FRP COMPOSITES AND REACTION-TO-FIRE CHALLENGES

Anna Sandinge

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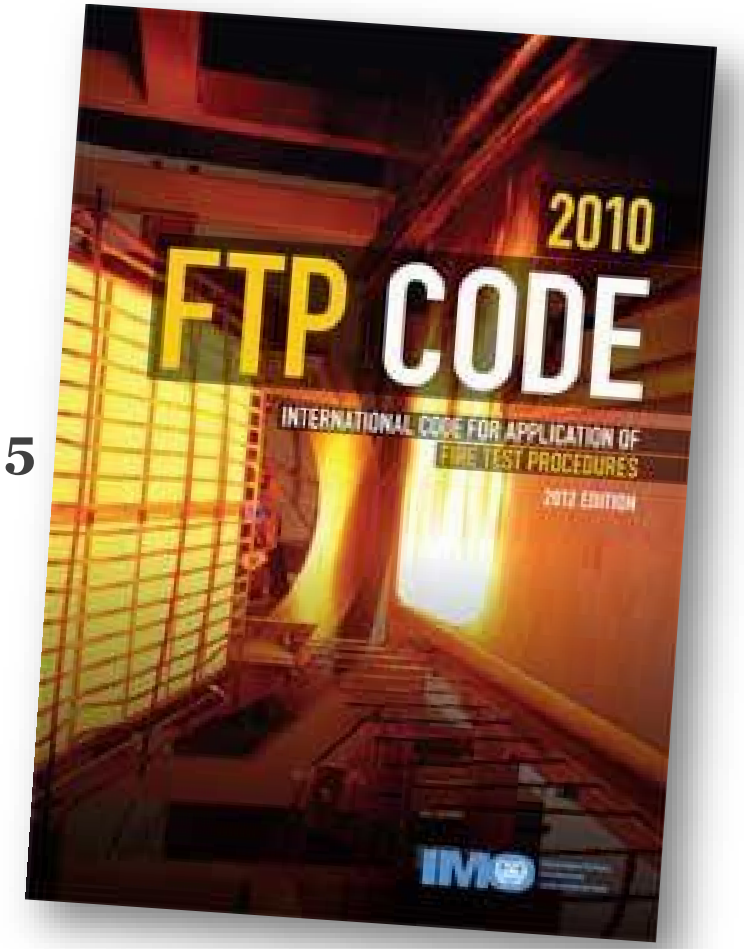
Vigo, Spain

