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REVIEW ARTICLE

Advancements in Potential Preservation and Decipherment Techniques of Charred Documents

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ABSTRACT

Documents have played a crucial part in our day-to-day life for ages. Documents contain vital information which can have evidentiary value that can link a criminal to a crime. Sometimes, such documents get destroyed either intentionally or accidentally by means of fire, water, moisture and humidity, dyes and paints, etc. Many a times, criminals try to destroy the valuable documents by setting them on fire in order to hide their criminal activity having wrong intention. Charred document is one such case where the documents under excessive heat become carbonized, brittle and fragile. The most perplexing problem faced in the area of arson investigation is the handling and preservation of charred documents which ultimately render the decipherment of contents written on it. This is due to the obvious reason, that is, its extreme fragile and brittle nature. Researches have also pointed towards this huge challenge for questioned document examiners to potentially preserve the charred documents for further investigation. Hence, the present paper aims to highlight the ancient and the recent advanced preservation and decipherment techniques of charred documents to summarize it with their pros and cons, so that the need to enhance and develop a better new technique of preservation can be looked into.

KEYWORDS | charred documents, decipherment, qd, polyvinyl acetate

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INTRODUCTION

Questioned document (QD) is a document whose legitimacy is questionable. Hence, the name Questioned document. Most often, valuable documents are ruined by fire and other means in order to cover up unlawful act. "Whether accidental or deliberate, fires have a devastating effect on paper or other writing materials."[1] Gases such as CO_2, CO, nitric oxide etc., and airborne particles like organic matter, soot come out of fire and causes damage to the material. Charred documents are one such class of QDs that become black and extremely fragile by the action of fire, extreme heat or smoke.

Charred documents are generally made up of paper (cellulosic fibers), obtained from wood or similar sources. In arson or other fire investigation, these documents are unlawfully linked to some or the other kind of crimes ranging from fraud and ransom, robbery to anonymous letters, extortion, phony, insurance and financial matters, even suicide and murder.[2,3] Written or printed documents will be severely damaged through fire, smoke or soot. The content of the document like, what was originally written, may provide some clue to who wrote it.

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Burning of document is one of the most common ways of destroying evidence, and in case of documents being deliberately burnt, many people think that as soon as the proof of their guilt has reduced to ashes, it cannot be retrieved. Although most of the paper that is set on fire, there are still chances Where a number of other factors like temperature, atmospheric condition, storage area, paper quality etc., come into play during the burning which may prevent the document from getting completely burnt to ashes. Thus, it is possible for paper to be not completely burnt into ashes, Rather it is burnt to a point of becoming black, making the writing illegible to someone looking at it with the unaided eye.[4]

Since ages in the field of QD and in cases of arson, one of the most confounding problems lies in the handling and preservation of charred documents, which ultimately render their decipherment process. Forensic document examiners apply range of techniques and make sufficient use of technology-based equipment to conduct various analysis on documents. However, its blackened, carbonised state renders ordinary restorative processes ineffective.[5] A completely new approach to a unique problem is thus needed. Therefore, this paper seeks to highlight and summarize the existing techniques and methods for handling, preservation and decipherment of charred documents, with their relative pros and cons, and to put forth the current advanced methods which gave satisfactory results in many cases, in order to guide QD examiner to benefit from the potential and appropriate technique of analysis.

Before getting into the techniques, let us look into certain important aspects with regard to this challenge, since the charring process is dependent on several factors and thus on the technique used for decipherment.[6] These factors are as follows:

Factors During Burning of Documents:

Place of Storage: Sometimes it is important to differentiate between slightly and completely charred documents. More often, slightly charred documents can be read with the naked eye. Moreover, charring that lead from burning in a closed storage area (e.g., in a box or metal cabinet) have been observed to create different effects than those produced under conditions of complete oxidation, i.e., in open air. Therefore, area in which document was placed and burnt affects the level of charring and its analysis.

Type of Flame and Temperature: The documents when burned in an open flame obeys different pace and unstructured path than those burned in a limited flame and temperature. This is due to the availability of oxygen at different portion of documents which makes each component of document to burn at its own pace. During charring, paper goes through various stages at different temperature turning the paper/document from light brown to black and finally gray ash to white ash.

