

## **REDUCING THE RISK ON A FOOD INDUSTRY ‘SERIOUS’ FIRE A Fire Investigation Case Study**

Dimitrios Tsatsoulas <sup>a</sup>

<sup>a</sup> Greek Fire service, Kritis 46 & Martiou, 54008, Thessaloniki

### **Abstract**

A case study of fire investigation of a ‘Serious fire’ in a food industry located in Northern Greece is presented. This work summarized, analyzes and reports detailed fire experience data through on-site investigation and significant investigation report. This fire investigation provides all evidence, witnesses and suspect statements, as well as conclusions and recommendations offered by the fire investigative team in relation to the fire itself, the suspect and potential prosecution.

Areas documented in this work include details about the place of the onset of fire; ignition sources; first ignited materials; time of ignition; degree of spread; contributions of building construction; suppression scenarios; performance of structures exposed to the fire; smoke and toxic emissions; human reaction (response) and evacuation; and the extent of life loss, injury and property damage. Fire Brigade intervention and the time taken to undertake its activities at a fire scene has been evaluated.

Fire investigation analysis clearly show that the prevention of fire spread beyond the first ignited item would have a major impact on the reduction of fire losses. Experimental analysis included small scale (Cone Calorimeter) and medium scale (Enclosed Fire Rig) equipment combined with online effluent gas analysis equipment (FTIR) were employed to estimate the potential of reducing the probability of breaking out and spreading of fire.

**Keywords:** risk, fire, food industry, ignition, fire fighting, fire prevention

### **1 INTRODUCTION**

This study examines a case of a ‘Serious fire’ in a food industry located in the industrial area of Thessaloniki. This food industry was complied with fire safety measures as predicted by the Greek Government Decision (1589/104/2006) ‘Industrial Fire protection’. (So, it has been supplied with passive protection measures i.e. means of escape, emergency lighting and signs, and active measures i.e. fire detection, permanent fire water supply network but with no sprinkler installation.) The food industry was a 10.190 m<sup>2</sup> concrete building with 105 employees. Processed materials were Glucose, ground sesame, sugar, cocoa, vanilla, dried fruit put on many mdf wooden pallets. Also, many wooden (mdf) wrapping material used to pack final products.

### **2 INCIDENT ANALYSIS**

The fire has been caused by ‘electrical spark’ originated in the ‘production and machinery area’ below wooden pallets. First ignited materials were ‘unprotected’ wooden mdf pallets and secondary materials were raw mdf wooden material. These factors were leading to the rapid fire growth and flash over conditions. Fire almost immediately spread from first to second ignited materials. It was not contained to the room of origin and spread beyond to the whole building i.e. first and second fire Compartments were inadequate to stop the fire and fire was not been possible to be suppressed by permanent fire fighting hose reels by industrial fire staff.

Almost the whole processed (raw and secondary) materials, final products and electro-mechanical equipment of industry have been destroyed by the fire. Estimated property loss 1,600,000 euro. On the other hand, the reinforced concrete, columns, beams performed very well in such a severe fire due to high fire resistance of reinforced concrete (above two hours and a half). Estimated property value saved 1,250,000 euro.

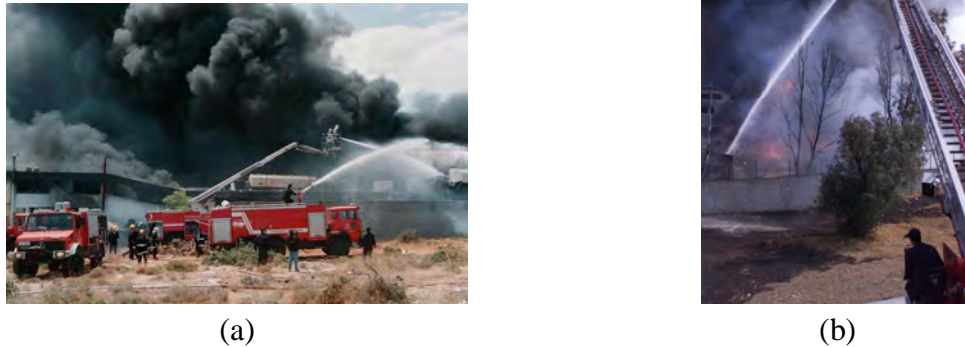


Fig. 1 Fire incident during post-flashover period (a) production and maintenance area, (b) storage area

Because of the size of the fire, a site-wide evacuation was immediately initiated. Unfortunately, five workers sustained minor injuries including scrapes and smoke inhalation.

