

Original Research Paper

Effect of Soaking on Gel Pen Writings: A Forensic Examination

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Abstract:

Forensic document examiners daily meet new type of challenges during document examination. Many of documents, sometimes in drastic conditions such as torned, burnt, shredded and soaked in some liquid are faced by experts for examination. Sometimes the criminal tries to hide the documents in water tank, pond etc. Very less research work has been reported on documents in soaked conditions. So, the study has been carried out to analyze the effects of water soaking on gel point pen ink writings on different surface at different time intervals. The samples of writings with different brands of gel pens were prepared on different types of paper in the forensic science laboratories (documents division) to assess the effect of different liquid mediums (acidic, basic, and neutral) on to gel pen writings and the paper surfaces.

Key Words: Suicidal Death, Dowry, Autopsy, Crimes Against Women Cells

Introduction:

Questioned document examination is becoming a tough challenge for the document examiner day by day. Criminals often try to damage, hide or destroy important information. Different kinds of documents, such as daily dairy writings, letters, wills, suicide notes, etc. are submitted to a document examiner in a variety of conditions such as shredded, torn, burned and thrown in water media, etc, to examine. A forensic document examiner is prepared to meet new and unique challenges during an examination of any kind of document. Cases have been reported in which important documents are either flooded in disaster cases or are thrown deliberately in lakes, ponds, canals and other water streams to destroy vital information.

These types of documents come to the document expert to decipher the content of the writing on the papers. The success of restoration of different writings depends on writing medium, type of paper and period of immersion.

Researchers have attempted and successfully restored and deciphered different writings using stereo microscope, vacuum freeze dehydration method, liquid nitrogen and freeze drying method.¹⁻⁷ Phenomena such as the feathering of ink, lateral spreading of ink, transference of ink on subsequent or facing paper, change in sheen, etc, have been studied in the soaked ballpoint pen writings⁸. From the literature survey, it has been apparent that less research work has been reported on the soaked document examination.

The aim of the present research was to acquire a conceptual knowledge on the effect of soaking on gel pen writings written on the different nature of substrates in different mediums such as acidic, neutral and basics at different time intervals. An effort was made to decipher the writings of gel pen by using stereo microscope and UV light. The project gives a perfect vent to the understanding made on various aspects of gel pen inks writings made on different types of papers soaked in the different nature of liquid media.

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L.. M. No: Not a Member

DOR: 02.01.2018 DOA: 04/12/2018

DOI: 10.5958/0974-0848.2018.00079.9

Materials and Methodology:

The present study was carried out to analyze the soaked blue color gel pen writings of different brands made on bond paper and A4 size paper in three different natures of liquids at three different time intervals, after approval from the Institutional Ethics Committee. The samples of gel pen writings were prepared with five different brands of blue gel pens commonly available in the market (**Table 1**). The writings of gel pens were prepared on two different types of paper. The type of paper selected for the study was Bilt Royal bond paper of white color of size A4 (21cm X 29.7 cm) with 100 GSM and white normal printing paper of JK Copier brand A4 size (21cm X 29.7 cm) with 70 GSM that makes the sample number ten.

Table I Brands of gel pens chosen for the study.

S.No	Brands of Gel Pen	Color
1.	Today's	Blue
2.	Flair writometer	Blue
3.	Cello Sprinter	Blue
4.	Octoglide	Blue
5.	Stic gel	Blue

Three different natures of liquid mediums, i.e. acidic (pH 3), neutral (pH 7) and alkaline (pH 13) were prepared for the study for soaking the gel pen writings prepared on the two different natures of paper. The normal tap water with pH 7 was selected as a neutral medium for the study. The tap water was made acidic and alkaline by adding concentrated hydrogen

chloride (HCL) and sodium hydroxide (NaOH) and their pH was maintained to 3 7 13, respectively. The pH level of each solution, i.e. acidic (pH 3), neutral (pH 7) and alkaline (pH 13) were measured using a pH meter before soaking the samples.