Type and Quality of Paper and Ink: Another important factor which lacks attention, is the type of paper and ink used. Variety of papers and inks are available depending on the construction, loading and use. Those ink made up of mineral pigments do not get completely charred. On the contrary, printing ink (based on dye solutions made from non-volatile solvents) after the solvent evaporates, leave more dyes that are more susceptible to get charred than mineral pigment and can be completely destroyed. Writing inks usually contain iron, which is often left as an iron oxide deposit and is less visible. Therefore, the color reaction of the iron metal can be used to understand it.

Handling and Preservation of Charred Documents

Field Investigation: The fragile pieces of charred documents must be handled with utmost care. Some pieces of partly charred documents may be less vulnerable to get damaged, than others which have undergone extreme heat, may fall off even with the least interference. The fragility, sensitivity and pliable nature of charred documents merely depends upon the type of paper and composition. The solution to the problem of un-needed breakage can be by treating all the charred documents with some preservative solution. Most important documents can be found in a cupboard, in sturdy boxes, or in safe places, or that one document burned on the stove, or other open surface may need to be deciphered.

David A. Black (1948) safely delivered two boxes of charred documents from the Philippines, following this procedure by incorporating a pack

of cotton wool between and sides of the charred documents, thus creating a layer of protection against damage. Very small damage was observed in such a case.[7]

In case where much of the documents get burnt, then the best way is to take out the whole charred mass by gliding a thin metal wire or pie tin under the mass and transport them to the laboratory by carefully placing them in a container. If the charred bundles are tightly bound, each piled parcel should be taken out manually with the help of fingers and put separately. For single charred documents, a flat tweezers are used to carefully pick each document and placed in separate containers. All these processes must be carried out in an air-free condition to avoid the loss of any fragment.

Laboratory Treatment

In laboratory, the separation and segregation of the documents take place. It is of utmost importance that these charred documents are separated by causing least damage to each document; and this is not an easy part, because the documents are found in a folded or crumpled pieces of tightly adhered paper.[8] However, in cases where the documents get charred in a mass, it is possible to separate the paper individually without the use of solvents, or other chemical methods as was seen in John F. Tyrell's case using the manual method for separating the documents kept in a solid box.[9]

There are a number of other proposed theories for separating individual charred documents by several researchers:

- C. A. Mitchell (1922) attorneys immersing the mass of charred documents in hot water (40 0 C).[10]
- Water-bath with dilute glycerine was recommended which not only separates the documents, but also makes them softer to flatten.
- By keeping the charred documents in a damp/ humidified chamber for sometimes may aid to retain its moisture which can then be stabilized by some plasticizer.
- Immersion in alcohol, a process designed to break the bond between the pieces, thus allowing them to separate.[6]

Moreover, different authors also recommended several other tested solutions for this purpose, and the following were found useful by them:

- 5% aqueous solution of Sodium dodecyl sulphate (SDS) also known as Sodium lauryl sulphate (SLS), (NaC12H25SO4).
- Glycerine, distilled water, methanol (3:20:5 parts respectively) and 2% solution of sodium hydroxide, formalin and boric acid. The prepared solution is applied with pipette on the charred paper. Once the solution gets soaked before getting dried, the individual paper can be separated with a small spatula.[6]

Earlier, before the solution was tried upon. Black in Philippines handled the charred document by using standard 18x20 ferro-type plates to act as a supporting stage to congregate and safely place the charred document during the long decipherment process.[7] This was found to be time consuming and tedious process to follow.

Dr. Hans Gross (1906), also described a method for the purpose of charred document examination in a flat state.[11] His method suggested to firstly soften the fragments of charred documents in water, damp air or steam due to the fact that documents are hygroscopic in nature. Lastly, the drying process includes the usage of "gum Arabic" or "celluloid-acetone" type, while Dr. Gross principally used tracing paper, but a glass can provide a firmer and more transparent surface than tracing paper,[12] he concluded.

Stabilization Techniques of Charred Documents

NEATAN Treatment

Stabilization of charred document needs to be done in order to carefully handle the paper during decipherment since more than partly charred paper may be so fragile that it cannot be examined. When neaten new, developed by Merk, is applied over paper using eyedropper, it was possible to transfer to flexible sheets without much change in appearance and then the sheets could be handled relatively with ease.[8]

Lamination: Another way to preserve and make the charred paper stabilize is the lamination. This allows the papers to become flat, without breaking under the pressure of the heated rollers which makes it more readable. It also shields from any additional damage and makes handy to easily move and photograph. Moreover, it makes the

charred documents more impervious than the original paper.[8]

Plasticizers Treatment: Cellulose acetate solution in acetone or other like the 3% Polyvinyl acetate (PVA) solution in acetone (3 gms. PVA in 100 ml. acetone) are the plasticizer applied by spraying or glass rod. But there are various pros and cons of every plasticizer materials used. The cellulose acetate is a good plasticizer but it cannot be used as regular material here since it cannot be sprayed well which is one of the main characteristics of the stabilizing agents.