### 3 EMERGENCY RESPONSE

The initial call reporting this incident was at 13.08 hours i.e in the middle of working day at 23-09-11. Food industry had a trained and equipped Emergency Response Team (ERT) that included 25 members. On the day of the incident; 15 trained emergency responders were immediately available. They effectively helped building evacuation and tried to extinguish the fire using permanent fire water supply network of industry. Their effort was unsuccessful due to severe fire conditions.



Fig. 2 Fire fighters efforts to tackle the fire

Firefighters from the surrounding fire stations were at 'emergency alert' providing 27 fire vehicles with 80 fire fighters deployed at the scene of fire. Immediately four firefighters using breathing apparatus invaded into the storage area in the back of the building and rescued three employees that were trapped over there. One aerial ladder truck had been used with effective results in the fire extinguishment efforts (see Figure 1). It was used to fight a fire from above and access the upper reaches of a building from the outside. Simultaneously, fire fighters

deployed 2-1/2" (64 mm) handlines around the burning building (see Fig. 2). All lines were immediately placed into operations.

#### 4 LESSONS LEARNED

It is clear from the above that prevention of fire spread behind the wooden first item ignited would have a significant impact on the reduction of fire losses.

In this case where the first material ignited is wood, it is considered that ignition and fire spread could be prevented or minimized by treating the timber surfaces with suitable flame retardants. Fire data on the effects of flame retardants on wooden surfaces is not available, since the relevant market is quite recent and not particularly widespread in Greece.

#### 5 EXPERIMENTAL INVESTIGATIONS

Therefore, in order to investigate this possibility mdf type of timber (as the same that was mainly used for industry's wooden pallets and other industry's wooden construction), were tested with bare samples, as well as using flame retardants (treated at different percentage (%) of the total surface area with a water – based, intumescent flame retardant, suitable for internal surfaces) ; using small scale (Cone Calorimeter) and medium scale (Enclosed Fire Rig) equipment combined with online effluent gas analysis equipment (FTIR) (Small and Medium scale).

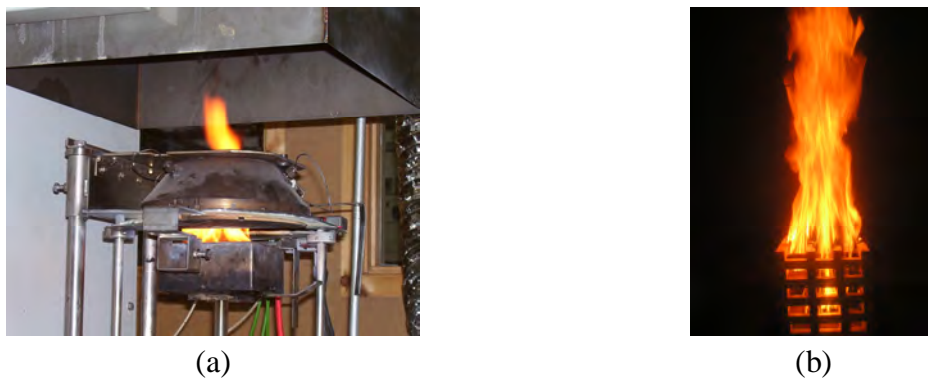


Fig. 3 (a) mdf exposed at heat flux  $35 \text{ kW/m}^2$ , (b) untreated mdf crib at 300 sec into the test

Analysis involved thermal behavior and toxic species analysis of the samples:

- 'No ignition' and lower toxic emissions compared to untreated samples were observed at  $35 \text{ kW/m}^2$  (small scale).
- The same behavior was observed in those cases where wooden surfaces located next to ignition source had been treated (medium scale).

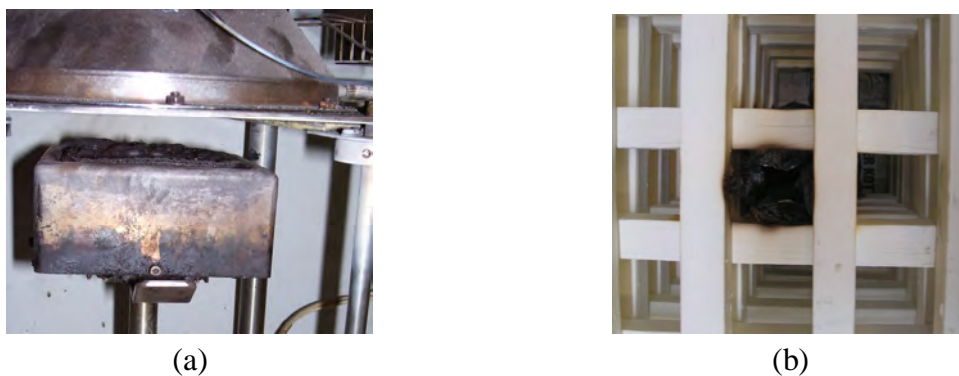


Fig. 4 (a) flame retarded Mdf exposed at Heat flux  $35 \text{ kW/m}^2$ , (b) flame retarded mdf crib at 300 sec into the test



## FTIR Toxic Gas Analysis

The European Community COSHH (COntrol of Substances Hazardous to Health Regulations) workplace 15 minute maximum allowable toxic concentrations are used to evaluate overall toxicity. For untreated mdf, formaldehyde and acrolein were the dominant gases. NH<sub>3</sub> was also significant. CO emissions was significant but not very high. Lower toxic concentrations measured for full (100%) treatment case where acrolein was the dominant toxic.

