BC origins

- Established 1989
- Original focus on wood based panels, pulp and paper, and novel products from agricultural residues
- Pilot plant for particleboard and MDF production
- Long natural fibres in non-woven mats for composites and insulation
- Resins from plant oils and extracts
- Bio-derived products in a wide range of applications
- New Technology Transfer Centre at Mona on Anglesey opened in 2006

INNOVATION IN BIO-MATERIALS FOR INDUSTRY

BC Materials

Materials Research

- Lead Scientist: Graham Ormondroyd
- Personal Research Areas Include:
  - Bio-based Construction
  - Timber Composites
  - Timber modification (chemical / impregnation)
  - How bio-based materials interact with the environment
- Notable Projects
  - ECO-SEE (FP7)
  - Plants and Architecture

Manufacture of fibre board products

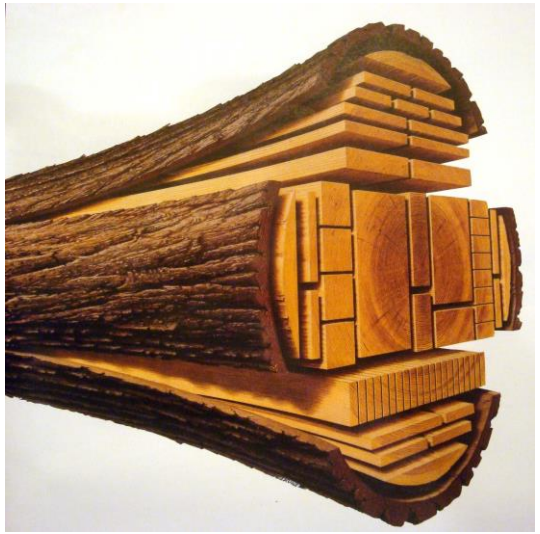
Dr Graham Ormondroyd

Contents

- Fibre based board products
- The ‘Dry’ manufacturing Process
- The markets for the products
- Is panel products still an area for research?

Limitations of Lumber

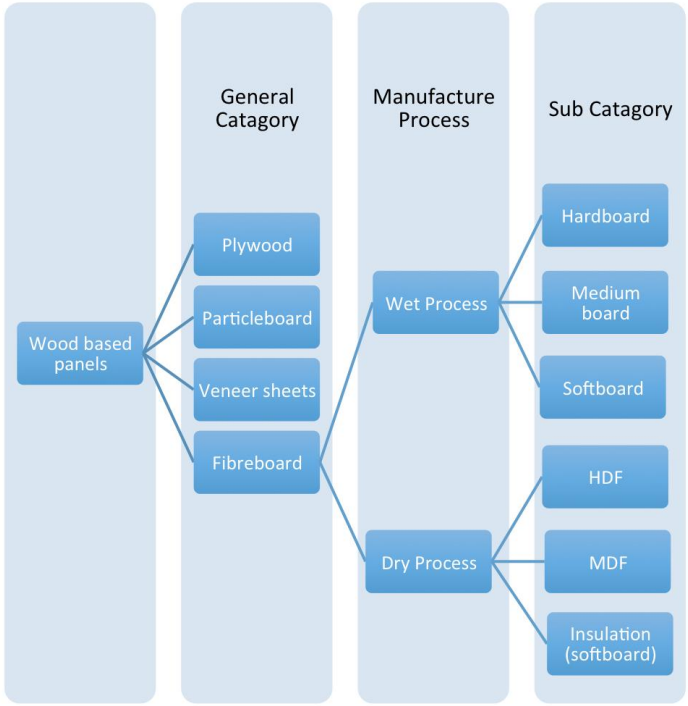
- Variable properties
- Anisotropic behaviour
- Structural flaws
- Limited dimensions
- Reducing availability