As the booklets were to be soaked in three media chosen for the study, it made the sample number thirty. The thirty booklets were to be soaked for three different time intervals, i.e. one week, fifteen days and one month; that made the sample number ninety. Before immersion, these booklets were examined and recorded in daylight and under UV radiations. One booklet from each brand of blue gel pen, prepared on two different papers selected for the study, were prepared and was preserved as control samples. One booklet was taken out from each medium, i.e. acidic (pH 3), neutral (pH 7) and alkaline (pH 13) after one week, fifteen days and one month, respectively, and was examined in day light, under stereomicroscope and UV radiations and the results were compared with the control samples. The results given by each soaked gel pen writings on different papers at different interval in three chosen mediums were recorded (**Table 2-4**). Blind samples were also prepared for the same examination in a similar manner by the other author and key exemplars were preserved.

Table - 2: Showing phenomenon observed in blue gel pen writings immersed in acidic medium (HCL) on A4 paper and bond paper at different intervals.

S. No	Brands of gel pen	Color	Time Interval of one week	Time Interval of fifteen days	Time Interval of one month
1	Flair Writometer Gel	Blue	1.No change in ink color. 2.No Spreading or feathering of ink. 3.No ink transferred on facing or subsequent paper. 4.No fading of ink color. 5. No change in paper texture.	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4. No fading of ink color. 5. No change in paper texture.	1. Change in ink color. 2. Spreading or feathering of ink. 3. Transfer of ink on facing paper. 4. Fading of ink color. 5. No change in paper texture.
2	Cello Sprinter Gel	Blue	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4. No fading of ink color. 5. No change in paper texture.	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4. No fading of ink color. 5. No change in paper texture.	1. Change in ink color. 2. Spreading or feathering of ink. 3. Transfer of ink on facing paper 4. Fading of ink color. 5. No change in paper texture.
3	Octoglide Gel	Blue	1. No change in ink color. 2. No Spreading or feathering of ink.	1. No change in ink color. 2. No Spreading or feathering of ink.	1. Change in ink color. 2. Spreading or feathering of ink.

			3. No ink transferred on facing or subsequent paper. 4. No fading of ink color. 5. No change in paper texture.	3. No ink transferred on facing or subsequent paper. 4.No fading of ink color. 5. No change in paper texture.	3. Transfer of ink on facing paper. 4. .Fading of ink color. 5. No change in paper texture.
4	Stic Gel	Blue	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4.No fading of ink color. 5. No change in paper texture.	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4. No fading of ink color. 5. No change in paper texture.	1. Change in ink color. 2. Spreading or feathering of ink. 3. Transfer of ink on facing paper. 4. Fading of ink color. 5. No change in paper texture.
5	Todays Gel	Blue	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4.No fading of ink color. 5. No change in paper texture.	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4. No fading of ink color. 5. No change in paper texture.	1. Change in ink color. 2. Spreading or feathering of ink 3. Transfer of ink on facing paper 4. Fading of ink color. 5. No change in paper texture.

Table - 3: Showing phenomenon observed in blue gel pen writings immersed in neutral medium (tap water) on A4 paper and bond paper at different intervals.

S.No	Brands of gel pen	Color	Time Interval of one week	Time Interval of fifteen days	Time Interval of one month
1	Flair Writometer Gel	Blue	1. Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Little is fading of ink color. 4. No change in paper texture.	1 Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Fading of ink color. 4. No change in paper texture.	1 Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Disappearance of ink color. 4. Indentation left by gel pen present. 5. No change in paper texture.
2	Cello Sprinter Gel	Blue	1. Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Little is fading of ink color. 4. No change in paper texture.	1 Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Fading of ink color. 4. No change in paper texture.	1 Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Disappearance of ink color. 4. Indentation left by gel pen present. 5. No change in paper texture.
3	Octoglide Gel	Blue	1. Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Little is fading of ink color. 4. No change in paper texture.	1 Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Fading of ink color. 4. No change in paper texture.	1 Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Disappearance of ink color. 4. Indentation left by gel pen present. 5. No change in paper texture.
4	Stic Gel	Blue	1. Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Little is fading of ink color. 4. No change in paper texture.	1 Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Fading of ink color. 4. No change in paper texture.	1 Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Disappearance of ink color. 4. Indentation left by gel pen present. 5. No change in paper texture.
5	Todays Gel	Blue	1. Spreading or feathering of ink. 2. Transferred on facing or subsequent paper 3. Little is fading of ink color 4. No change in paper texture	1 Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Fading of ink color. 4. No change in paper texture.	1 Spreading or feathering of ink. 2. Transferred on facing or subsequent paper. 3. Disappearance of ink color. 4. Indentation left by gel pen present 4. No change in paper texture.

