sweet

When we were little kids, now and then for a special treat, our Dad would make us toffee – it was one of those things he did! I just loved it; not just the end result but the whole process.

He would make it in an old pot over an open coal fire, which was the sole source of heating in our living room/kitchen. Although there may have been some butter and vinegar involved, the main ingredient was sugar. Held over the heat the sugar spluttered and melted into a syrup which, with further heat, thickened and turned a deep rich amber, achieving the magical transmogrification to toffee.

Controlling the process was vital! Dad always kept a glass of cold water in the hearth and, as he judged the time nearing, he would run a little of the melt into the cold water to quench it before checking its consistency. At a premature stage, he would pour the melt into a pre-buttered tray to allow the final cooking to occur while cooling. This stage was critical as a few seconds too much on the heat would render the toffee dark brown and with a less than pleasant burnt flavour. We still ate it all!

The whole process was in fact a very complex and not fully elucidated series of chemical reactions, often described by the umbrella word 'caramelisation'. Sugars (also described as carbohydrates) are molecules that have reactive chemical groups hanging off them, which can make them water soluble and water sensitive (hydrophilic is another word for this). The reactions my Dad was controlling involved the 'dangly bits' hanging from the molecules coming together, splitting of water (hence the spluttering) and building higher molecular weight, less water-soluble molecules (which a kid could suck for a long time!)

Wood contains a lot of natural sugars, which confer quite a lot of water sensitivity to timber; especially to soft woods.

These sugars, lumped together under the generic 'hemicelluloses', locked within the wood cells as well as in the interstitial areas, contribute to the cyclical swelling of timber and to the nourishment of many mould species. Tree lovers claim that these properties are because wood is a 'living' substrate. Sorry to disappoint but the tree died once it met the chainsaw and hydrophilic hemicelluloses produce the zombie properties.

To get back on track, these wood sugars can be subject to the same chemistry our Dad practiced. Heat treatment of timber can induce the same reactions (and more) as described above. Temperatures generally need to be between 180-220°C and the process must be done in the absence of (or at very low levels of) oxygen to avoid bonfires! Different processes require different degrees of drying of the wood before treatment and the treatment environment may be in an oil bath, an atmosphere of nitrogen or, probably most popular, steam. It may seem odd to use an atmosphere of steam in what is mostly dehydration (properly called condensation) chemistry but the steam actually encourages the reaction of the 'dangly bits'.

So (and because it is not yet fully elucidated there is a fair bit of opinion here) we have a situation in which low molecular weight hemicelluloses become upgraded to more water-resistant molecules, which is an improvement. Furthermore, the cellulosic cell walls have a few 'dangly bits' of their own which can be involved in these reactions and can become reinforced by the grafting on of the new upgraded molecules. Even the relatively inert lignins are upgraded through their 'semi dangly bits' being affected by heat treatment.

A possible drawback, apart from the costs involved are the development of the caramelans, -ens and -ins, which gave our Dad's toffee its colour.

The treated timber undergoes a slight weight loss (that's the spluttering again) and an increase in porosity brought about by the hemicelluloses migrating to the cell walls (still opinion!) and leaving voids from whence they came. The increase in porosity does not indicate water sensitivity; an unglazed brick will absorb lots of water but be totally unaffected by it.

This is borne out by the fact that thermally treated Pinus Radiata has a tangential expansion of 2.5% as compared to 5% for untreated material. This of course, leads to better dimensional stability.

As to whether the intrinsic durability of treated timber is improved has yet to be determined but my money is on an improvement. The equilibrium moisture content of treated Pinus Radiata is 30-40% lower than for untreated material, which is a very good indicator.

Our own testing shows that thermally treated timber is a relatively problem-free substrate for painting. There is no adverse interaction with the performance of alkyd-based primers and stains, nor for waterborne paints. The improved hydrophobicity may require adequate substrate wetters in waterborne stains.

There is a question regarding the mobility of the coloured moieties. Our most stringent testing has shown some stain transfer, which can be managed. There is a natural inclination for any such staining to be referred to as tannin or sap staining. Your scribe suggests that any colour will be due to our caramelans, -ens, -ins family, which is quite a different chemistry!

To reassure my devoted readers – yes, both of you, this memo was not sponsored by the thermally treated wood industry. After a lifetime of working to upgrade the properties of wood, both chemically and with various coatings I simply find that this concept is – well – sweet!