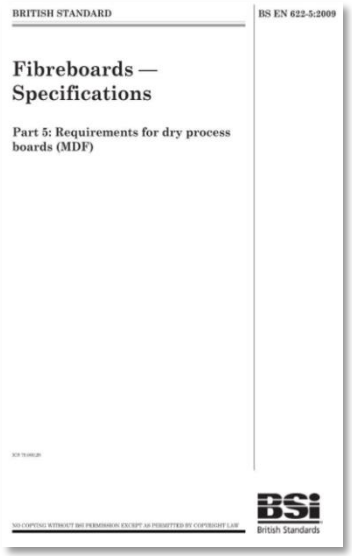
Why manufacture ‘board’ products

- Scarcity of suitable timber
  - Need to use the forest resource more efficiently
- Improvement of properties of the resources
  - Anisotropy
  - Strength
  - Dimensional stability
- The ability to tune properties for the required needs
  - The properties can be engineered
    - Including the resistance to moisture
    - Sizes of panels

Defining fibre based products



Definitions of fibre based panels

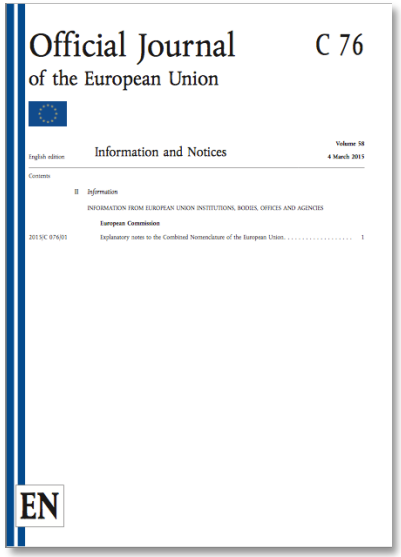

BRITISH STANDARD

BS EN 622-5:2009

Fibreboards — Specifications

Part 5: Requirements for dry process boards (MDF)

BSi British Standards


Official Journal of the European Union

C 76

Information and Notices

Volume 58

4 March 2015

EN

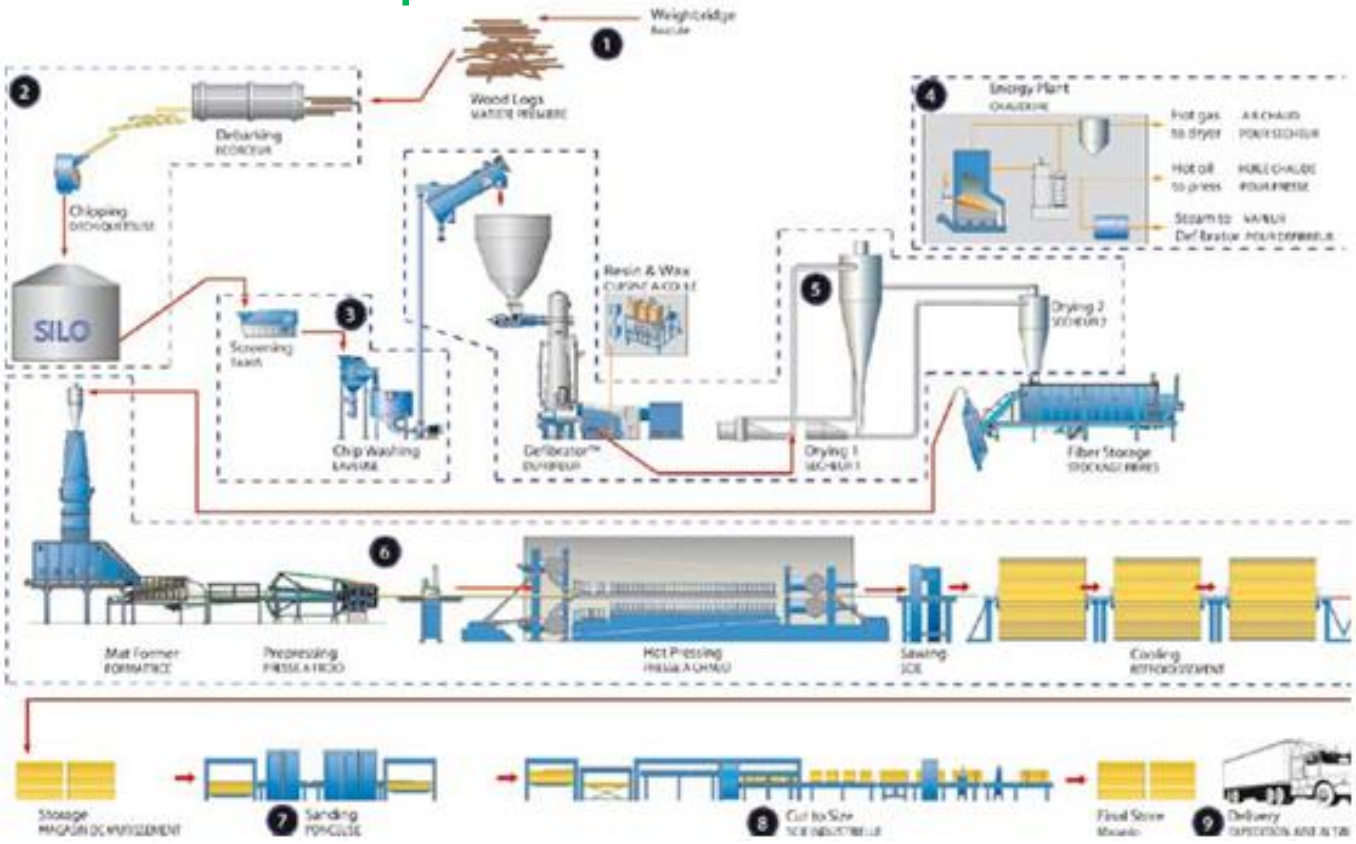
ISO International Organization for Standardization