Before the application of polyvinyl acetate, the glass surface should be polished with 1% solution of silicon type water repellent substance in petroleum-ether. Due to this silicon type water repellent, the charred document does not get bound to the glass on application of the polyvinyl acetate. Thus, the document can be lifted with ease after being stabilized by stabilizing agent. The polyvinyl acetate solution is made in acetone gets evaporated after application.[13]

Gum acacia is another material which can be used for the purpose of stabilization of the charred document but it has a bad property of sticking to the glass on which the charred document is placed. Moreover, the spraying property of the gum acacia is also not good.

Methyl methacrylate (C5H8O2), commonly known as 40% Bed acryl, also serve this purpose and is applied by spraying.[14]

Decipherment Techniques of Charred Documents

The composition of writing inks, prior to the 20th century, had traces of metals such as iron and copper as a tagging material. Therefore, for deciphering the contents written with such inks, different researchers applied various techniques.[15] These are briefly summarized as follows:

- Blagden (1787), made use of 'potassium ferrocyanide' (K4Fe (CN)6), commonly known as Prussiate of Potash, to assess the nature of ink on ancient parchment.
- Davy (1821), discovered the 'Colour test method' wherein written content was deciphered by the use of potassium ferrocyanide.
- Davis (1922), developed the 'Photographic plate development method' to decipher content on the charred document.
- Mitchell (1925) used a 'Calcinated method' wherein the printed, typewritten contents and those written with pencil or some special inks, were deciphered by further burning the documents.
- Mitchell (1935), made use of 'IR light' incorporating filters and plates for making a contrast between the content and background, hence deciphering them.
- Radley and Grant (1940), used 'Fluorescent oil' and 'UV light' to decipher content of printed, photocopied, typescript as well as carbon-copied.
- Taylor and Walls (1941), advanced 'Chloral hydrate method' for printed and typescript contents.
- Gones (1941), used 'Photographic method' to improve the visibility of manually written content of charred document.
- Murray (1941), deciphered letter pressed printed documents as well as ink having metal content as a tagging material using 5% solution of 'Silver nitrate' (AgNO3).
- Black (1948), deciphered charred printed and typescripts using 'Alcohol-glycerine method'.

To categorize charred documents decipherment techniques, they have been classified in two broad categories: (I) Photographic, those processes that are completely based on photographic techniques, and (II) Visual, those processes which require the documents to at first visually examined, treated with some medium (if required) and then the contents are visually tabulated either under different lighting condition or through any specific instrument and finally photographically reproduced.

Photographic Techniques

Contact Process: This process was based on the fact that in the absence of light, some emitting gases and vapors would fog or make the emulsion of a photographic plate or film cloudy. Based on this principle, Davis (1922) of the "Bureau of Standards" conducted experiments16 wherein he was able to develop a latent image on photographic emulsion by making use of gases emitting from freshly burnt charred documents.[17]

Later, John F. Tyrrell (1939) by using the above principle and applying his own technique, was

able to decipher 85% of the charred documents burnt in a container producing a series of contact photographs. To obtain a more contrast of the image, a strong developer "Eastman Dl-type" was used, which produced the most satisfactory results.[9]

Furthermore, Tyrrell made little enhancement in his process. Prior to contact process, he exposed numerous pieces of charred document under UV radiation for long-term duration. The results obtained by this treatment was found to be far better than those obtained without it, particularly when the fragments were older and less effective to photographically. However, this whole process took larger care and time.

Filter Photography

Filter photography overcomes two of the cons of contact process, (i) time duration, and (ii) weaker photographic-activity of charred fragments i.e., the contrast. The filter photography make use of a "Wratten #48" deep blue filter in combination with commercial film. The function of the filter is unknown, but it seems to highlight the difference in the "actinic power" of the charred document compared to those areas of the paper on which printing ink was deposited, hence creating the difference in contrast with that of background.

