

Case Report

Refrigerator Blast: A Rare Explosion Fatality

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Abstract

Death from the blast of refrigerators is a rare entity and the cause of such explosions was contaminated gas in the cooling units. Methyl chloride or chloromethane also called as R-40 is a hazardous chemical compound that is extremely flammable, which was widely used refrigerant but its usage has been discontinued because of its toxicity and flammability. This paper reports a rare incident of blowing up of the fridge while filling nitrogen gas in compressor; at a refrigerator-cum-air conditioner repair center. Two youngsters who were filling the nitrogen gas were killed on the spot following explosion. Investigation confirmed that the cause of the explosion was the contaminated gas in the cooling units, which is very unusual and it was identified as R-40. The impact of the blast was so severe that the fridge dismembered into smithereens, ceiling fan and window panes were shattered to pieces.

Key Words: Refrigerator, Explosion, Methyl Chloride /Chloromethane, Contamination of Gas

Introduction:

Explosions or blasts results in some pattern of injuries or sometimes it might result in death. Death or survival rate sometimes depends on the site of the explosion.

Explosion in confined places such as buildings, mines are usually associated with greater morbidity and mortality. [1] The severity of these injuries also depend victim's vicinity to the source of the explosion. Among the variety of explosions, refrigerator blasts are considered to be the rarest. Few cases have been reported in lay press in recent past years in India.

On early morning a blast inside an apartment in residential area of New Delhi, left four members of a family seriously injured.

Sources said the compressor of the 6-7 year refrigerator [with recently replaced compressor] exploded and was so intense that portions of the doors and windows were blown away under its impact.

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Akhilesh Arora, who teaches refrigeration at Delhi Technological University, said, "If the safety valve, which is used for high-pressure cut out, malfunctions and cuts off the electric supply it may cause an accident.

Another common reason of the blast could be the fact that these days compressors in refrigerators use hydro fluorocarbon (HFC) or hydrocarbon instead of chlorofluorocarbon (CFC). HFC is more flammable and in case of leakage the compressor can catch fire and explode. [2] He added the temperature of the winding of thermostat used in the compressor could rise due to fault in electric supply resulting in fire and blast. Arora said that routine maintenance by authorized mechanics could prevent such accidents. [2]

The refrigerators mainly follow the law of thermodynamics. Firstly the refrigerator requires a gas that cools on expansion and secondly, when two things of different temperatures comes in near or contact each other, the hotter surface becomes cooler and vice versa. [3]

Many of the old refrigerators around 1950's used refrigerants called Chlorofluorocarbons (CFC's) which was called as Freon. The liquid form of CFC is pushed by the pump through coils in the freezer area where it turns into a vapor. Then it soaks up some of the heat in the freezer compartment because of which the coil gets colder and the freezer begins to get colder.

But these CFC's are no longer used in the refrigerators as they were not environmental friendly and were harmful to the atmosphere upon release. [3, 4] Modern refrigerators are not using CFC's and these are replaced by another

type of gas called HFC-134a, also called as tetrafluoroethane. It is the widely adaptive alternative refrigerant for refrigeration and air conditioning equipment. [3, 4]

Case History:

On 7th August 2013, two youngsters working in a refrigerator cum air conditioning work shop located in the area limits of Asifnagar police station, Hyderabad. They were filling the gas (nitrogen) in the pipe of the fridge which was under repair. An explosion occurred at 4:45pm.

Both the youngsters sustained blast injuries and succumbed to severe disruptive injury on the spot. (Fig.1) The impact of the blast was so severe that the fridge dismembered into smithereens, ceiling fan and window panes were shattered into pieces.

They ran out till the gate and collapsed. One of the vehicles parked outside the workshop was knocked down due to explosion and was layered with bluish color material [melted flex banner]. (Fig. 2)

Surprisingly the compressor tank was found intact amongst the debris of blast. (Fig. 3)

Autopsy Findings:

At autopsy following injuries were observed:

Victim-1:

Blast injury at centre and left side neck extending into upper part of the chest cavity with massive disruption of muscles, nerves, vessels and fracture of C6 and C7 cervical bone.

Multiple fragmentations of left forearm fracture of tibia, fibular bone with torned muscles, tissues and vessels.

Victim-2:

Abdomen blasted with expelling out its contents with puncturing of intestines with multiple liver lacerations and multiple perforations. Blast injury extending from midline of chest to the right nipple with underlying tissue contused, fracture of 6th rib right in the mid clavicle line.

The samples collected from the scene of blast; analyzed at FSL by the flame Halide lamp test [A blue flame indicates the presence of normal gas while the green flame indicates the presence of chlorine] demonstrated the presence of chlorinated compounds. Traces of alumina (Al_2O_3) were also found at the site.

A case of rash and negligent act resulting in death [U/S 304 A of IPC] was registered against the owner of that work shop.