ISO 16896 ‘Wood-based Panels – Dry Process Fibreboard’

The dry process – Medium Density Fibreboard

- Also High Density Fibreboard
- And Softboard

Production process



Feedstocks

- Softwood – Spruce Pine Fir mix
- Hardwoods
- Waste wood – clean, sawdust, chippings
- Recovered wood – limited use and has to be clean

Logyard

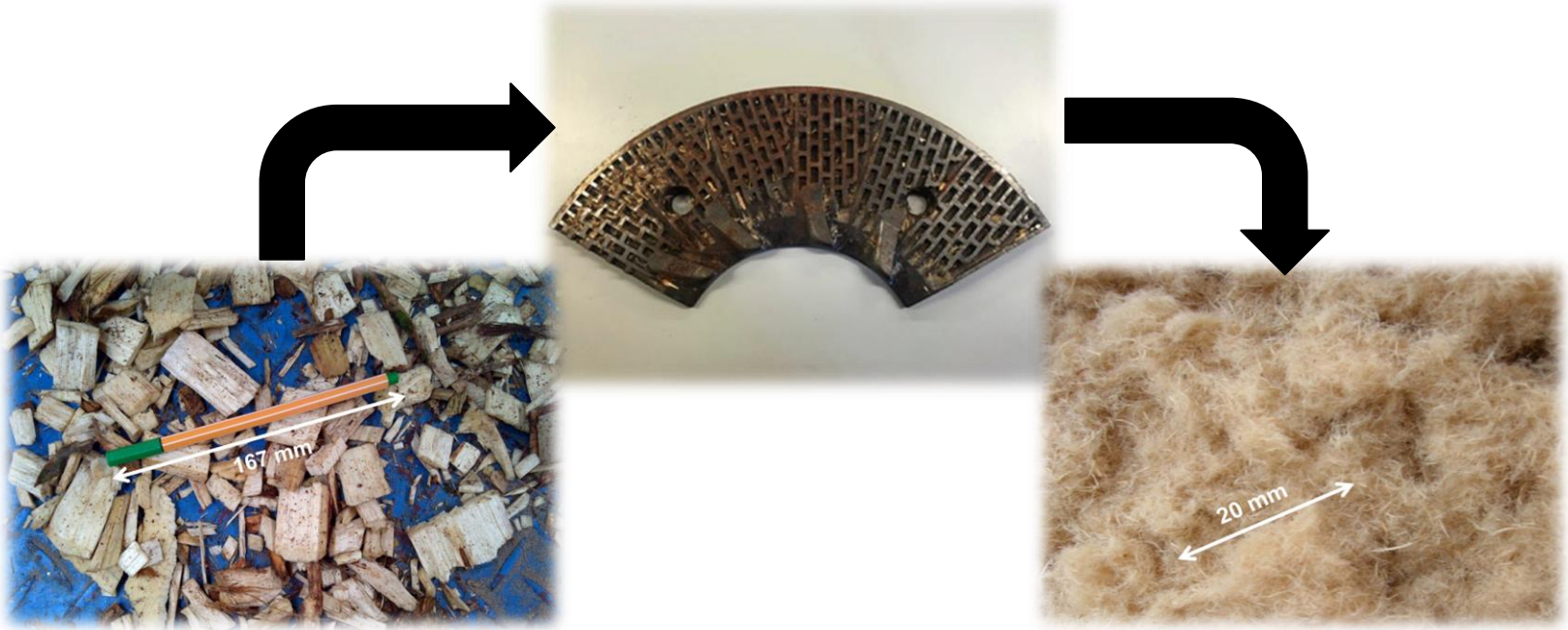
Chipping

- Logs are de-barked before chipping
- Chip size has to be accurate for the plant
- Chips screened to remove over and under size

Refining

- Chips are steamed at 6 – 10 bar (175 – 195 °C)
- Fed in to the refiner

Production process



Two types of resin blending techniques

EVOjet™

Dry blending technique

Consists of rotating spiked rollers and nozzles which create a fine mist of droplets which the fibres fall through. Resination takes place after the drier

30% savings (up to) compared to conventional blow line

Reduced emissions out of the drier

System capacity up to 45 t/h d.b

PROjet

Blowline blending technique

Consists of a spool of resin injectors with steam atomizing nozzles. Resination takes place in the blow line, which connects the refiner to the drier.

15% savings (up to) compared to conventional blow line

Higher board quality due to less resin spots on board surface

Less energy consumed in the drier due to less water addition

Reduced drier build up

Resination (Blowline)

- A pipe of 80 – 120 cm in diameter
- Resin blended at high pressure
- Velocities of up to 100 m/s
- High turbulence

Resins

- Majority of Panel boards in the world made with ***formaldehyde resins***
  - Cheap
  - Tried and tested
  - Understood
  - Resin manipulation easy and understood

Resins

Property	UF	MUF	PF	PMDI
Price	Low	Medium to High	Medium	High
Cure temp	Low	Medium	High	Low
Press time	Short	Medium	Medium to Long	Medium
Susceptibility to species of wood	High	Medium	Low	Low
Efficiency	Low	Medium to High	Medium to High	High
Ease of modification	Easy	Easy	Easy	Difficult
Resistance to hydrolysis	No	Medium to High	High	High
Use in humid conditions	No	Partial	Yes	Yes
Formaldehyde emission	High	Middle	More or less none	None

Drying

- Wet resinated fibre is ‘shot’ into the dryer
- Pipe between 1 – 3 metres in diameter
- Moisture content is reduced from 200% to 8 – 12%
- Stored in silos or straight to forming

