Chapter 2
Objective and Scope
2.1.0.0 Objective and Scope

The present investigations were carried out with the following objectives in view:

(i) To prepare flame resistant wood/wood veneers/wood composites by treating them with flame retardant chemicals via impregnation and coating methods.
(ii) To determine the mechanism of action of flame retardants on wood/wood veneers/wood composites by TG, DTG, DTA, SEM, LOI and UL 94 methods.
(iii) To utilize fly ash in order to develop fly ash-intumescent composites for wood/wood veneers.

In the view of above, following series of wood and modified woods were prepared and their flammability and thermal degradation kinetic studies have been carried out:

2.1.1.0 Wood Veneers

(i) Poplar (Populus) *
(ii) Eucalyptus (Eucalyptus globulus)
(iii) Mango (Mangifera indica)
(iv) Gurjan (Dipterocarpus alatus)

2.1.2.0 Poplar Wood and Woods Impregnated With Guanidine Nitrate in Presence of Catalytic Amount of Bases

(i) Poplar (Virgin wood)
(ii) Poplar wood impregnated with guanidine nitrate (20% w/v)
(iii) Poplar wood impregnated with guanidine nitrate in presence of catalytic amount of N,N-dimethylformamide
(iv) Poplar wood impregnated with guanidine nitrate in presence of catalytic amount of 4-dimethylaminopyridine
(v) Poplar wood impregnated with guanidine nitrate in presence of catalytic amount of pyridine
(vi) Poplar wood impregnated with guanidine nitrate in presence of catalytic amount of triethylamine

* Botanical name of woods are given in parenthesis.
2.1.3.0 Poplar Wood and Woods Impregnated With Cetyltrimethylammonium Bromide (CTMAB) and Ammonium Dihydrogen Orthophosphate (ADHOP) Blends

(i) Poplar (Virgin wood)
(ii) Poplar wood impregnated with 8% w/v CTMAB
(iii) Poplar wood impregnated with 2% w/v ADHOP + 6% w/v CTMAB
(iv) Poplar wood impregnated with 4% w/v ADHOP + 4% w/v CTMAB
(v) Poplar wood impregnated with 6% w/v ADHOP + 2% w/v CTMAB
(vi) Poplar wood impregnated with 8% w/v ADHOP

2.1.4.0 Poplar Wood and Woods Impregnated With Tetrakis(hydroxymethyl)phosphonium Chloride (THPC) and THPC/Urea/Urea Derivatives Blends

(i) Poplar (Virgin wood)
(ii) Poplar wood impregnated with 40% v/v THPC + 20% w/v urea blends
(iii) Poplar wood impregnated with 40% v/v THPC + 20% w/v thiourea blends
(iv) Poplar wood impregnated with 40% v/v THPC + 20% w/v dimethyl urea blends
(v) Poplar wood impregnated with 40% v/v THPC + 20% w/v dimethylol urea blends

2.1.5.0 Poplar Wood and Woods Coated With Fly Ash-Intumescent Composites

(i) Poplar (Virgin wood)
(ii) Poplar wood coated with intumescent formulation (18% w/w Ammonium polyphosphate (APP) + 6% w/w Melamine (MEL) + 6% w/w Pentaerythretol (PER))
(iii) Poplar wood coated with 18% APP + 6% MEL + 6% PER + 2% w/w fly ash
(iv) Poplar wood coated with 18% APP + 6% MEL + 6% PER + 4% w/w fly ash
(v) Poplar wood coated with 18% APP + 6% MEL + 6% PER + 6% w/w fly ash
(vi) Poplar wood coated with 18% APP + 6% MEL + 6% PER + 8% w/w fly ash
2.1.6.0 Various Studies/Techniques Used in Present Work

The following techniques have been used to obtain information on thermal, morphological and flammability of wood and modified woods:

(a) Mass Gain Percentage and CHN Analysis: Mass gain percentage (MGP) and CHN analysis have been used to confirm the impregnation of chemicals into empty pores of wood. MGP due to chemical load has been calculated using following equation:

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MGP = \left[ \frac{M_{odf} - M_{odt}}{M_{odt}} \right] \times 100
\]

where \( M_{odt} \) and \( M_{odf} \) are oven dried mass (g) of specimens before and after treatment, respectively.

(b) SEM Study: SEM has been used to study surface morphology of wood and modified wood in order to confirm the impregnation of flame retardant chemicals. SEM after performing limiting oxygen index (LOI) test of samples has been used to find out the mechanism of action of flame retardants.

(c) Thermal Study: TG, DTG and DTA studies have been used to calculate following parameters:

(i) Initial/onset decomposition temperature and corresponding mass loss.

(ii) Maximum mass loss rate (MMLR) that refers to the peak heights of DTG graphs and it is measured in \% min\(^{-1}\). MMLR is related to fuel combustibility; flame retardant chemicals are expected to decrease MMLR values, according to their efficiency [125].

(iii) Overall combustion/pyrolysis duration (OCD/OPD) that is measured in minutes by subtracting the onset from the offset values of DTG peaks. This parameter may be related to the combustion ability and efficient retardants are expected to increase OCD/OPD values [126].

(iv) Char yield that is related to the combustion ability of fuel \( i.e. \) more the value of char yield less will be the flammability of samples. The retardant additives increases mass residue according to their efficiency [127,128].

(v) Degradation activation energy (E) by ‘model free’ methods O-F-W, Kissinger, Friedman and modified Coats-Redfern methods.
(d) **LOI and UL 94 Testing**: These tests have been used to compare the flame retardancy of wood and modified woods.