Table - 4: Showing phenomenon observed in blue gel pen writings immersed in alkaline medium (NaOH) on A4 paper and bond paper at different intervals.

S. No	Brands of gel pen	Color	Time Interval of one week	Time Interval of fifteen days	Time Interval of one month
1	Flair Writometer Gel	Blue	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4. No fading of ink color. 5. No change in paper texture.	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4. No fading of ink color. 5. No change in paper texture.	1. Change in ink color. 2. Spreading or feathering of ink. 3. Transfer of ink on facing paper. 4. Fading of ink color. 5. No change in paper texture.
2	Cello Sprinter Gel	Blue	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4. No fading of ink color. 5. No change in paper texture.	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper 4.No fading of ink color 5. No change in paper texture	1. Change in ink color. 2. Spreading or feathering of ink. 3. Transfer of ink on facing paper 4. Fading of ink color. 5. No change in paper texture.
3	Octoglide Gel	Blue	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4. No fading of ink color. 5. No change in paper texture.	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4.No fading of ink color. 5.No change in paper texture.	1. Change in ink color. 2. Spreading or feathering of ink. 3. Transfer of ink on facing paper 4.Fading of ink color. 5.No change in paper texture.
4	Stic Gel	Blue	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4. No fading of ink color. 5. No change in paper texture.	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4. No fading of ink color. 5. No change in paper texture.	1. Change in ink color. 2. Spreading or feathering of ink. 3. Transfer of ink on facing paper 4.Fading of ink color 5.No change in paper texture.
5	Today's Gel	Blue	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper 4.No fading of ink color 5. No change in paper texture	1. No change in ink color. 2. No Spreading or feathering of ink. 3. No ink transferred on facing or subsequent paper. 4.No fading of ink color. 5. No change in paper texture.	1. Change in ink color. 2. Spreading or feathering of ink. 3. Transfer of ink on facing paper. 4. Fading of ink color. 5. No change in paper texture.

Results and Discussion

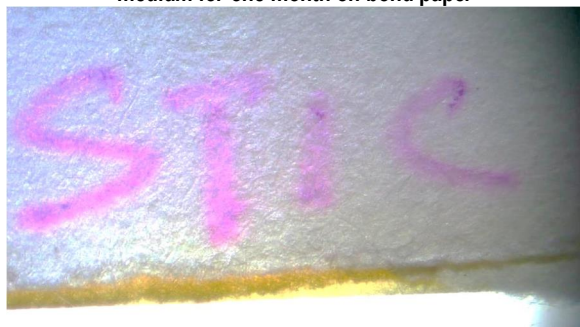
The results of each booklet of gel pen writing prepared on two different papers, i.e. bond paper and normal printing paper immersed in three different liquids such as acidic, neutral and alkaline for three different time intervals have been interpreted (**Table 2-4**). The results have been based on the various phenomenon shown by the immersed booklet which were interpreted on the basis of ink transfer on subsequent paper/ facing paper, seepage of ink, feathering of ink, lateral spreading of ink, wrinkling of paper surfaces, fading of ink color or change in ink color, disappearance of ink color and presence and absence of indentations.