Forming

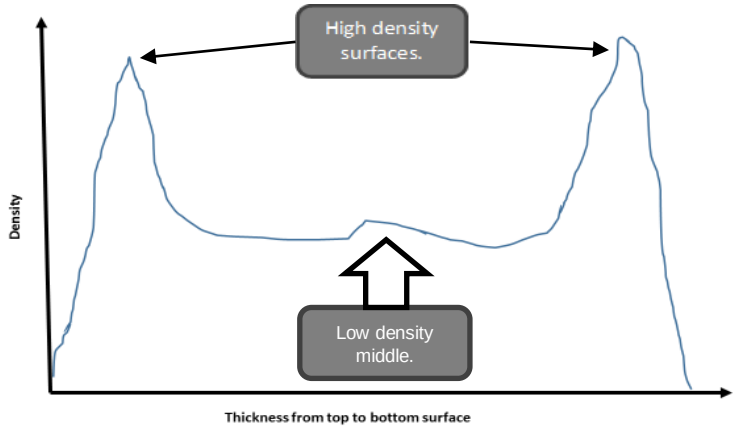
- Continuous or batch process

Pressing

- Continuation of forming

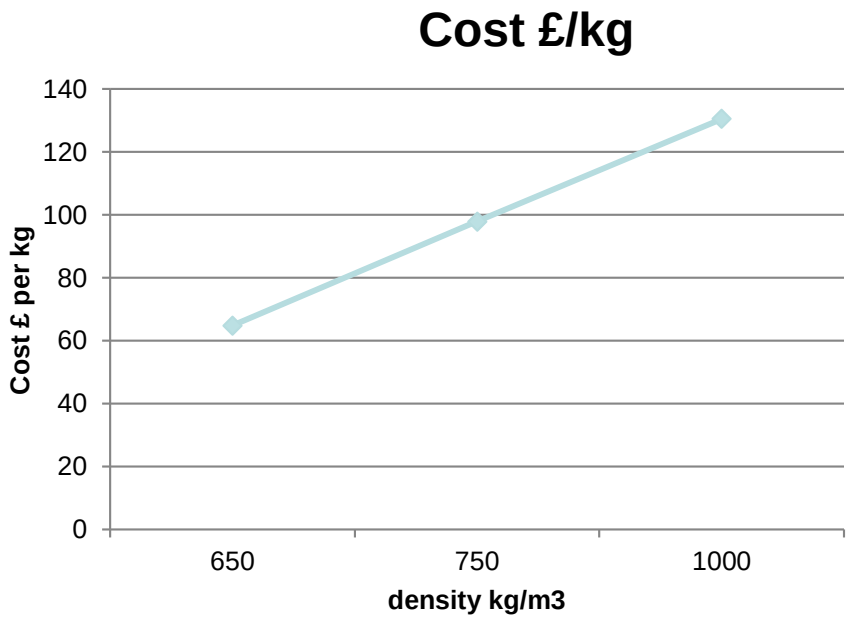
Pressing the panel

- Heat (180 – 210°C) and Pressure (0.5 – 5MPa) applied
- Closure and heat ramps controlled
  - Multi-daylight press Vs. Continuous press



Cost of production

- Approx. 60% is raw material cost



Assumptions
Wood £0.08/kg
Resin £0.46/kg (UF)
Wax £0.68/kg

Properties of MDF

- Standard properties
  - Internal Bond strength
  - MOE / MOR
  - 24 hour cold water soaks

- A whole array of other properties depending on the use of the panels

Improved properties of MDF

- Moisture resistant – from bathrooms to outdoor applications
- Fire resistant – addition of fire retardant, often with patented and secret formulations
- HDF – density over 800 kg/m^3
- Sanded and routed
- Laminated

Standards and regulations

- Hierarchy of standards
