

■ REVIEW ARTICLE

A Systematic Review on Restoration of Obliterated Serial Codes from Iron and Steel Surface by Chemical Etching Process

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ABSTRACT

Serial numbers are mostly observed on the surfaces of iron, steel and metallic-alloys. Such kind of serial numbers in the form of alpha-numerical codes are obliterated to conceal the identity of the materials by various methods. The decoding or restoration of erased numbers from the surfaces is one of the main challenges in criminal investigation and quite difficult to restore on tougher obliterations. However, deciphering the obliterated unique codes using chemical reagents (chemical etching) has been proved of its ability to deciphering the mechanical erasures.

Here in this study we discuss about the ability and effect of particular chemical reagent on the iron, steel and aluminum-alloy surfaces. Such types of metallic surfaces have been proved of various applications in chassis of motor vehicles, railway iron rods, engine parts etc. The chemical reagent's properties on obliterated metal surfaces were studied using different types of Fry's reagent (Table1-4). Hence this study may have application relevance in criminal investigations involving erasures of identity serial number. **KEY MESSAGES:** The author(s) tried to include scientific explanation restoring serial numbers on iron and steel surface using chemical etching process and some challenges.

KEYWORDS | obliterations, chemical etching, erasures, alpha-numerical codes

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INTRODUCTION

SERIAL NUMBERS ARE ALPHA-NUMERICS with or without logo or unique codes which are cast, engraved or stamped on the metal surfaces which are used for the purpose of identification.¹ These alpha-numerical numbers are sometimes erased from the surface to conceal its identity. Restoration of these codes plays a vital role in providing crucial information as evidence in criminal investigation. Unfortunately, erased marks are impossible to restore. Meanwhile, the other two types of markings may be restored using appropriate chemical etching and other procedures.^{1,2,5} The restoration process will also be affected by the nature or method of

obliteration i.e. obliteration using drilling² and welding.³ There are different techniques that are used by Forensic experts to restore erased serial numbers. The adoption of particular technique is determined by the type of surface where serial numbers are obliterated.⁵ Nowadays, forensic experts encounter different challenges involving different metal-alloys in motor vehicle serial number on the chassis and varies from vehicle to vehicle and also in the breech end of firearms. Automobile's engine and chassis have been constructed or preferred with metallic alloys rather than steel to reduce mass and increase metallic strength.¹⁴ Nowadays improvement in technologies made

serial numbering more advanced and engraved by pin stamping and laser etching methods. Innovation of Fry's reagent for the deciphering the obliterated number from steel surface made a huge impact in investigation of crime involving erasures of serial number.^{6,8} Some years back Graham and Jennifer¹ have reported successful restoration of erased identification number on steel surface by Fry's chemical reagent and also study stated that obliteration caused due to over-stamping can be regained by polishing and chemical etching. Better results have been showed by Fry's chemical reagent made by 90g crystalline cupric chloride, Hydrochloric acid (Concentrated HCl) 120 ml, 100 ml of water and also alternate solution of 80 ml hydrochloric acid, 60 ml water, 12.9g of copper chloride and 50 ml of alcohol successfully restored marks erased, it presents itself as the responsive reagent for steel surface. Zaili *et al.*, studied the effect of Fry's reagent to restore obliterated marks on steel surface.²

METHOD

Search Action

An organized search was conducted for articles related to the particular topic includes Restoration of erased number, chemical etching process in *PubMed*, *Google Scholar*, *Web of Sciences* and *Research Gate*. A comprehensive search methodology was used to put together all the criteria included in the review and beside the point are excluded. Preliminary investigation in *Google Scholar* gave auxiliary unique results with respect to particular topic; therefore, the investigation for journal was restricted to *PubMed*, *Web of Science* and *Research Gate*. Detailed strategy is mentioned in (Appendix 1)

Study Selection

The search results from the database gave back 547 articles from *PubMed*. A supplementary 36 journal reports and articles were received from *Web of science* and 18 from *Research Gate*, relevant to the study criteria. These contents were analyzed independently. 601 articles were included for the study, and 550 were removed

SL. NO	METHOD	EXPLANATION
1	Filing or grinding	The surface is removed by means of grinder
2	Peening	The superficial layer is hammered to conceal number
3	Over stamping	New serial number is stamped or engraved over old serial number
4	Centre punching	Obliteration using pointed punch like nailing
5	Substitution	The serial number is substituted with another by means of pasting
6	Drilling	Removing content and surface with welding machine
7	Welding	Heating with oxy-acetylene welder
8	Sometimes an original appearance would be given to a previous erased number surface	

Table 1: Describing the method of obliteration

due to their insignificance to the pertained topic. The complete texts of 51 articles were scrutinized for inclusion, and 34 were rejected in final scrutiny, by reason of reiteration of information. 16 journal reports from the initial search action were used in the study selection.

