

Jungbunzlauer Tripotassium Citrate:

Environmental and health friendly flame retardant in wood application

With intense ongoing discussions about the ban of various compounds in fire retardants mainly in Europe Jungbunzlauer was looking for an environmental and health friendly solution. Within this discussion, building trends are leaning also towards natural building material such as wood. Softwood is one of the main building material used worldwide. As wood is highly flammable it needs to be treated with certain methods in order to make it convenient for the construction industry. Tripotassium citrate is known for its characteristics to act as a fire retardant. For instance, tripotassium citrate is already widely used in cigarette paper in order to control the burning rate of cigarettes.

Tripotassium citrate monohydrate (TPC) is a tribasic salt of citric acid. It is produced by complete neutralisation of citric acid with high purity potassium hydroxide and subsequent crystallisation. It is an odourless substance, which is slightly deliquescent in moist air, very soluble in water and practically insoluble in ethanol (96%). It is a non-toxic, neutral salt with low reactivity and chemically stable if stored at ambient temperatures. TPC is fully biodegradable and can be disposed of with regular waste or sewage.

In several trials, we were able to discover a new characteristic in the field as fire retardant for wood: Wood impregnated with a TPC solution does not only protect the wood to catch fire but also builds an intumescent char, which additionally protects the lower layers of the wood against fire. Jungbunzlauer has conducted trials with different TPC solutions with solid wood, veneer and chipped wood. Target was to prove that a TPC solution can work efficiently as a flame retardant for solid wood. A single burning item test was chosen to prove above-mentioned properties of TPC. Several pretest were done in order to show a first tendency if TPC can be used for said application.

Veneer and chipped wood was watered in different TPC solutions (15-60%), a modified single flame test (EN 11925) was performed afterwards. Impregnated veneer was hold for 120 seconds into a flame in a 45-degree angle. We could observe a fast-extinguished flame, combustions marks were below 150 mm. Furthermore an intumescence layer could be detected which protected the layers underneath. An equal test was conducted with solid wood from pine and spruce. As preparation, wood was impregnated with a 30% TPC solution. Afterwards the impregnated wood was presented for 120 seconds to a vertical flame. Results were similar to those mentioned above: TPC formed in combination of wood particles and flame an intumescent layer.

We chose spruce for the SBI test as this type of wood is known to the industry as the one, which is hard to impregnate and to penetrate sufficiently due to its high rate of aspirated pits. Spruce boards were set under vacuum to remove entrapped air and were submerged in an aqueous 60% TPC solution. The moistened wood was set under a pressure of 9 bar for 20 hours letting the TPC penetrate into the wood. To reach equal results wood was dried at 23 °C/50 rH. The average impregnation ratio was 103% compared to untreated boards. An indicating SBI Test was performed following the guidance of an EN 13823 (reaction to fire tests for building products) test. The boards were tested by a thermal attack (30 kW) of a single burning item for 21 minutes.

During the test the (total) heat release and smoke production rate was measured. Additionally the flame spread and the potential formation of burning droplets were visually checked. The results were very promising as a 60% TPC solution could reach the highest class available for combustible material: Euroclass B. Additionally results showed very limited contribution to the fire and the TPC impregnated spruce was ranked with S₁ (hardly any smoke) and d₀ (no burning droplets). Furthermore, results with 60% TPC solution were so convincing that there is a huge potential to lower the ratio of TPC without compromising on the functionality as a fire retardant for wood.

Being a leading producer of TPC, Jungbunzlauer is able to provide a very promising natural alternative flame retardant for solid wood. The food-approved substance is safe and easy in handling. Furthermore, TPC is one of the few fully biodegradable and non-toxic flame retardants.