  - Industry bodies < National < ISO < European Standards
- Already mentioned the classification standards
- Standards for;
  - Classification
  - Quality Assurance
  - Physical properties
  - Mechanical properties
  - Decay resistance
  - Chemical release (VOC / formaldehyde)
  - Testing standards
  - Product standards (eg ‘the Toy Standard’; ‘Flooring’)
  - End of life disposal

Markets

EU MDF Production

- Grew 2.7% in 2015 reaching 11.8 million m^3
- Peaked in 2007 at 13.2 million m^3
- Germany largest manufacturer (3.6 million m^3)
- Surface improved panels represent 35% of production
- MR grade increased in production

MDF Consumption

- European demand for EU MDF 10.7 million m^3
- Extra EU sales 910,000 m^3
- Largest market was Germany followed by UK

Product mix

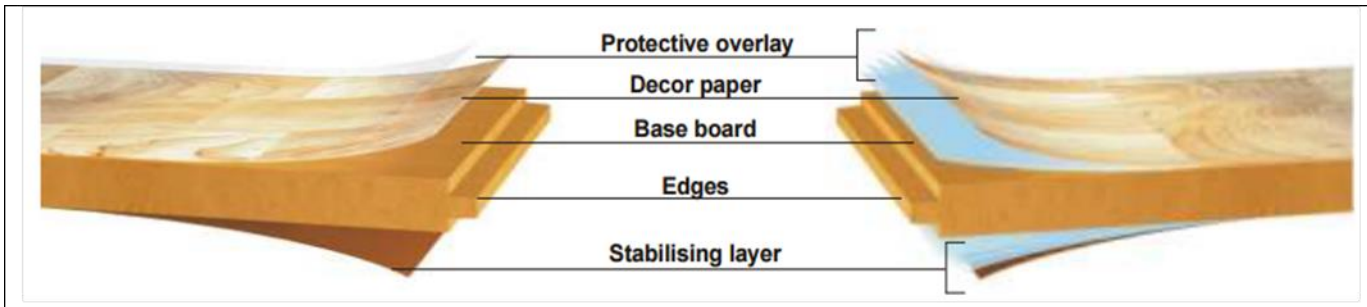
- approx. 45% of MDF production 9mm and above
- approx. 30% of production is 5mm to 9mm in thickness
- approx 25% of production less than 5mm

