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ANATOMICAL STUDIES OF WOOD TREATED WITH PRESSURE PULSE SHOCK WAVES

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Introduction

Similar to a normal wave, a shock wave travels as energy through matter but it causes an abrupt raise of pressure, temperature and density. In this study the influence of shock waves on wood structure were investigated in the light of possible future industrial utilization e.g. timber impregnating treatment.

Because of their anatomical structure some wood species, e.g. fir, are hardly penetrable. In this study the possibility of impregnation through pits with shock waves is also examined.

Methods

Shock waves were generated either by an electrical pulse breakdown of a spark gap arrangement (C see Fig.1) or by electromagnetic actuators (B see Fig.1) within a test fluid. In order to analyse the penetration depths, water stained with Aniline blue was used as putative impregnating liquid.

Preconnected to the shock wave event a vacuum pump or high pressure air compressor (10 bar) can be combined in the process (A see Fig.1). The cylinder (D see Fig.1) can be loaded with up to 4 wood beams simultaneously. The electrodes are made of Wolfram-Copper with a spherical shape. Shape and material are necessary for a durable spark mechanism. The electromagnetic actuator works via induction of eddy currents caused by a sudden current change. The magnetic force between the source coil and the metal disk results from the magnetic interaction between the source field and the eddy currents induced in the disk. Both mechanisms can be connected to the same energy source. As shown in fig. 5 a capacitor bank with an energy content of 900 J is charged and releases 20 kA and 30 kV in less than 20 μ s.

Results

Analysis via light and scanning electron microscopy (Fig. 2 and 3) show no success to damage the torus, instead the cell walls have collapsed and cracks appear at the end grain.

The impregnation depth achieved by using up to 50 shock waves in combination with air evacuation (vacuum) or pressure was equal to the trials without the use of shock wave.