Protocols of Caring and Analysis of Evidence

Preliminary examination

The method of obliteration may affect the restoration but the degree of destruction caused affects the most. Before restoration using chemical etching process preliminary examination is mandatory using hand magnifier to see whether physical removal has been found place at all. The surface has to be clean with methanol or acetone to remove debris and dirt to avail better visualization and to avoid chemical hindrance during chemical etching process.^{1,2,4} The disturbance in the pattern of serial number is suspected of erasure. Identification of erasure and appearance of serial number left is important as well as identifying whether it has been repaired after erasure. The surface may also examine using alternate light source to obtain vital information.⁷

Preparation of surface

The preparation of surface for chemical itching process is much crucial for restoration of obliterated number. Cleaning of surfaces using benzene or acetone is significant to remove the dirt solvents such as chloroform also used. This procedure is commonly preceded with emery cloth or cotton. Sometimes polishing is avoided as the surface is smoothened with sand paper.^{4,7}

Chemical etching

SOLUTION 1	
Crystalline Cupric Chloride	90gms.
Concentrated HCl	120ml
Distilled Water	100ml
Solution 2	
Nitric Acid	15%

Table 1: Sol A (Fry's Regent 1)

SOLUTION 1	
Crystalline Cupric Chloride	45gms.
Concentrated HCl	180ml
Distilled Water	100ml
Solution 2	
Nitric Acid	15%

Table 2: Sol B (Fry's Regent 2)

SOLUTION 1	
Crystalline cupric chloride	12.9gms.
Concentrated HCl	80ml
Distilled Water	60ml
Ethanol	50ml
Solution 2	
Nitric acid	15%

Table 3: Sol C (Fry's Regent 3)

SOLUTION	
Copper Sulphate	5gms.
Concentrated HCl	60ml
Ammonium Hydroxide	30ml
Water	60ml

Table 4: Sol D (Fry's Regent 1)

Chemical is selected according to the surface identified. Fry's reagent is known to be very effective on steel surfaces. The methodology includes cotton swabs or emery cloth dipped in the chemical solution. The chemical reagents are very specific for the surface material.⁹ The focused chemical reagents are mentioned below in table format (Table 1- 4).

RESULTS AND DISCUSSION

The study shows effective reagents on different surfaces and conducted. The most commonly used restoration technique is Chemical etching process and found very triumphant. The chemical reagent selected was Fry's reagent of three types (Table 1- 3) for steel and cast-iron surface where obliterations were observed. Use

SOLUTION	
Nitric acid (65-68 %)	10ml
Hydrogen Fluoride (40%)	-
Acetic acid (99%)	15ml
Acetone	-

Table 5: Sol E (Fry's Regent 1)

SOLUTION	
Nitric acid (65-68 %)	10ml
Hydrogen Fluoride (40%)	0.5ml
Acetic acid (99%)	10ml
Acetone	-

Table 6: Sol F (Fry's Regent 1)

SOLUTION	
Nitric acid (65-68 %)	10ml
Hydrogen Fluoride (40%)	0.5ml
Acetic acid (99%)	-
Acetone	10

Table 7: Sol G (Fry's Regent 1)

SURFACE UNDER CONSIDERATION

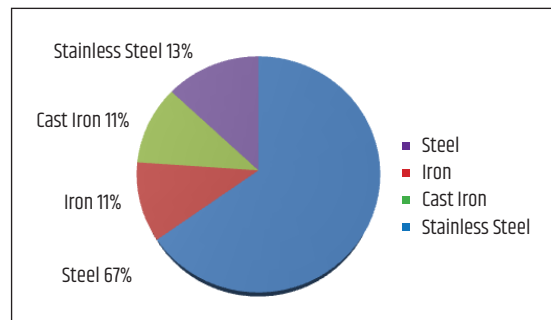


Figure 2: The surfaces considered for restoration in the study under consideration

of reagent 5g copper sulphate CuSO_4 , 60 ml hydrochloric acid, 30 ml ammonium hydroxide (NH_3OH), 60 ml H_2O (Table 4) found successful on steel surface but the same time failed to decipher the serial number on cast iron engine block of car engine. The chemical reagents solution E, solution F, solution G (Table 5-7) found very successful to re-establish the identity by means of recovering serial number within 6 minutes on motorcycle engine shell and fraction of minutes on car frame.⁹ All the Fry's reagents were given moderate contrast on cast iron surface whereas faint and transient on steel surface.^{1,2} The solutions considered in restoration is defined in Table 1-7 (Sol A-G) for the surfaces described in the study (fig 2). Automobile theft investigators often deals

with obliterated serial numbers and without finding the serial number the investigation may not be able to lead. Chemical etching process have been proved the capability of restoration in such cases. The development must be observed closely and may not be available for long. Hence, the development is also known as magical development in midst of forensic professional.^{14,15}

Preparation of chemical etching solution is described in MA Zalli *et al.*, study. The preparation scheme has distinct impact on restoring erased number. At the same time factors such as type of obliteration, depth of obliteration, choosing appropriate chemical influence in restoration and time. The restoration is not an instant process, the author recorded the minimum time for deciphering on various depth of obliteration is found to be varying from 10-20 minutes to 35-60 minutes.¹⁶ The surfaces of chassis are developing nowadays. Light weight and more strength alloys are developed for the vehicles. Automobiles work in CNG, hydrogen and electricity may use different alloys for its chassis and engine. The developed chemical agents may not be working for restoration of numbers on such alloys. Thus, it is recommended for research in newly arrived vehicle's alloys for restoration.

CONCLUSION

From the studies, it is clear that chemical etching process especially Fry's reagent as well as reagents mentioned in table 5-7 on steel surface made significant impact on restoration of obliterated number. Here we conclude that

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the study on different metallic surfaces using chemical reagent etching's having a greater forensic significance in the restoration of serial number on chassis, automobile engine, metallic pipes etc that might lead to solve the crime. In spite of destructive nature of the chemical etching process it gives lead to decipher the concealed sequence number. **IJFMP**

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