Gel pen writings in acidic medium at different periods of time:

The results of gel pen writings immersed in acidic medium, i.e. hydrochloride acid in acidic medium after one week were interpreted (**Table-2**). It was observed from the results that no phenomena of lateral spreading or feathering of blue gel inks, fading of ink color, change of gel ink color, transfer of ink on facing paper or subsequent papers was observed on both bond paper & A4 size printing paper in acidic medium in any of brand gel pen after one week and fifteen days. Similarly, no effect was seen on the texture of bond paper and A4 printing paper after soaking them in acidic medium for one week and fifteen days. Whereas, the characteristics of lateral spreading of blue gel inks, fading of gel ink color, change of gel ink color to brown and pink, transfer of ink on facing paper or subsequent papers started gradually

appearing in gel ink writings written on both bond paper & A4 size printing paper after fifteen days to up to one month. No change in the paper texture was observed in both paper types in the same medium and time interval. After almost one month, the phenomena of color change of ink and spreading of ink around the letter are more frequent and prominent **Figure 1**. So, as the immersion time interval increases more were the characteristics shown by the gel inks writings.

Figure 1 Change in color of gel ink after immersion in acidic medium for one month on bond paper



Gel pen writings in neutral medium at different periods of time:

The results of gel pen writings immersed in neutral medium, i.e. tap water were interpreted (**Table 3**). It was observed from the results that the phenomena of lateral spreading of blue gel inks, feathering of ink color, little fading of gel ink color, transfer of ink on facing paper or subsequent papers started appearing on both bond paper & A4 size printing paper writings immersed in neutral medium in all brand gel pens after three days of soaking (**Figure 2-3**). The color fading of gel ink appeared at about one week of immersion. The color of ink then started disappearing and there was a change in ink color in gel writings sample and by about one month, the ink completely disappeared and indentations were left (**Figure 4-6**). The indentations left by gel pens were observed in the paper that helped in restoring the content under stereomicroscope with oblique light. It is worth mentioning here that more heavily the pen pressure, more deeper the indentations and more easily the content deciphered. But no effect was observed in change in texture of bond paper and A4 printing paper after soaking them in neutral medium until a month.

Figure 2 Appearance of lateral spreading of gel ink on A4 paper after immersion for three days in neutral tap water

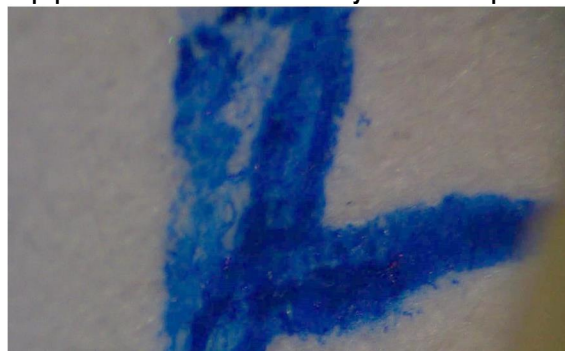


Figure 3 Transfer of gel ink on facing paper immersed in neutral tap water after one week



Figure 4 Starting of color change and the disappearance of gel ink after immersion for fifteen days in tap water

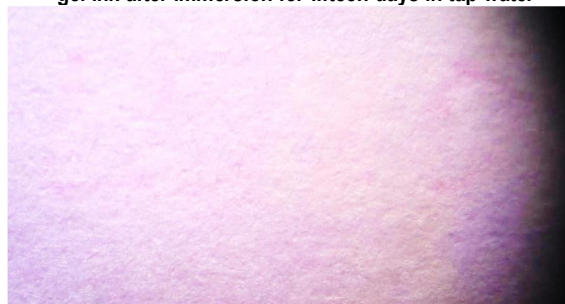
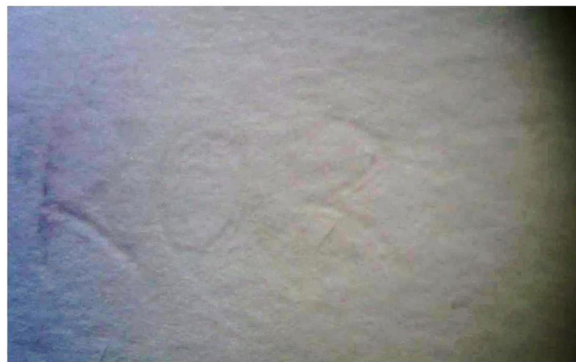