RISE Research Institutes of Sweden

Safety and Transportation
Safety – Fire Research, Materials

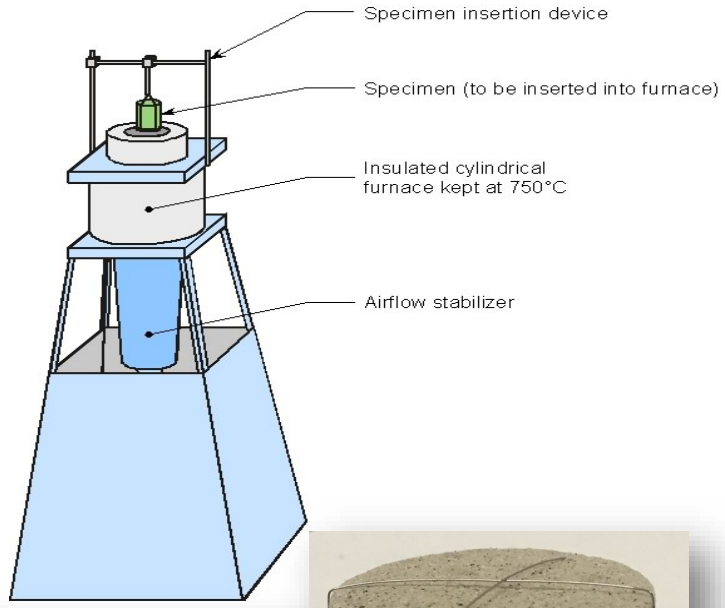
Test methods – IMO FTP Code 2010

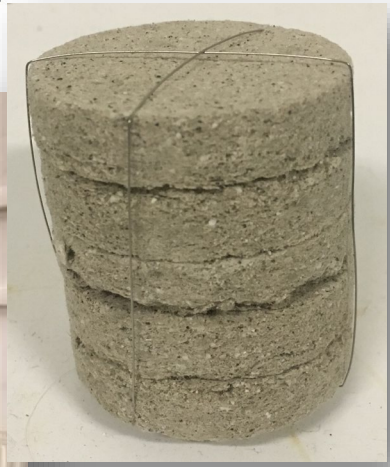
- **Non-combustible test – IMO FTP Code Part 1**
- **Smoke and toxicity – IMO FTP Code Part 2**
- A, B and F class divisions– IMO FTP Code Part 3
- **Surface flammability, Spread of flame – IMO FTP Code Part 5**
- Ignitability of vertically textiles and films – IMO FTP Code Part 7
- Upholstered furniture – IMO FTP Code Part 8
- Test for bedding components – IMO FTP Code Part 9
- **Room corner test – IMO FTP Code Part 10**
- Furniture, Cone calorimeter – IMO FTP Code Part 10 (ISO 5660-1)
- Fire resisting division (FRD) – IMO FTP Code Part 11



Non-combustible test – IMO FTP Code Part 1

- The test sample is placed horizontally and subjected to thermal radiance.
- The test specimen is located inside a cylindrical furnace tube at 750 °C.
- The furnace and specimen temperatures are measured continuously during the test.
- Potential combustion of the test specimen is registered as temperature rise and/or visible flames.
- Mass loss of the test specimen is calculated after the test.





Non-combustible test – IMO FTP Code Part 1

Criteria

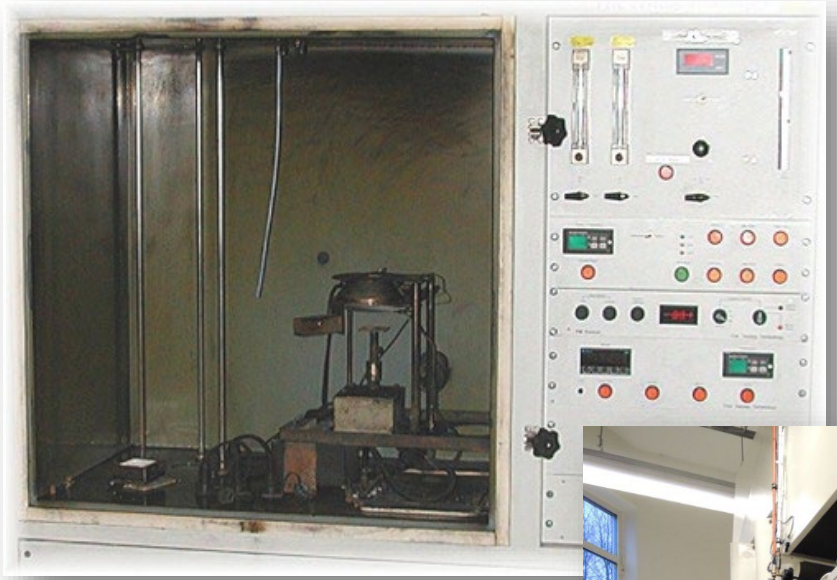
- Average furnace temperature raise not more than 30°C
- Average specimen surface temperature raise not more than 30°C
- Sustained flaming not more than 10 s
- Mass loss of specimen not more than 50%