Hardboard production

- Increased by 6% reaching 616,000 m^3
- Main EU producer is Poland
- Main applications are packaging (32%) and DIY (20%) followed by furniture (19%), construction (9%) and automotive (5%) with other (15%)

Laminate flooring market

- Mature market
- Germany, France and UK key markets
- 452 million m^2 in 2015 (drop of 3.% compared to 2014



Furniture Applications

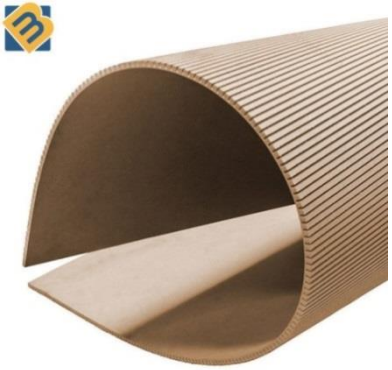
- Slow decline in EU but overall global growth
- Potential growth factors
  - Single occupancy on increase
  - Aging population
  - Functional products for children
  - Tax benefits (Italy)

Packaging Applications

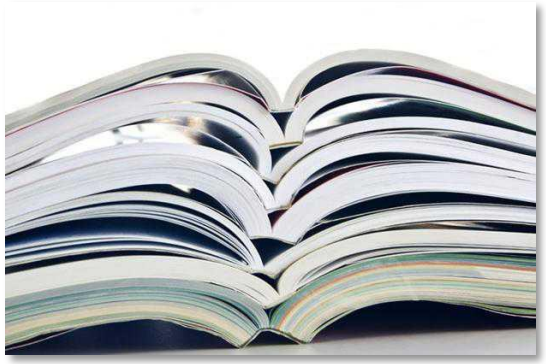
- Increased requirement for fresh products
- Smaller households-smaller pack sizes
- Convenience-life on the go
- Brand enhancement
- Environmental issues recycling or composting
- Aging population

Future Trends

- Insulation markets for fibres
- Packaging materials for fresh produce
- Recycled MDF
- Bendy MDF
- WPC



