcohol solution made a nice yellow ink, but this ink darkened when exposed to sunlight. A similar experiment with the Alizarin Yellow GG ended with the same results.

Since these were the only possibilities for yellow pigment, the work then turned to the use of negative catalysts to prevent the darkening of the ink when it was exposed to sunlight. The catalysts selected were those that had previously met success in other lines as antioxidants or materials which are strong reducing agents. This first trial was only qualitative. Solutions containing the following were introduced to saturated alcohol solutions of the sodium salt of p-nitrophenol: Benzoic acid, formic acid, oxalic acid, salicylic acid, benzene sulfonic acid, benzaldehyde, camphor, resorcinol, sodium sulfite, and sodium nitrite. Samples of each of these solutions were put on paper and exposed to the sunlight. Six of the ten withstood the action of sunlight. Benzoic acid, formic acid, oxalic acid, salicylic acid, benzene sulfonic acid, and benzaldehyde.

The experiment now took a quantitative form. Two grams of antioxidant in 100 c. c. of an alcohol solution of p-nitrophenol, made slightly basic with sodium hydroxide, were used. None of the six negative catalysts in this small amount resisted the darkening action of sunlight.

The next work was similar to the previous one, except that the antioxidant was introduced in the amount of ten grams of antioxidant to 100 c. c.

of solution. All of the samples from this experiment turned dark upon exposure to sunlight. When the darkened ink was treated with a base, the yellow color was partially restored. This discovery led the way to the next trial.

There were now left six possibilities for antioxidants. Of this number salicylic acid was discarded because it turned pink when acidified, after being exposed to the sunlight. Of the remaining five, oxalic acid was selected for detailed study because it was easily obtained and because in the previous tests it had made a slightly better showing than some of the other materials used.

Starting with 5 c. c. of a slightly basic alcohol solution of p-nitrophenol containing oxalic acid in the ratio of ten grams to 100 c. c. of solution, sodium hydroxide solution (6 Normal) was added three drops at a time for five intervals, taking out samples after each addition. All of these samples were affected by sunlight.

The next experiment began with a slightly basic alcohol solution saturated both with p-nitrophenol and with oxalic acid. Sodium hydroxide solution was then added at intervals until the solution was approximately 1.3 N. with respect to hydroxyl ion. When these samples were exposed to light the solution containing the most base was the least affected. Evidently the minimum concentration of hydroxyl ion to prevent oxidation had just been reached.

The blue print paper used throughout this experiment was not affected by the ink. Direct sunlight has no effect on the oxalic acid, hydrochloric acid, or sodium hydroxide used.

Now that a satisfactory ink has been found, the next problem is the removal. The work on this phase is not yet complete. However, certain things are certain from the experimentation. A very weak acid will remove the ink. Clark lists the ink as changing color at pH5 to 7. The experiments have brought out the fact that the colorless (acid) p-nitrophenol molecule is affected by light more readily than the basic configuration. This would suggest that in removing the ink, several applications of acid should be made, with immediate blotting following each to remove all the acid p-nitrophenol before the acid evaporates.

A brief comparison of this ink with the commercial yellow inks on the market would not be out of place. The three yellow inks most commonly used are the Higgins and the Pelican India Inks, and an ink known as Batik Yellow, the last originally made as a cloth dye. All of these inks seem to have a water soluble pigment. They all turn purple when made basic. They are hard to remove, as I stated before. They are all darkened more by light than is the p-nitrophenol yellow finally used. Black India Ink can be used over the p-nitrophenol yellow with less subsequent spreading than results with the others.

This is the history of p-nitrophenol as an ink. All the details have not yet been completed. This could well be considered as only a progress report.