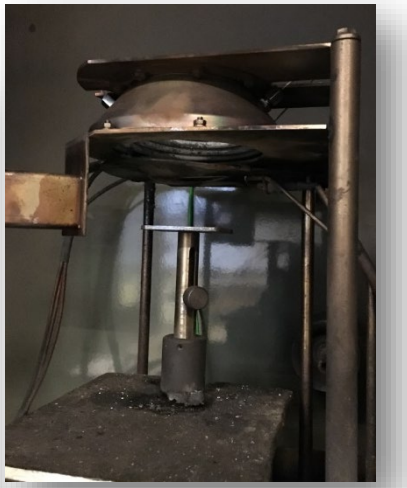
Challenges

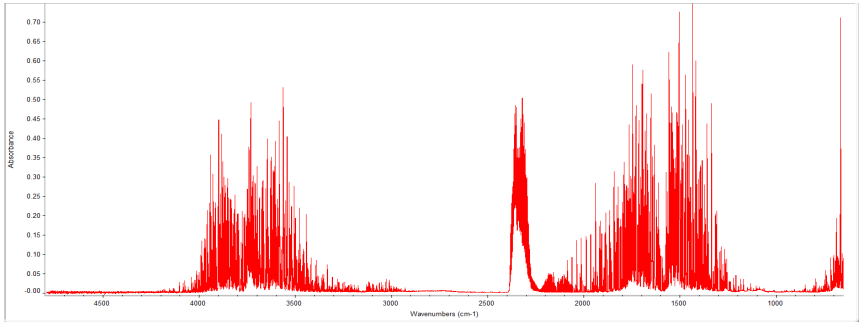
- The combustible content have to be low!
  A content of ~ 3-5 % can be used as a rule of thumb.

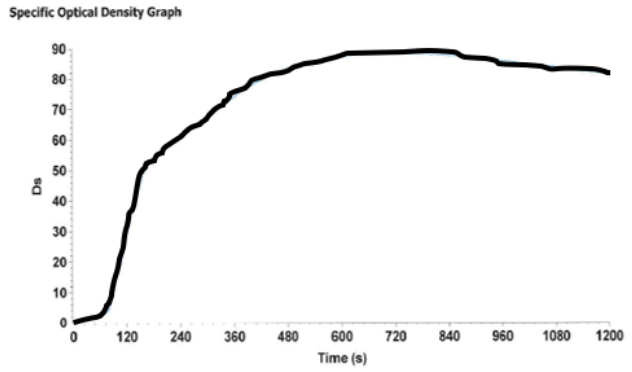
Smoke and toxicity – IMO FTP Code Part 2

- The test sample is placed horizontally and subjected to thermal radiance. The specimen starts to emit smoke which is collected in the chamber. The smokes specific optical density (transparency) is measured with a light source and a photo cell.
- The smoke toxicity analysis is done with FTIR. Quantified gas species are CO_2, CO, HF, HCl, HBr, HCN, NO_X och SO_2









Smoke and toxicity – IMO FTP Code Part 2

Criteria – smoke density

- Surface of bulkhead, linings or ceilings: $D_m \leq 200$
- Primary deck coverings and plastic pipe: $D_m \leq 400$