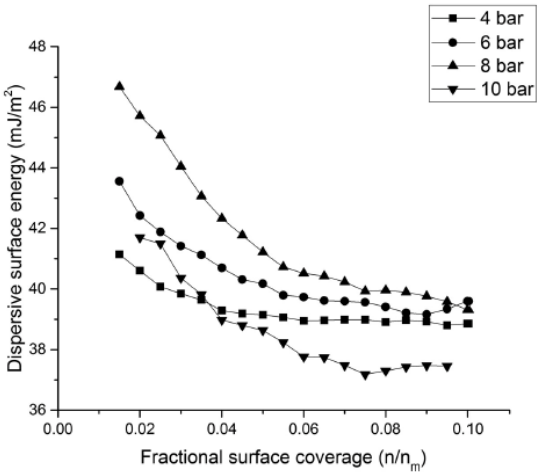
State of the Art - Research

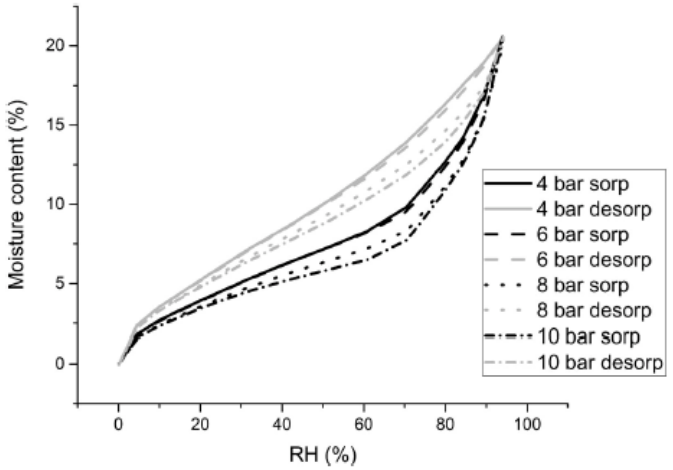


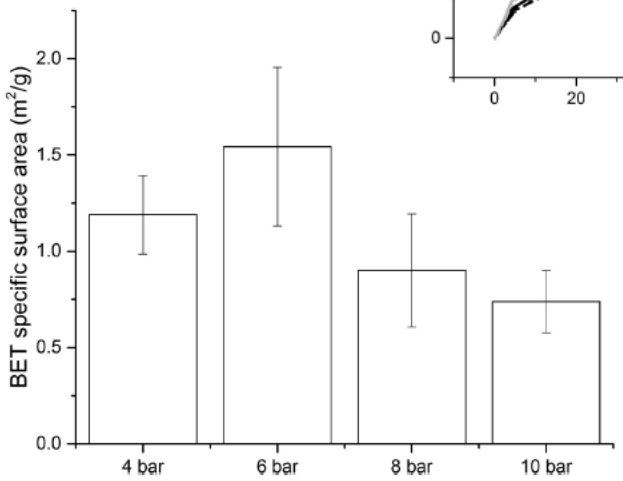
- Search of literature (2011-2016)
  - Fibreboard *15,900 returns*
  - Medium Density Fibreboard *11,400 returns*
  - High Density Fibreboard *10,200 returns*

  - Breakdown of main foci of papers
    - New resins
    - Replacement feed stocks for Wood
    - Understanding the effects of components on the properties of the panels
    - Environmental concerns (LCA)
    - Indoor air Quality (VOC release / formaldehyde)
    - Reuse, Recycled and End of Life

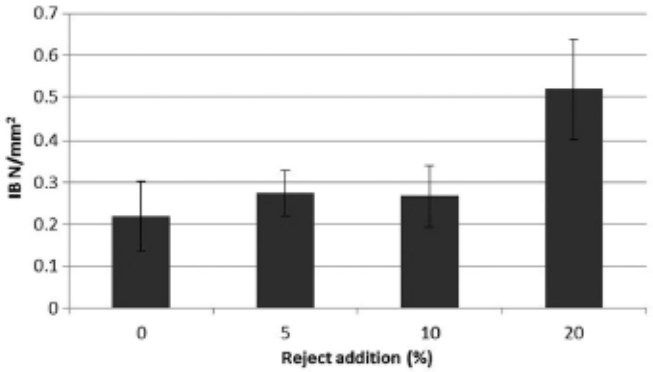
Ormondroyd, G.A., Kallbom, S.K., Curling, S.F. Stefanowski, B.K., Segerholm, B.K., Walinder, M.E.P. and Jones, D. (2016) Water sorption, surface structure and surface energy characteristics of wood composite fibres refined at different pressures *Wood Material Science and E*ngineering