Infrared (IR) Photography

Infrared photography is one of the highly utilized decipherment techniques. Though, it does not prove to provide much satisfactory results in many cases of charred documents decipherment. The development of an infrared viewer helped to provide better results, which resulted in probable success of IR photography.[18]

The technique of IR photography uses deep red 'Wratten #87' filter in conjunction with 'Eastman IR plates', and 'Eastman DK 50 is used as a developer, developed by Dr. Bendikson (1936). Incandescent light source can provide a good lighting for IR photography. The 'Wratten F' red filter was used to focus but later, 87-infrared filter took place of Wratten F filter. This method gave quite amazing outcome with inks of typescript, pencil, and dense iron-gall ink.[17]

Visual Decipherment Techniques

Reflectivity Technique: This is the one of the simplest yet most versatile decipherment procedures in which burnt documents are examined under controlled light source directed at various angles relative to the paper surface. This technique is applied by placing the charred documents between two suitable size glass plates and cautiously bind them together with tape after pressing plates from both sides. Setup is then analyzed under oblique lighting. "900 flare-type" lighting do not fulfill the required need, because of the reflective property of glass plates. For decipherment of content, a photographic record, only a single glass plate fulfils the setup by fixing the charred pieces over glass plate by means of some transparent adhesive20. This technique depends to a large extent on level of charring as well as the density of the ink or pencil made on the document.

Potassium Ferrocyanide Application: This method was developed by the fact and phenomena that even when the paper documents get charred, the residues of iron base ink retain in the paper fibers, thus can be made to react with come solution to produce a colour change. For this purpose, potassium ferrocyanide acidified with 2% solution of HCL (hydrochloric acid) was spread on the charred document with the help of a dropper or soft camel hair brush.

Davis (1922) reported an alternative to this procedure by using a portion of blotting paper immersed in potassium ferrocyanide16. However, later this technique with some charred documents gave disappointing results as the colour did not turn to blue rather it changed to deep pink and the cause of this was unknown whether the result did not appear because of non-presence of iron residue in the paper after getting charred or due to some other unknown factor.

Silver Nitrate Technique: The Superintendent Cherrill (1941) of Scotland Yard discovered this method. According to his procedure, "charred document is first allowed to rest on a glass plate in support of a standard pan placed at the bottom. Then a 5% aqueous solution of silver nitrate is poured on to it and at the top of it, a second plate is positioned. It takes 3 hours to the contents to get visible as a dark black writing against the lighter grey background. A lower concentration of this solution for longer duration is recommended in case when original writing appears to be faint. By wetting the pieces of charred document several

times in water and subsequently drying may result in obtaining a permanent image"20. For future record, image is instantly photographed. This technique was found fruitful for printed documents than for most ink and typescripts.

Chloral Hydrate Treatment: This method was developed by H. J. Walls and W. D. Taylor (1942) during World War II19. The active solution for this treatment is 25% chloral hydrate in alcohol. Applying this solution on both side of the charred sample using soft camel hair brush or immersing in the solution can serve best ways of application. The sample is then dried either in an oven at 600C or hot plate by placing it on heat resistant glass. After it gets dry, the process of immersion-drying continues several times and, on last immersion, a 10% glycerin solution is also added to prepared solution of chloral hydrate, then finally dried. The contents of charred documents become visible by the gradual accumulation of chloral hydrate crystals. Certain typewriting inks, iron gall inks, and printing ink show better legibility by undergo through this process, while washable aniline dye does not.

According to Grant's report (1941), this method gives more successful result with heavily loaded/higher grade paper than that of normal paper, thus concluded that test depends upon the incomplete combustion of the cellulose as in case of heavily loaded papers.[20]

4.2.5 Fluorescence in Ultraviolet Light: Another method of decipherment was developed by Julius Grant (1941). According to him, "the charred document when visualized under filtered UV light, before and after applying a solution of equivalent proportion of pale mineral oil and petroleum spirits, followed by drying, can observe a difference in florescence between written matter and paper background. The method depends on the composition and how old the ink is, paper type, and the level of charring. Quiet a number of samples were examined by this method, but in an instance, it failed to produce remarkable result in the case when the oil ink and paper absorbed oil equally, therefore not producing clear contrast"20. The technique gave positive result with printed, type written, even duplicate and carbon copy but they failed to give results with the ordinary pencil and old document.

