

Origin and Cause of Fire in a Medium Duty Truck: A Forensic Approach



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Submission: September 27, 2017; Published: October 12, 2017

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Abstract

Determination of origin and cause of fire in motor vehicle fire cases is a very challenging task for forensic investigators. The forensic investigation involves physical inspection of the burnt vehicle to locating the origin of fire by analyzing fire dynamics and fire pattern. However the chemical testing conforms the cause of fire as accidental or intentional. In this study medium duty truck of Bharat Benz 1214-R was examined to determine the origin and the cause of fire. The origin of fire was located by analyzing the V-pattern of fire. However, nature and cause was determined by using gas chromatography mass spectroscopy and microscopy.

Keywords: Forensic investigation; Vehicle fire; Accidental fire; Short circuit; Intentional fire

Introduction

Motor vehicle fire (auto fire) is an uncontrolled intense burning of vehicle resulting heat, light and reaction products [1,2]. The manner in which a fire is initiated and finally spread depends on many complex factors as vehicle itself is packed with highly flammable materials [3,4]. The motor vehicle systems associated with ignition are electrical, fuel, engine and exhaust [5,6]. The failure in one of the systems results fire in motor vehicles [7]. Forensic investigation involves the study of behaviour of fire dynamics, damage pattern and accelerants (ignitable liquid residues) to determine the nature, origin and cause of fire [8]. The scientific methodology employed by forensic investigator helps in distinguishing accidental and intentional (arson) motor vehicle fires [9]. The intentionally set motor vehicle fires are disguised by arsonist to mislead the insurance companies for false gains [10]. One of the case of auto fire of medium duty truck of Bharat Benz 1214-R received by the laboratory for determination of the origin and its cause. The truck was fully examined to determine the system involved in initiation of fire and its causative agents by forensic approach, which involves physical inspection of the vehicle to find the origin and other testing parameters for determination of the cause of fire.

Material and Methods

Chemicals

Diethyl ether (HPLC grade), 5% Nitric acid, Distilled water (HPLC grade) and Glassware (Borosil India).

Equipment's

GC-MS (7820A-5977E MSD Agilent), Digital Microscope U500X, Hand lens and Camera DSLR.

Physical Inspection and Sampling



Figure 1: Photograph of burnt medium duty truck of Bharat Benz 1214-R.

The physical inspection of the burnt medium duty truck of Bharat Benz 1214-R was conducted as per as NFPA 921:2008 to analyze the fire pattern and to locate origin of fire (Figure 1) [11]. The extent of damage in various systems of the truck helps to locate the origin [12]. The V fire pattern was observed near the battery and controlling box position suggested the origin of fire (Figure 2) [13]. The electrical wiring of the controlling box near the left chaises also showed the symptoms of short circuit

(Figure 3) [14]. Visible arc beads are observed in the wires of controlling box. One burnt wire and two debris samples were collected, packaged in air tight container for laboratory testing as per ASTM E 1188-11.

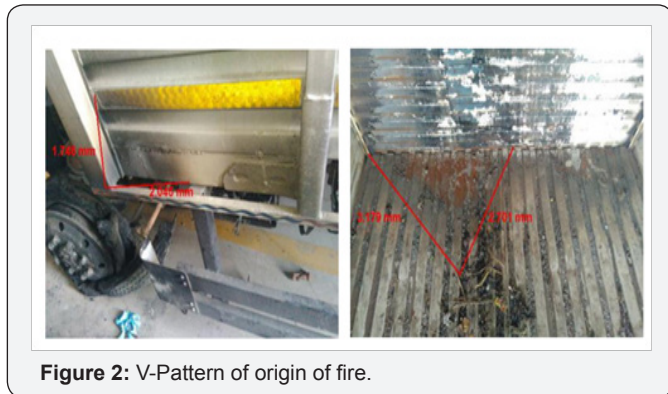


Figure 2: V-Pattern of origin of fire.



Figure 3: Visible arc beads.

Chemical Tests

The debris sample are analysed for the presence of accelerants (ignitable liquid residue) using gas chromatography and mass spectrometry series 7820A-5977E MSD Agilent. The samples were prepared using diethyl ether (HPLC grade) by solvent extraction. The tests were conducted as per as ASTM E 1386, ASTM E 1618-01 [15].

a) GC Conditions: split injection mode; HP ultra inert column (30mx250umx0.35um); injection port temperature 280°; carrier gas helium; flow rate 1ml/min ; column temperature 50° for 2 min then 10°/min to 300°for 30 min ; run-time 30 min.

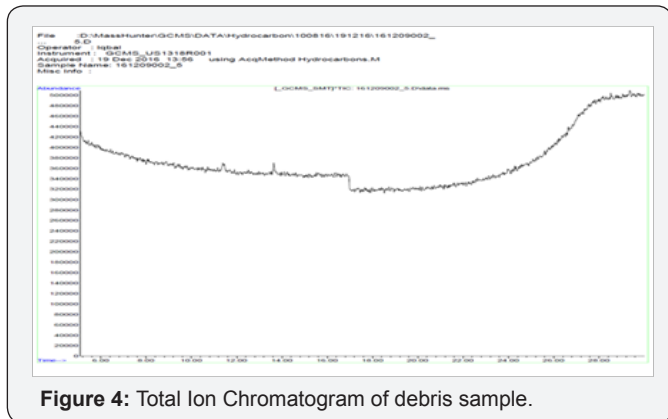


Figure 4: Total Ion Chromatogram of debris sample.

b) MS Conditions: scan mode 20-500 amu; IE ion source; solvent delay 5min; source temperature 230°; quad temperature 150°.NIST-MS library 2.0 used for interpretation of results. No accelerants (ignitable liquid residue) were detected in the debris samples (Figures 4 & 5).

