

FIRE INVESTIGATION INTELLIGENCE

EXOTHERMIC REACTION: Spontaneous Self-Heating

Cotton towelling is a particularly flammable substance and is susceptible to ignition not only by the application of a direct flame but also from exothermic reaction due to pre-heating such as in a tumble dryer or due to some form of oil contamination, (such as Linseed oil).

In an exothermic reaction, there is a transfer of energy to the surroundings in the form of heat.

The materials surrounding the area of reaction will experience an increase in temperature to the point of combustion. This may occur inside the dryer or after removal from the dryer, although there is evidence to suggest that in some cases the towels could ignite during the drying cycle.



Image 1: The brown towelling material is visible in the centre of the image, (red ring). Also note the black, smooth cotton apron material to the bottom right of the image (Yellow ring) this has been converted to brittle carbon.

If the cotton towels or other materials in direct contact with the towels are contaminated with oil, (cooking oil etc.), this too may also create an exothermic reaction.

This is due to the oil oxidizing on the cotton towels causes their temperature to increase and eventually ignite.

A key feature of the dryer process is the high degree of heat imparted into the towels during the dryer process. If the dryer is well ventilated the temperature should be managed by the thermostatic control of the dryer machine.



Image 2:

Here we can see the lint trap from the dryer is totally blocked.

This indicates a particular lifestyle issue of the owner of the dryer.

Hot air cannot vent fully from the drum of the dryer because the trap is blocked.

However, if the dryer cannot lose heat, for instance because the lint trap is full and cannot allow hot air to be vented through the lint trap properly, the towels will remain at a very high temperature.



When the towels are removed, they must be opened-out, exposing the maximum surface area to cooler air, to liberate the heat trapped in the towel fibre.

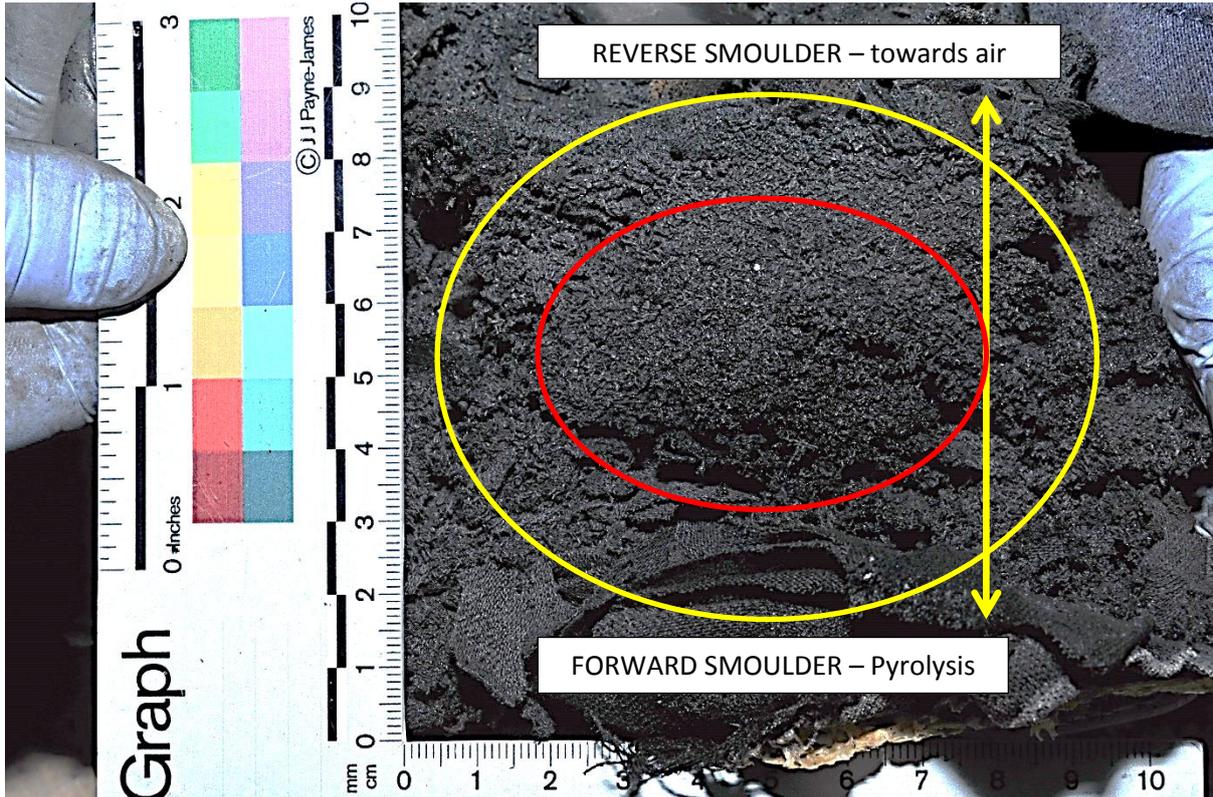
In the image on the left; the source of ignition is the pile of cotton aprons and towels (red ring) on the worktop above the dryer.

As the towels and aprons have not been unfolded, they transit through a process of exothermic reaction, generating temperatures as high as 600°C.

The towels and cotton materials generate heat in an intense smouldering fire. The smoulder begins to work outwards towards the outer face of the pile and into the oxygen-rich available fuels. This is termed Reverse smoulder.

The same process will occur deeper inside the pile but this works downwards consuming the available fuel (towel and cotton) through direct pyrolysis consuming the oxygen at an atomic level.

This is Forward smoulder and creates both an intense heat (600 - 800°C) and a very fine ash formed from pure carbon.



The image above shows the intense burn has consumed the towelling and converted it to pure carbon, (carbon zone - red ring), producing temps of 600 - 800°C.

The exothermic reaction will reach a point where the outer surface of the pile will auto-ignite and radiate heat and flame directly on to the surface of the surrounding combustible items.

In terms of time; from time of removal from the dryer to flaming combustion is difficult to assess as this depends on the fuel source and the degree of ventilation. However a rough rule of thumb is somewhere between 1 to 5 hrs.

To prevent exothermic reaction of materials from a dryer:-

- ❖ Allow the dryer to finish the cycle and run through the 'cool-down' mode.
- ❖ Open materials and larger garments out fully, shake them to expose them to cooler surrounding air.
- ❖ Hot, slightly damp materials should be hung up and allowed to cool for a five minutes before folding.
- ❖ The lint trap should be emptied frequently.