The effects of flame retardant treatment on major toxic emissions compared with the bare samples are shown on the following Table. In most fully-treated (100%) cases, even in the half-treated (50%) cases, lower or almost equal to unity emissions were measured compared with the bare samples. This is due to the fact that, in such cases, due to the intumescent action, there was either no ignition of the samples (100%-treated cases), or a considerable delay was seen (50%-treated cases). Excessive HCN and NO occurred in 60% of the untreated cases due to the considerable involvement of the flame retardant paint in flaming combustion, since it contains N in its chemical composition.

Tab. 1 Comparative effects of flame retardant treatment on major exhaust emissions

<i>Coated emission</i>	100%F.R. 6 g ethanol	100%F.R. 20 g ethanol	100%F.R. 30 g ethanol	50%F.R. 6 g ethanol	60% Untreted 6 g ethanol	60% Untreted 20 g ethanol
<i>Bare emission</i>						
'Peak CO(ppm) Ratio'	↓ ↓ ↓	↓ ↓ ↓	↓ ↓ ↓	↓ ↓	↓	↓
'Peak HCN(ppm) Ratio'	↓ ↓	↓ ↓	↓	↓	↑ ↑	↑ ↑
'Peak Acrolein(ppm) Ratio'	↓	↓	↓	↓	≈	≈
'Peak NH <sub>3</sub> (ppm) Ratio'	≈	≈	≈	≈	↑	↑
'Peak NO(ppm) Ratio'	↓	↓	≈	≈	↑ ↑	↑ ↑

Each arrow  /  indicates decreasing/increasing up to a factor of three. Two arrows together is equivalent to a change by a factor of 3-6. Three arrows together is equivalent to a change by a factor for greater than 6.

## 6 CONCLUSIONS

The main factors leading to the rapid fire growth and the fire spread to almost the whole building were:

- the lack of effective fire suppression measures close to ignition source;
- the untreated wooden first and secondary ignited materials;
- it is proposed that the application of intumescent flame retardants on wooden surfaces located close to ignition sources in the most probable areas for a fire to break out, could be a safe and approach in reducing fire loss in food industry;
- fire safety management of industry need to be improved following the guidelines below:
  - proper use of fire safety measures from Emergency Response Team. Therefore more fire safety education is needed. Participation in fire fighting exercises in corporation with local fire service is necessary;
  - all building employees were required to participate in periodic emergency evacuation drills;
  - check the company's space; Keep out the flammable substances and sparks and take the necessary fire precautions where is required.

A prosecution may be initiated for industry failing to comply with preventive measures as predicted by government decision 7/1996.

## **7 SUGGESTIONS**

Performing of more small- and medium – scale experiments, treated with the updated technology of the intumescent paints different types of wooden(in the form of cribs or some other form of samples), and using various ventilation rates to achieve both establishing and documentation of the contribution of intumescent technology in fire suppression, are suggested.

## **REFERENCES**

- Directorate of Fire Investigations Arson Crimes Control. Greek Fire Service ‘Special investigation reports 2011’, Thessaloniki 2011.
- D. Tsatsoulas. ‘Industrial fires in Northern Greece. The influence of Flame retardant on Timber Fires’. Ph.D. Thesis, Leeds (UK) 2008.
- D. Tsatsoulas . ‘Thermal behaviour and toxic emissions of various timbers in Cone Calorimeter tests’ ‘International Journal of Safety and Security engineering’, Vol.1, N01(2011) 45-64.
- D. Tsatsoulas “Thermal behaviour and toxic emissions of flame retarded timber in Fire Enclosure tests”,pp 295-306.Seventh International Conference on ‘Risk Analysis 2010’, 13-15 September, Algarve, Portugal.
- D.Tsatsoulas, H.N.Phylaktou and G.Andrews. ‘Thermal behaviour and toxic emissions of various timbers in Cone Calorimeter tests’. Third international Conference on Safety and Security Engineering, 1-3July 2009, Rome. In the proceedings of ‘First International Conference on Disaster Management and Human Health Risk’, pp.181-194, 23 -25 September 2009, New Forest, UK.