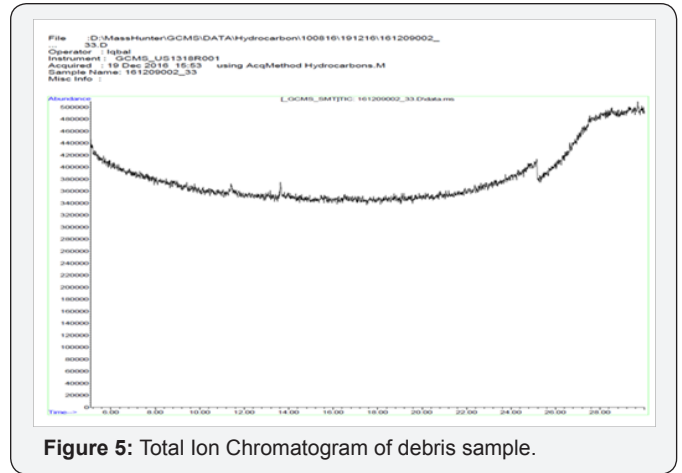


Figure 5: Total Ion Chromatogram of debris sample.

Microscopy



Figure 6: Arc beads caused due to short circuit.

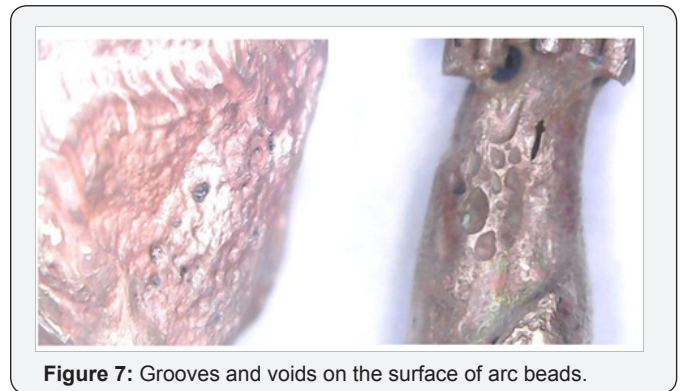


Figure 7: Grooves and voids on the surface of arc beads.

The burnt wire sample of the electrical system was visualized under digital microscope after washing with 5% Nitric acid followed by washing with distilled water [16]. The presence of arc beads in the burnt wire, also the presence of grooves & voids on its surface under microscopy indicating them as Cause Beads [17,18]. The Arc Beads (Cause Beads) are prominent in the burnt wires of the controlling box, hence conforms nature of fire as a short circuit (Figures 6 & 7).

Results and Discussion

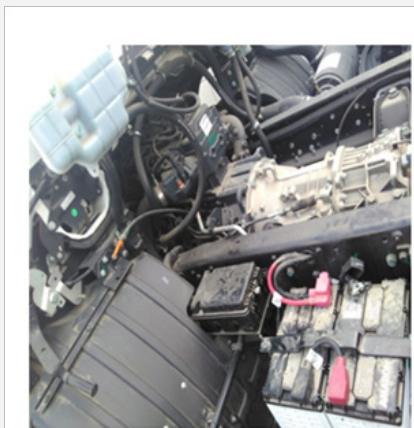


Figure 8: Exemplar photograph of controlling box near battery.



Figure 9: Controlling box area of medium duty truck Bharat Benz 1214-R.

Forensic investigations are carried out to determine the origin and cause of the fire as per as NFPA 921:2008. The identification of the V-pattern fire marks near the controlling box area revealed the origin of fire. The burnt wires at left chaises area showed visible arc beads which are further confirmed by microscopy. However, these arc beads are showing grooves and voids which are caused due to electrical arcing. The fire was generated in the electrical system as the controlling box is of plastic polymeric type, which helped to spread the fire (Figure 8). The electrical fire which initiated at controlling box spreads into whole cabin and in turn engulfs the whole vehicle. The accelerants (ignitable liquid residues) are not detected in debris samples and presence of arc beads confirms the nature of fire as accidental (electrical fire) caused by short-circuit (Figure 9) [19-22].

Conclusion

In this study the origin and cause of fire in medium duty truck of Bharat Benz 1214-R was determined by forensic approach. The origin of fire was at controlling box and cause was short circuit as arc beads were observed in wire samples, furthermore

the controlling box near the battery of the truck are made up of plastic polymer and the other polymeric material nearby enhance the fire. The nature of fire is accidental (electrical fire) as confirmed by microscopy which ruled out the possibility of intentionally set fire (arson).

Acknowledgment

Authors are very thankful to kuldeep dhangra, managing director and sushant gupta, director spectro analytical labs ltd for their support and advice.

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DOI: [10.19080/JFSCI.2017.05.555672](https://doi.org/10.19080/JFSCI.2017.05.555672)

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