Figure 5 Lighter indentations left by gel pen after total disappearance of gel ink immersed for one month in neutral in tap water



Figure 6 Heavier indentations left by gel pen after total disappearance of gel ink immersed for one month in neutral in tap water



Gel pen writings in alkaline medium at different periods of time:

The results of gel pen writings immersed in alkaline medium, i.e. sodium hydroxide solution after one week, fifteen days and one month were interpreted (**Table 4**). It was observed from the results that no phenomena of lateral spreading of blue gel inks, fading of ink color, change of gel ink color, transfer of ink on facing paper or subsequent papers was present on both bond paper & A4 size printing paper in alkaline medium in any of brand gel pen after one week and fifteen days. Similarly, no effect was seen on the texture of bond paper and A4 printing paper after soaking them in alkaline medium for one week and fifteen days. Whereas, the characteristics of lateral spreading of blue gel inks, fading of gel ink color, change of gel ink color to purple and pink, transfer of ink on facing paper started appearing in gel ink writings written on both bond paper & A4 size printing paper after fifteen days to until one month. (**Figure 7-8**).

Figure 7 Fading of ink on bond paper after immersion after fifteen days in the alkaline NaOH medium

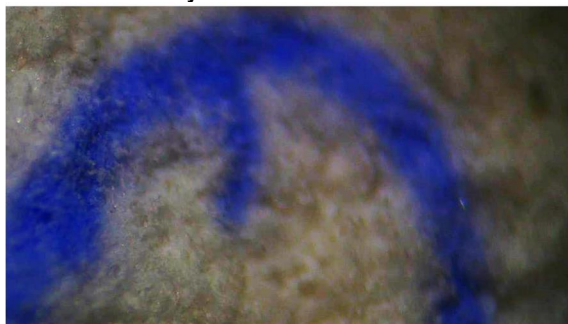


Figure 8 Fading of gel ink on bond paper after immersion for one month in the alkaline NaOH medium



Whereas, after fifteen days to one month, there was the appearance of wrinkles on paper surface that damaged the indentations left by the gel pens on paper surface (**Figure 9**). The wrinkles on the paper surface in alkaline medium did not help in restoring any type of content present on the paper surface, whether written with less pen pressure or heavier pen pressure. So, the different phenomena such as color change of ink, feathering of ink, spreading of ink around the letter, fading of ink color and appearance of wrinkles on paper surface were apparent after long immersing the gel ink writings in alkaline medium.

Figure 9 Appearance of wrinkles on the paper soaked in alkaline NaOH medium after twenty two days



Deciphering of the disappeared content under UV light and stereo microscope Under UV light:

The factor that was taken into account to decipher the writings or content is the fluorescence of the ink when they are exposed to UV radiations. It was seen that no gel pen ink produced fluorescence during exposure to UV light where the ink color totally disappeared in neutral medium.

Under Stereomicroscope:

Another feature that was employed for deciphering the disappeared content was the examination of indentations left by pen on the paper where the ink disappeared. It was noted that analysis of indentations with oblique light at the angle of approximately 60-65° under the stereo microscope revealed the content present on the paper surface. The indentations made with heavy pen pressure were more easily deciphered than the lighter indentations.

In the similar way, the blind samples were analyzed for the estimation of soaking time period of gel pen writings in different medium prepared on two different papers from the appearance of different phenomena. 100% accuracy was achieved in the estimation of time periods from the presence of different phenomena in gel pen writings on different papers at different time periods as the results were matched with the keys preserved. The content was restored only in cases where indentations were made with heavy pen pressure than the lighter indentations.

Conclusion:

It is concluded from the study that research project on the gel pen writings soaked in different nature of liquid medium prepared on two different natures of papers generated very encouraging and reliable results. The results observed in the study can be successfully utilized used in forensic evaluations of soaked gel pen writings. The present study is limited to one month only which can be extended to more time period and other writing or printed materials can be explored with a similar study.

Conflict of interest: None

Financial Assistance: None

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