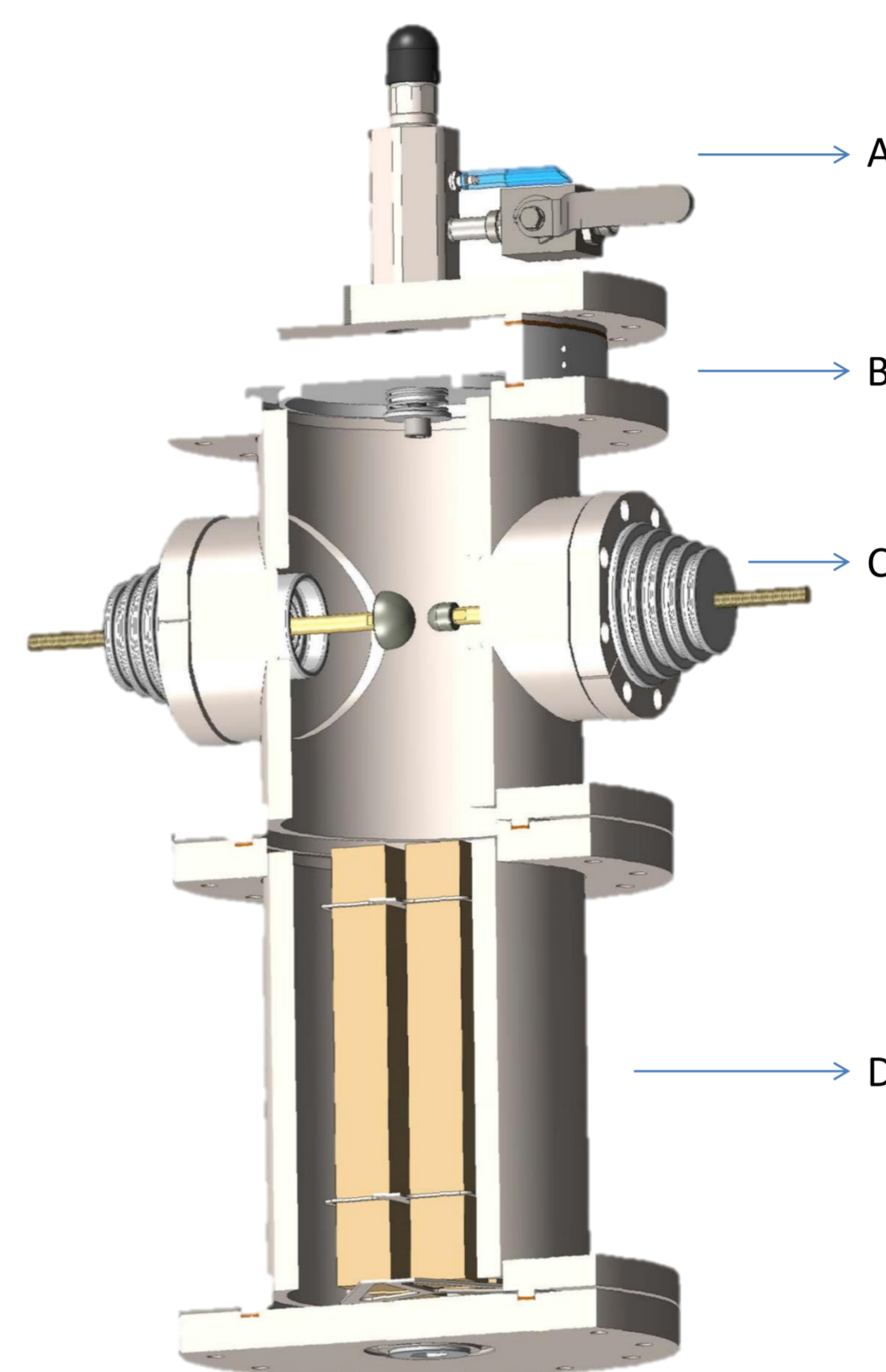


Fig. 1: Design of the autoclave A,B,C,D relevant components

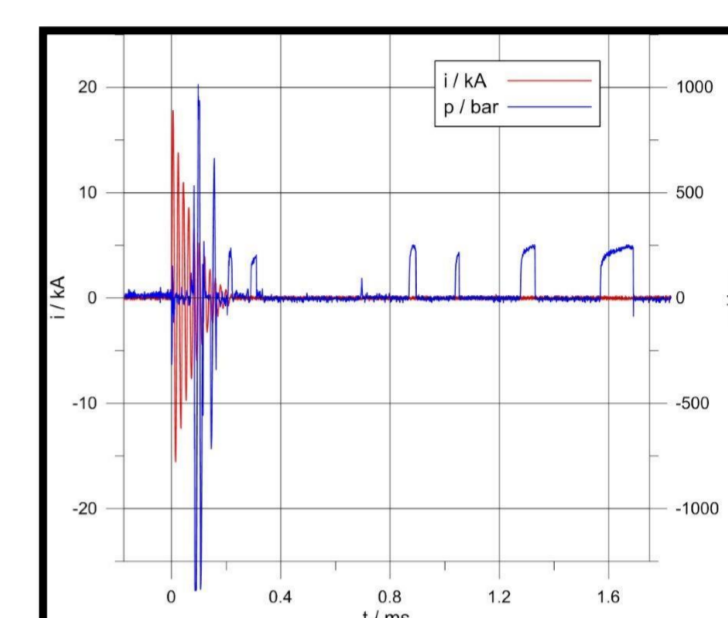


Fig. 4: Current - time curve (red) and pressure - time curve (blue)



Fig. 5: real life test setup

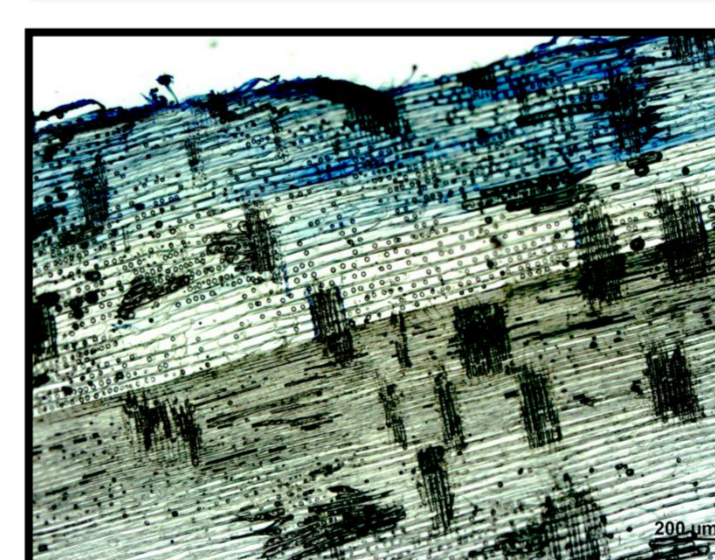
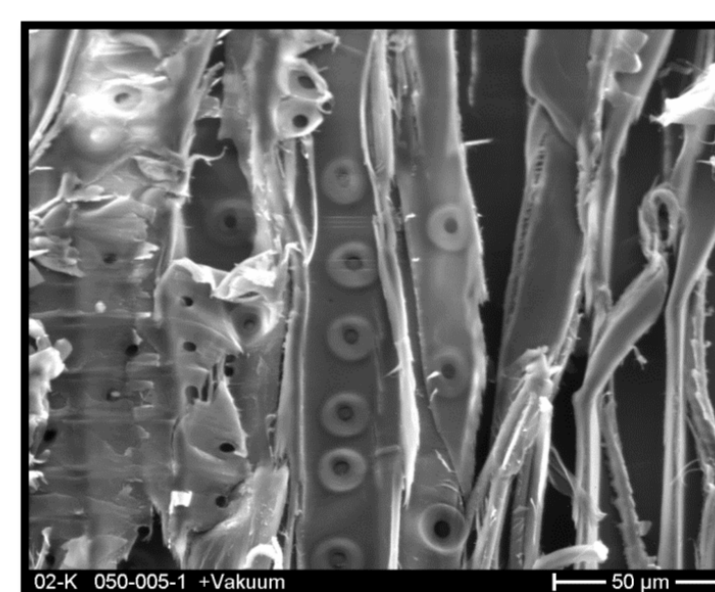