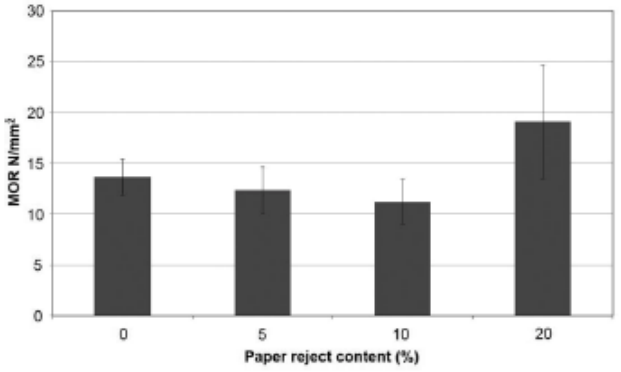


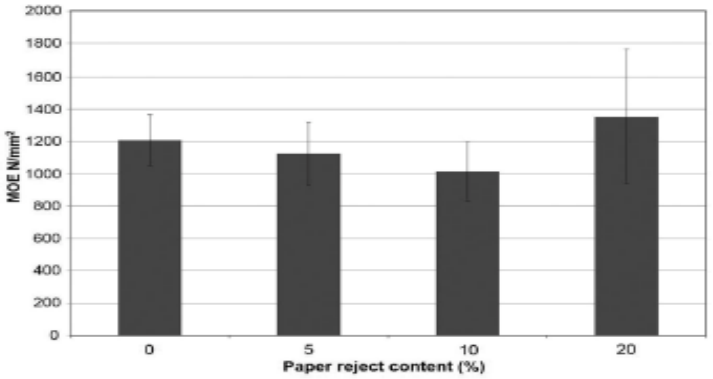


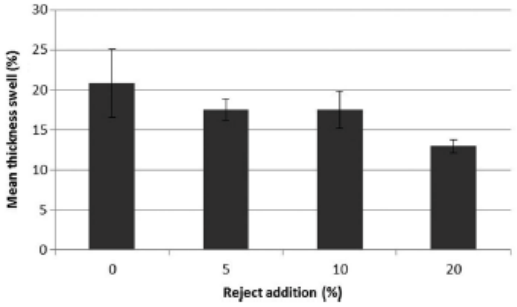


Curling, S.F. Stefanowski, B.K. Laflin, N. Davies, G. Ormondroyd G.A. (2016) The effectiveness of the incorporation of reject paper fibre into MDF panels. *International Wood Products Journal*

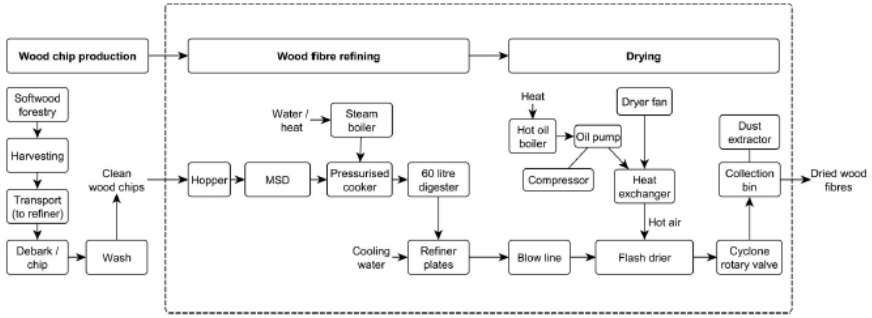




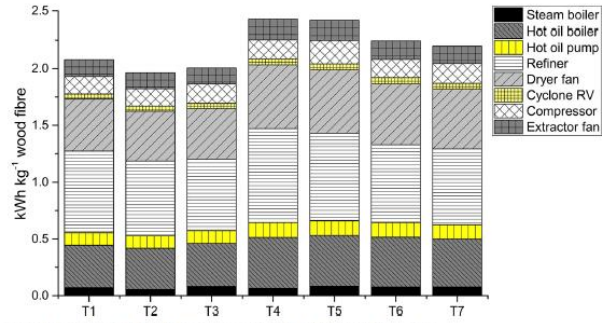




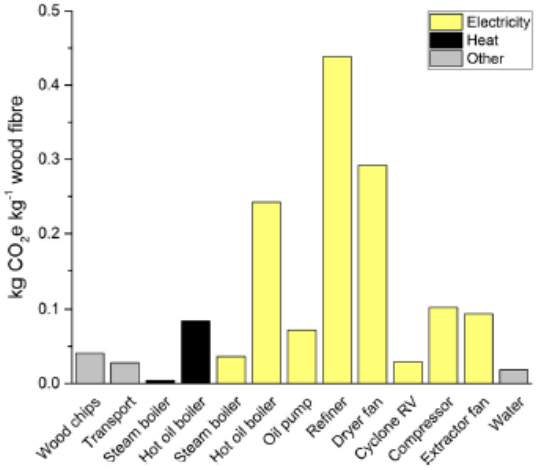
Skinner, C. Stefanowski, B. Heathcote, D. Charlton, A. Ormondroyd, G.A. (2016) Life Cycle Assessment of pilot scale wood fibre production using mechanical disc refining at different pressures. *International Wood Products Journal*



1 System boundary of the modelled wood fibre production process. Dotted line shows the shorter gate-to-gate processes of refining wood chips in to dried fibre. MSD = modular screw device



2 Comparison and breakdown of electricity usage across the different refiner trials



4 Breakdown of GHG emissions associated with pilot-scale production of 1 kg wood fibre at 8 bar (trial two conditions) using heat scenario 3 (100% biomass). (Data for wood chips includes all upstream forestry operations.)

Harry Earl Memorial Prize

- Awards of £500 are offered annually to assist with costs to attend events which support career development.
- Applicants should send a completed application form together with a current CV which includes the names of two referees.

http://bc.bangor.ac.uk/ipps/HarryEarlMemorial.php