1.12 **Fire research in Greece** (short version)

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Integrated Fire Engineering and Response

Fire research in Greece

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Thermal behaviour and toxic emissions of various timbers in Cone Calorimeter tests.

- Eight (8) types of wood , the most widely used in Greek industries, were chosen for experimental testing in a cone calorimeter (small-scale) at 30,50,65 and 80kW/m2 linked with FTIR analyzer

University of Leeds Cone Calorimeter.

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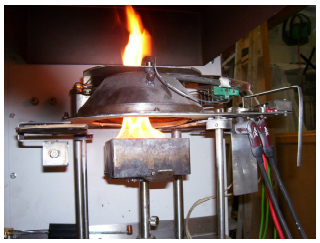
Thermal behaviour of various timbers in Cone Calorimeter tests.

- **'No significant' differences were observed in terms of HRR values. Some slightly lower HRR peak values (kW/m2) were noted for homogeneous (pine) compared with composite in nature samples (e.g., MDF, chipboard).**
- **Substrates covered by melamine or maple, seem to reduce the peak HRR values for MDF and chipboard against fire conditions.**



Pine exposed at Heat flux 35kW/m2

➢**At low irradiance (i.e., 35kW/m2), facing types of timber, e.g., MDF, Chipboard, with melamine or maple increases significantly the ignition resistance of MDF and Chipboard by a factor of 1.5 to 2, due to the flame retarding properties of melamine and maple.**

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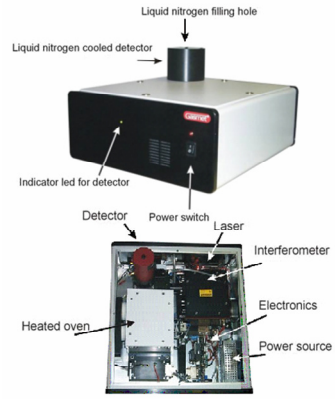
Toxic emissions of various timbers in Cone Calorimeter tests.

"Significant" acrolein peak values are measured for all samples.

Samples with a facing layer (melamine in particular), which are known to have a chemical flame retardation reached higher peak values of CO, HCN and NH3 during combustion.



University of Leeds FTIR and its internals.

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Thermal behaviour of flame retarded timber in Cone Calorimeter tests.

- The effects of three (3) typical intumescent flame retardants (latest technology) on four (4) types of timber, i.e., the most representative ones in terms of thermal behaviour, were tested in a cone calorimeter subjected to constant incident heat fluxes of 35, 50, 65 and 80 kWm-2 in a Cone Calorimeter linked to the FTIR analyzer.

The main findings are the following:

'Zero Flame' treated Pine exposed at Heat flux 35 kW/m2

➢'No ignition' of all flame retarded samples was observed at 35kW/m2.

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Thermal behaviour of flame retarded timber in Cone Calorimeter tests.

- A considerable ignition delay (compared to untreated sample) is seen at 50kW/m2 and 65kW/m2 from 15 to 30 for 'Zero Flame', and from 2 to 5 for 'Synto Flame', as well a reduction in peak HRR from 4 to 5 for 'Zero Flame' and 2 times for 'Synto Flame'; this is attributed to their different chemical composition (water-based versus solvent-based).
- The intumescent char cracks marginally thus allowing the formation of only thin flamelets scattered on the sample's surface

'Zero Flame' treated Pine exposed at Heat flux 65 kW/m2

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Toxic emissions of flame retarded timber in Cone Calorimeter tests.

- In most cases of samples with 'no ignition', -compared to untreated samples- there is either reduction in toxic emissions by a factor of 2 ('Zero Flame' paint) or almost equal to unity ('Synto Flame' paint).
- As irradiance increases, increasing values of toxic emissions by volume -compared to untreated samples- are seen during flaming combustion.
- Excessive toxic emissions by mass are also seen as irradiance increases.

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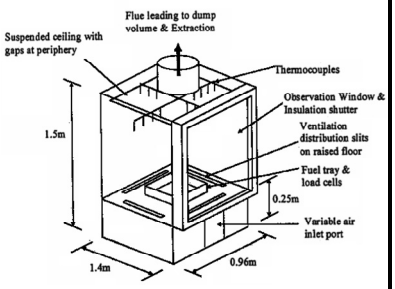
Thermal behaviour and toxic emissions of flame retarded timber in Fire Enclosure tests.

- From the various types of wood found in different structures in the Greek Industry, pine was selected for further medium-scale experimental investigation, since it is the most commonly used type of wood, is "easy-to-use" and produced in large quantities from the Greek forests.
- It was chosen to be tested in form of cribs, because, as mentioned before in real fires there are complex wooden geometries and configurations strongly affecting the "spreading of fires".



University of Leeds Fire Rig Enclosure

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Thermal behaviour of flame retarded timber in Fire Enclosure tests.

- **Seven (7) wooden crib fires were investigated using pine wooden cribs untreated or treated at different percentage (%) of the total surface area with a water – based F.R., intumescent, suitable for internal surfaces.**
- One untreated sample was tested using 6g of ethanol as ignition source.
- The untreated sample clearly burned faster and with the highest HRR.

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Thermal behaviour of flame retarded timber in Fire Enclosure tests.

- In all fully-treated (100%) cases, there was no ignition, and increasing amounts of ethanol, i.e., 6, 20, and 30g, were used as ignition sources.
- In half-treated (50%) cases, there was a considerable ignition delay (> 300 sec), as well as a reduction in peak HRR values by a factor of 2.

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Toxic emissions of flame retarded timber in Fire Enclosure tests.

- Lower values of toxic emissions or almost equal to unity are released in most fully-treated (100%) cases, compared with the untreated cases.
- The half-treated (50%) cases released have similar or even lower values than fully-treated cases, as seen in several cases.
- Increased values of toxic emissions, compared to untreated samples are observed in '60% untreated' cases, due to higher involvement of the flame retardant paint in flaming combustion. Excessive toxic mass emission occurred in the latest cases.

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Conclusions

- Based on the above findings, 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 effective approach in reducing fire losses in industries.

Suggestions

- Performing of more small- and medium – scale experiments, treated with the updated technology of the intumescent paints (different parts of wooden 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.
- Different coatings should be evaluated in terms of durability, impact resistance, weatherability, etc.;

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