Alcohol-Glycerin Immersion Technique: Black (1948) devised this simple, rapid and non-destructive method of decipherment by taking advantage of the phenomena that, "when the charred documents are immersed in certain liquids, a contrast between the writing and background at different portion of the charred document could be observed due to varied reflectivity. Therefore, when the American forces recaptured Manila, he devised a method for treating hundreds of valuable charred documents with alcohol-glycerin-water (5:3:2). About 90% of the contents of two boxes were possibly deciphered by this technique7. The readings were taken at varied stages of immersion in the solution. Each component used in this method has its own significance; alcohol act as wetting agent, whereas glycerin helps in partial drying of the burnt document by restoring some part of water before and after drying12. Moreover, this treatment with alcohol-glycerin-water does not permanently change the appearance of the charred fragment which give the additional success to this technique.

Ammonia Treatment

Tidke (2019) conducted an experiment, wherein the decipherment was carried out with alcohol treatment by first placing the charred documents in a fuming chamber containing 50ml ammonia for about 12 hours. This way, no writings could be deciphered. Thereafter, alternatively the ammonia solution was sprayed over the charred samples using spray pump. This way, the results were quite satisfactory and writings were clearly visible. As the ammonia solution readily evaporates, hence the deciphered contents were immediately photographed under visible light before the contents gets vanished.[15]

With growing advancement and development in technology, a wide range of optical instruments or systems are being developed to enhance the process of document analysis and decipherment. These are as follows:

Video Spectral Comparator (VSC): This instrument is the most commonly used, recent technology based optical instrument which utilizes a combination of Alternate Light Sources (ALS) under varied wavelength and high-quality camera to reveal the most desired features of document. Andrew (2016) conducted a study,

where the charred samples were analyzed under VSC using ALS and co-axial lighting at different wavelength of UV and IR radiations i.e., ranging from 300-900 nm.[4]

Another study by Moorthy (2016) revealed that "VSC 6000 could provide appreciable contrast between the background and writing, thus providing a safe and reliable alternative tool for deciphering the contents of charred documents when visualized under 'flood-light beam' and 'spot beam' setting of VSC". The samples were viewed at varied wavelengths, such as 645, 725 and 780 nm. Using a piece of equipment that is somewhat new to the field of forensics, the VSC, to show that ALS can be used for these purposes is good option to opt for minimal damage to the fragile documents.[3,18]

Projectina Inspec-8: This compact instrument, Inspec-8 was developed by Projectina for analyzing and detecting the alterations in documents and for verification of security documents such as driving license, bank notes, visa, passport, etc. It incorporates 8 integrated lighting sources: UV-IR for anti-stoke inks, blue-light 380-570 nm, LED (light emitting diode) for the OVD (optical variable device), Camera barrier filter, Excitation filter, Digital Video Interface (DVI) monitor to view live image, live camera port and USB remote control. In a study by Sharma et al. (2020), the security features of documents were analyzed by Projectina Inspec-8 under varied light sources before and after charring the documents. He analyzed those samples under UV and IR radiation at varied wavelengths for deciphering the charred contents21 and observed that some security features of the documents could be revealed by colour change while other does not. However, the stamp paper gave successful outcome as the details of it was visible under UV-IR light even after charring.

RESULT AND DISCUSSION

Based on the chronological study and development in the area of handling, preservation and decipherment techniques developed for the charred documents during the ancient times till today, it has been observed that not all techniques can be expected to be suitable for all types of charred documents because of several affecting factors as well as the type and composition of ink and paper. All the above techniques discussed provided successful results to a greater extent relating to the specific problem. However, some fails to do so because of one or the other factor. The most recent technology used today for decipherment such as, VSC and Projectina Inspec-8 are the potential techniques that allows a quick and thorough analysis of the documents, without causing any specific damage to the sample. However, the investigator and document examiner may realize the necessity to try several of the above techniques before choosing the one that will achieve a successful result.

CONCLUSION

By reviewing from most ancient to recent techniques followed in recent times for charred document examination, it can be concluded that there is a limitation of each technique when compared to the other. Therefore, with growing technology and development, it is the need of the hour to either differentiate the techniques based on the composition and type of inks, paper, documents, and other factors that render the process. The selective method of analysis should be fast, easy to use, cheap, handy, non-destructive, and provide result with higher accuracy. Hence, there is an urgent need to develop selective scientific techniques for the decipherment of destroyed documents which occupies the major areas in QD so that the investigators can reveal facts and findings more accurately and in a speedy manner with a less chances of error. IJFMP

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