AN INVESTIGATION INTO THE CAUSES OF LAUNDRY FIRES – SPONTANEOUS COMBUSTION OF RESIDUAL FATTY ACIDS

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ABSTRACT: Several laundry fires have been investigated during the period from 1993 to 1999, where the cause is thought to be spontaneous combustion. In each case cotton materials such as kitchen towels, serving towels and sports kit have been washed, placed directly into tumble dryers and subjected to heating. Combustion has occurred amongst these materials when the cloth is heaped or stacked immediately after drying. These materials are subject to contamination through their use with various unsaturated fatty acids. This work investigated the residence of selected fatty acids on cotton materials during various normal washing cycles. It was shown that significant measurable levels of linoleic and oleic acids were recoverable from material even after very hot washing cycles (90°C). If such materials were then exposed to heating (during the tumble-drying process) such that their auto oxidation temperatures could be reached and if subsequent heat was not allowed to dissipate then it is conceivable that spontaneous combustion could occur.

KEY WORDS: Laundry fires; Spontaneous combustion; Residual fatty acids.

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INTRODUCTION

The spontaneous combustion of fatty acids is a phenomenon which has been the subject of much study [1, 2, 3]. Many reports exist specifically in relation to the propensity for unsaturated fatty acids such as linoleic acid to undergo spontaneous combustion when applied to a plant fibre matrix such as cotton or linen rags [1, 2]. A number of conditions are required for this to occur which (at a simplistic level) include:

- The fatty acid undergoes auto-oxidation.
- The heat generated from this auto-oxidation cannot dissipate.
- There is sufficient cellulosic material available in the environment to ignite when its ignition temperature is reached.

– There are conditions present that will support combustion once it has occurred.

LAUNDRY FIRES

The specific fires, which are of interest in this case, had a number of common characteristics that were noted during either the scene investigation or the gathering of background information regarding the events. These are chronicled below:

1. All fires occurred in laundries where washers and separate tumble driers were in operation.
2. The load was most often cotton or linen materials and in all cases fell into one of the following categories:
   – kitchen or serving towels from local restaurants of cafes;
   – sports kit;
   – towels from saunas/sports clubs;
   – cotton material used to wrap animal carcasses.
3. Usually the fire occurred after the last washes of the day or at lunchtime.
4. There were no signs of arson and arson was not suspected in any case.
5. The premises were left secured in all cases prior to the fire.
6. There were no signs of electrical faults or gas leaks as a cause in any case.
7. In all cases the load had been either left overnight in the tumble drier or removed and piled in heaps, or immediately packaged.
8. In all cases the load had been dried at the maximum temperature setting of the drier and no cooling cycle had been used, in order to reduce time and/or costs involved in the process.

TYPICAL CASE EXAMPLE

Two fires occurred in a small laundrette that was situated at the rear ground floor of a street fronted building. The upper floors were occupied by offices and the entire premises was locked up after business hours each day. The first fire occurred during the night of 02/03 April 1999 and the second during the night of 05/06 April 1999, these were the evenings of Good Friday and Easter Monday respectively. The laundry had 3 industrial washing machines and 3 tumble driers (2 electrically heated,1 gas heated). Mostly washing loads consisted of domestic laundry and commercial laundry from restaurants and cafes in the locality.

The first fire occurred on the night of Good Friday. At the end of the afternoon the assistant washed and dried a load of kitchen and serving cloths (which were medium weight cotton) from a local chip shop. The cloths had been impregnated with cooking oil from the frying operations of the shop. The cloths were given a hot wash and normal rinse cycles and then dried at "high" setting in an electric drier. The drier had no cooling cycle. Once finished, the drier was switched off by opening the door and the load left inside overnight and the premises closed and locked for the night. This was the normal practice for the last washing load of the evening. The fire was discovered the next morning. It was localised to the drier and there was evidence remaining of the cloths which had smouldered to ash inside the drier. There was some smoke damage in the premises and the door seal had dropped off and smouldered on the floor. Figure 1 shows a picture of the drier.