Fig. 2: Top: SEM image of control specimen fir; Bottom: Light microscopy of Anilin Blue penetration depth

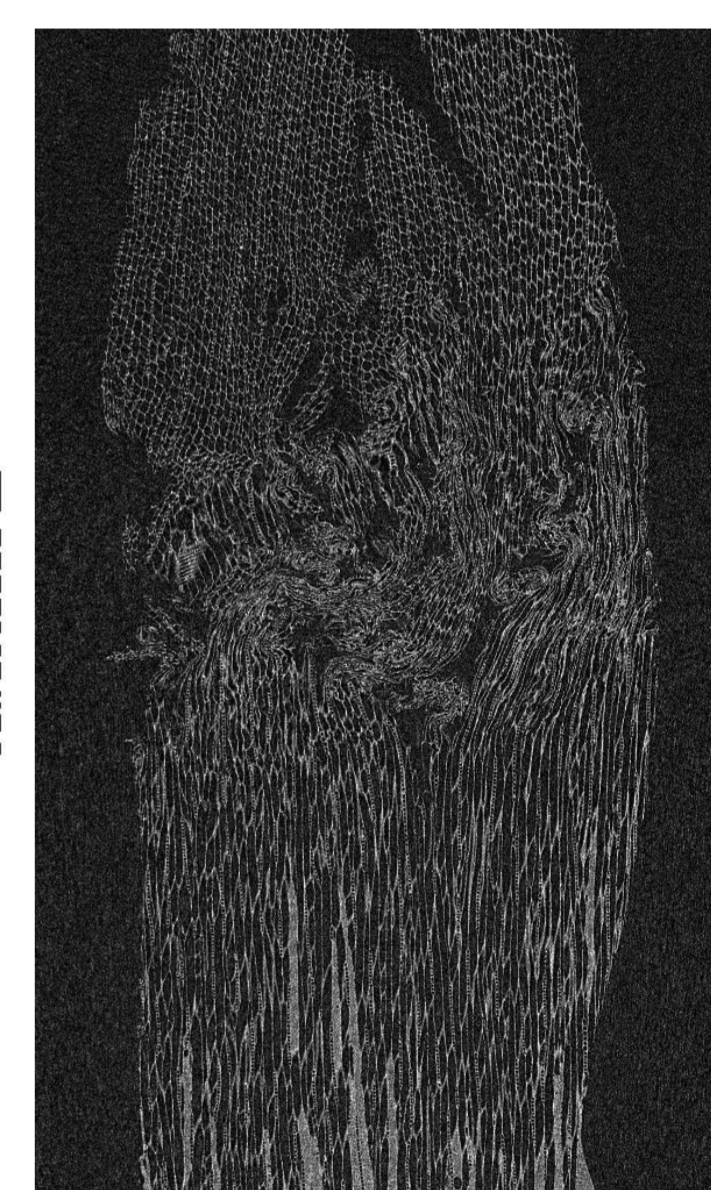


Fig. 6: 3D μ CT rendering of shock wave treated fir

In this study shock waves caused a destruction of wood cells similar to an dynamic compression force (Fig. 6). The damage on wood cells are irreversible, locally restricted and therefore not useful for any industrial process. The aim to crack the bordered pits has failed. An impregnation treatment, e.g. on fir, is still complicated, if not impossible.