Criteria – toxicity

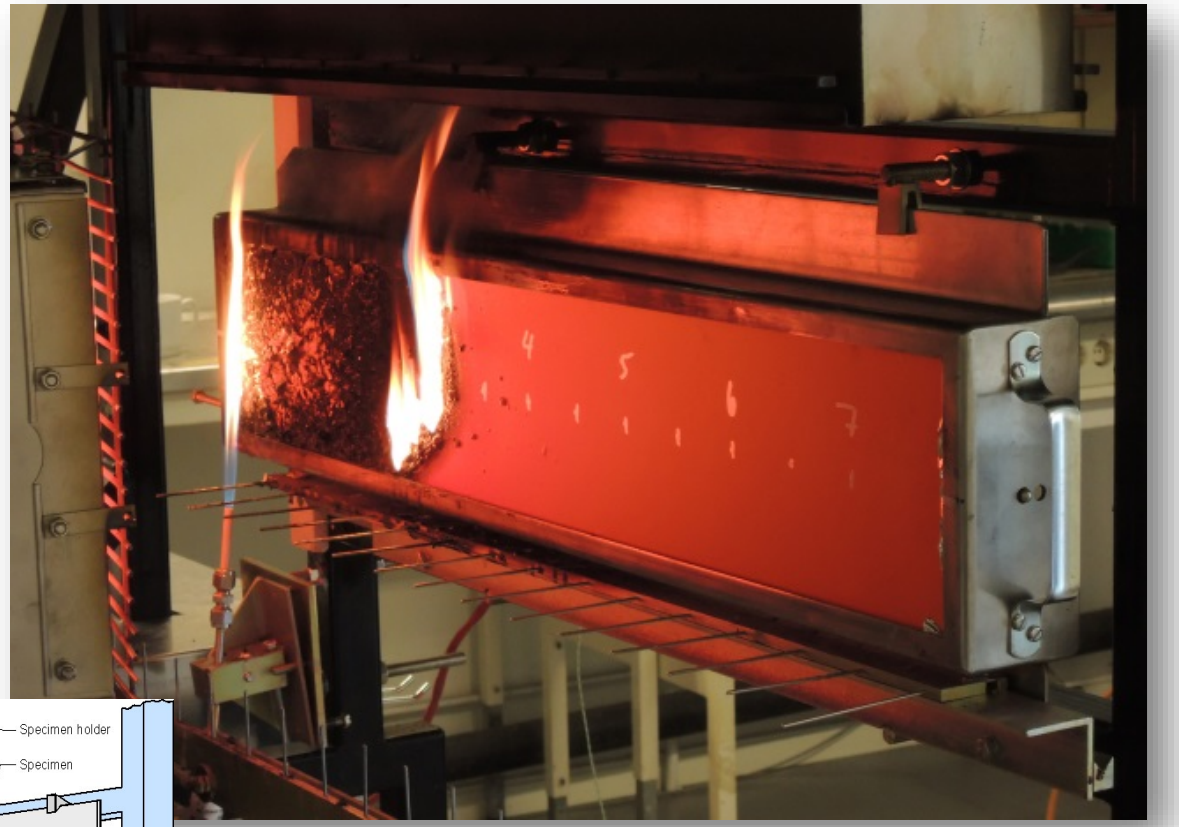
- Carbon monoxide, CO ≤ 1450 ppm
- Hydrochloric acid, HCl ≤ 600 ppm
- Hydrogen bromide, HBr ≤ 600 ppm
- Hydrogen flouirde, HF ≤ 600 ppm
- Hydrogen cyanide , HCN ≤ 140 ppm
- Nitrogen oxides, $NO_X \leq 350$ ppm
- Sulphur dioxide, $SO_2 \leq 120$ ppm

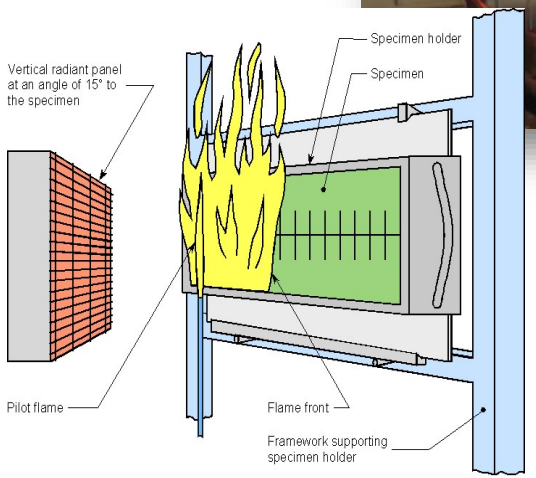
Challenges

- Non-complete combustion results in soot, ”dark” smoke and toxic gas species
- Toxic gas species can be formed during combustion from flame retardants

Surface flammability, Spread of flame – IMO FTP Code Part 5

- The specimen is vertically positioned during test and exposed to heat radiation from a radiation panel and a pilot flame.
- The time when the specimen is ignited and the time when the flame reaches every 50 mm mark along the specimen is noted. Time to flame out of the flame front on the center line, burnt length and any occurrence of burning droplets are noted.