Fig. 1. The first drier.

The second fire occurred on the evening of Easter Monday. Again the last load of the evening was a mixture of kitchen and serving cloths, this time from a local restaurant. The cloths were given a hot wash and the normal rinse cycles before being dried on "maximum" heat in the gas drier. Again the drier was switched off by opening the door and the load left inside the drum. On this occasion the work was done by the proprietor who had come in on the Bank holiday evening to oblige her business customers. On the following morning the fire was discovered and as before the cloths had smouldered to ash inside the drier. In this case the drier was gas operated. Figure 2 illustrates the second drier.

During the investigation of these fires it was clear that both driers were in good working order, there was no evidence of fluff build up in filters and

Fig. 2. The second drier.

there was no evidence that the fire was the result of an electrical fault or gas escape. Arson was not suspected.

POSSIBLE FIRE SCENARIO

In the above case and the other laundry fires mentioned, the various materials which were washed were impregnated with fatty acid materials. These originated either from cooking oils (as in the case illustrated), sweat, animal fats or mixtures of plant oils, animal fats and mineral oils such as would be used in gymnasiums and health clubs. Such contaminated materials are known to spontaneously heat given the right circumstances. The drying process that the various cloths were subjected to could produce these conditions assuming that the fatty acids present survived the laundering process making spontaneous combustion a viable scenario. It remained to investigate the extent to which these fatty acids would survive the washing process.

EXPERIMENTAL METHOD [4]

Linoleic and oleic acid were chosen as target fatty acids since they are both known to be constituents of sweat, cooking oils. 100% cotton fabric samples were spiked with known amounts of the two fatty acids. The samples were washed with detergent at 40°C, 60°C and 90°C. The remaining fatty acids were extracted using methanol and derivitised to their corresponding methyl ester. Each extract was analysed using gas chromatography with a dodecane internal standard. This procedure was repeated five times for each fatty acid and at each temperature.

A calibration curve of both fatty acids again with dodecane as internal standard was generated and the fatty acid concentration in each extracted sample calculated. This procedure was repeated five times for each fatty acid and at each temperature.

RESULTS AND DISCUSSION

Fatty acid residues were extracted from each cloth sample, regardless of washing temperature. The extent to which part of the fatty acid was removed did vary across the different temperatures. These results are shown in Table I. These results indicate that even after washing at 90°C a quantifiable amount of linoleic and oleic acids are still present on cotton.

TABLE I. PERCENTAGE REMAINING OF 1 ml SPIKE OF UNSATURATED FATTY ACID ONTO COTTON SUPPORT AFTER WASHING

Washing temperature [°C]	Oleic acid [%]	Linoleic acid [%]
40	84 ± 5	67 ± 5
60	50 ± 3	15 ± 4
90	25 ± 3	4 ± 2

Most washes in commercial laundries are carried out at 60°C. These results indicate that materials impregnated with fatty acids washed under normal laundry conditions would still contain significant levels of fatty acid residues. These materials are then placed in a drier and heated at high temperatures. Once the drying process has been completed, if the materials are left heaped either within the drier or on another surface or immediately packaged then the temperature within the material mass has little chance to dissipate. As a consequence of this it is conceivable that heat generating oxidation reactions of the fatty acids occur and since the heat generated cannot dissipate that combustion of the surrounding cellulosic material may follow.

CONCLUSIONS

It is conceivable that fatty acid residues from cooking oils, sweat, animal carcasses and mineral oils may remain on cotton materials even after a 90°C wash. If cotton towels or materials heavily impregnated with fatty acids are laundered, dried in a commercial tumble drier at high temperatures then it is conceivable that such materials will, given time, undergo spontaneous

combustion unless the are allowed to cool sufficiently and the heat within the load mass allowed to effectively dissipate either through running a cooling cycle on the drier or by spreading the materials out to cool. Such materials should not be left heaped within the drier, heaped in piles on other surfaces or immediately packaged.

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