Discussion:

Meticulous articulation of observations at autopsy and scene of blast was attempted to scientifically deduce the mechanism of explosion

in the present case. Causes and mechanism of explosion reported so far were also taken onto account.

Causes of Explosion:

The refrigerator explosions take place even after it was proved that R134a is an alternative to CFC's, safest and environmental friendly. It is now widely known that the contamination of the refrigeration systems is because of the addition of counterfeit refrigerant which uses a mix of chemicals including R40. [5]

R40 is a hazardous chemical compound that is extremely flammable. It was widely used in refrigerators in the past which stopped now.

According to Neutronics Inc.'s R40 alert [6]; R40 reacts with aluminum and creates trimethyl aluminum which will ignite spontaneously in air. The boiling point of R40 is similar to that of R134a; hence it is difficult to detect R40 when they were mixed into the refrigeration systems.

Explosion Mechanism:

Usually the registration units contain polyester oil and the refrigerant HFC-134a, which cease the exploding capability of the refrigerator. But use of hazardous chemical compounds such as R40 along with R134a makes the refrigerator more vulnerable to explosion. R40 works as a refrigerant and at times it reacts with the Aluminium in the compressor probably forming

Trimethyl Aluminium is a liquid at room temperature. [7] According to Wiley's Guide to Chemical Incompatibilities [8] the extreme reactive quality of liquid trimethyl Aluminium will make it react violently with hydroxides; carbon dioxide, carbon tetrachloride, halon, halogens, oxides of nitrogen and many other substances.

Excessive moisture in refrigeration systems may also cause corrosion. The combination of moisture with hydrofluorocarbon (HFC) refrigerant containing chlorine creates much more serious corrosion, as the chlorine hydrolyses with the water to form hydrochloric acid (HCL) which is aggressive. The acid forming process in turn is aggravated by heat. [9, 10] It is obvious; in the present case; that the gas cylinder used [Fig. 3] for filling up the compressor was contaminated with Methyl chloride and was responsible of chemical reaction with coils / tubes of compressor accessories leading to explosion.

The recovered material from the explosion site also showed the presence of chlorinated compounds and traces of alumina (Al_2O_3). So far as prevention of such explosion

matters; we suggest following safety precautions:

1. Refrigerant gas supplied to the service depots need to be from a certified source with a certificate of veracity of the contents;
2. The withdrawn units should be checked for contamination;
3. Once a contaminated unit has been identified a procedure for making them safe needs to be identified. There is no method till now for the removal of trimethyl Aluminium and yet to be identified;
4. Existing refrigerant stock needs to be checked for contamination;
5. A refrigeration certification scheme needs to be put in place for future purchases;
6. A method to check the withdrawn reefer units for contamination;
7. A safe method for compressor removal of contaminated units to be identified;
8. No repairs are attempted, parts cannot be removed;
9. They may not be plugged in until completion of the thorough technical investigation;
10. They should be stored in an isolated place;
11. It is also very to prevent unauthorized personnel in tampering with the containers.

Conclusion:

Advancements in various gazettes are a need of hour for better quality of life. Use and maintenance of ones with compressed gases needs a special attention for all concerned to avoid/ minimize the risks coupled there in. A multidisciplinary approach in such unfortunate events does contribute to the exhaustive lists of do's and don'ts.

References:

1. <http://www.cdc.gov/masstrauma/preparedness/primer.pdf>
2. Blast in Refrigerator injures four of family. The Times of India. New Delhi Edition. 14th March 2010.
3. http://www.energyquest.ca.gov/how_it_works/refrigerator.html
4. <https://scitech.web.cern.ch/scitech/TopTech/03/Refrigerator/refrigerator2.shtml>
5. Safety notice to all-star cool service providers: MAERSK Container Industry: www. Maicontainers.com
6. <http://www.refrigerantid.com/R40.html>
7. Revised Information regarding counterfeit refrigerant, Cambridge Refrigeration Technology: www.critech.co.uk
8. Richard P. Pohanish, Stanley A. Greene. Wiley's Guide to Chemical Incompatibilities- 3rd Edition
9. Refrigerant quality and its impact on refrigeration machinery http://www.wilhelmsen.com/services/maritime/companies/buss/BUS_S_Pressroom/Documents/Refridgerant%20quality.pdf
10. Mark Bennett. Contamination of Refrigerated Container Systems. UNEP - Joint Meeting of the Regional Ozone Network For South

Asia, Southeast Asia and the Pacific Paro, Bhutan, May 2012
http://www.unep.org/ozonaction/Portals/105/documents/webinar/2012/MarkBennett_16COAcontaminatedrefrigerants.pdf

Fig. 1: Dead Bodied of Victim at Scene of Blast



Fig. 2: Knocked Down Motor Bile Layer with Bluish Material (Melted flex banner)



Fig. 3: Investigating Officer Inspecting Debris (Left Hand) and Intact Gas Cylinder (right hand)