Surface flammability, Spread of flame – IMO FTP Code Part 5

Criteria	Surface of bulkhead, linings or ceilings	Floor coverings	Primary deck coverings
CFE (kW/m^2)	≥ 20.0	≥ 7.0	≥ 7.0
Q_{sb} (MJ/m^2)	≥ 1.5	≥ 0.25	≥ 0.25
Q_t (MJ)	≤ 0.7	≤ 2.0	≤ 2.0
Q_p (kW)	≤ 4.0	≤ 10.0	≤ 10.0
Burning droplets	None	No more than 10	None

The above follows the subsequent nomenclature:
CFE: Critical Flux at Extinguishment
Q_{sb}: average heat for sustained burning
Q_t: total heat release
Q_p: peak heat release rate

Challenges

- Limit flame spread in surface
- Keep fire in surface and not in core. If fire in core → higher heat release.

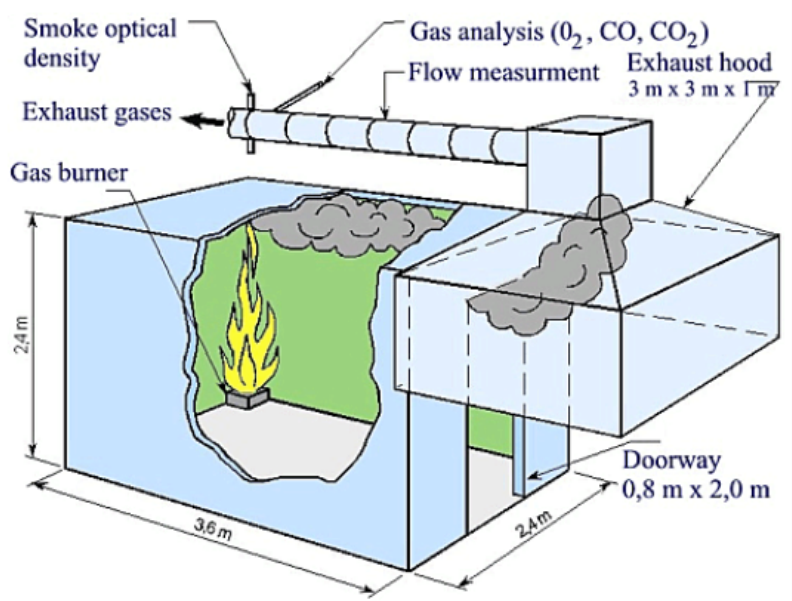
Room corner test – IMO FTP Code Part 10

The test sample is mounted on the inside of the room, in the ceiling and on all the walls except for the wall with the door opening.

A propane gas burner is located in one of the corners and produces a heat release rate of 100 kW during 10 minutes, and then 300 kW the following 10 minutes. The total test time is 20 minutes.

The combustion gases are collected through a hood where heat release rate and smoke production are measured. Flame spread along walls and ceiling are observed visually.

If flames emerge from the door opening, flashover has occurred and the test is terminated. The heat release rate at flashover is generally about 1 MW.



Room corner test – IMO FTP Code Part 10

Criteria

- Time average heat release rate ≤ 100 kW
- Max heat release rate ≤ 500 kW over a 30 s period of time
- Smoke production rate ≤ 1.4 m^2/s
- Max smoke production rate ≤ 8.3 m^2/s over a 60 s period of time
- Flame spread shall not reach any further down the walls than 0.5 m from the floor
- No flaming droplets or debris from the test specimen

Challenges

- As long time to ignition as possible
- Low flame spread in material
- Keep heat release rate and smoke production low during complete test
- Surface material important

Inventory of fire safety materials for SOLAS vessels

Task 1: Non-combustibility, FTP Code Part 1

- Lead by RISE SICOMP

Task 2: Surface flammability, FTP Code Part 5

- Lead by Infracore

Task 3: Fire restricting material, FTP Code Part 10

- Lead by Damen Schelde Naval Shipbuilding

The tasks will indicate problem areas in developing such materials. The study will also provide an inventory of currently ongoing developments that could offer promising results in the near future.

Fire testing a possibility to validate the reaction-to-fire properties.

CONTACTS

Anna Sandinge

anna.sandinge@ri.se

+46 10 516 5973

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