The Plato Technology

Since the 1950's research has been done on thermal modification of wood, based on heat treatment of (fresh or conditioned) wood at relative high temperatures: 230-260°C. This technology enables the upgrading of lower durability softwood and hardwood species like Scots pine, Norway spruce, Douglas fir, birch, and poplar, into wood products of constant quality. These products can be used for a broad range of applications such as garden fences and channel linings or even cladding, decking and exterior joinery. The main effect gained by heat treatment of wood is reduced hygroscopicity. The main advantages of wood treated in this manner are increased resistance to different types of biodegradation and improved dimensional stability, without the use of (toxic) chemicals. However, some undesired side effects, in particular loss of strength and increased brittleness were in the beginning the main objections for overall commercial utilisation of heat-treated timber. Development of suitable thermal modification techniques therefore focussed on optimisation of the process for a maximum increase of the dimensional stability and durability, while minimising the decrease of the strength.
An innovative heat treatment method, developed in the Netherlands, is the Plato* technology. This technology embodies an effective two-stage treatment under relatively mild conditions (<200°C). Originally this two-stage heat treatment is based on findings of H. Ruyter (1989) who started the development of this process in the Koninklijke Shell Laboratorium Amsterdam (KSLA). As a result of the oil crisis in the 1970's and an increasing concern about global warming, there was a worldwide interest in fuels and chemicals from renewable sources. In the KSLA laboratory of Shell, heat treatment processes at very high temperatures and pressures were developed in order to obtain fuels and chemicals from organic material. As a spin-off of this research a new process concept for the upgrading of wood was invented (Ruyter 1989), based on an adaptation of the process conditions. Developments in the 1990's, such as reduced oil prices and an increased industrial competition on a shrinking world market, forced companies back to their core business, and have led to the decision not to implement this project in Shell. In 1994 an independent research group was established in Wageningen (The Netherlands) to continue the development of this two-stage heat treatment method and to optimise the process conditions in order to develop an industrially applicable process and product. In the late 90's a pilot scale process was developed which resulted in the realisation of an industrial plant in 2000. Since 2001 Plato®WOOD has been commercially produced for a variety of applications, e.g. waterworks, garden wood and the building industry.

Currently, five distinct process stages can be distinguished including the two effective heat treatment stages (state of the art 2009):

1. pre-drying stage in a conventional industrial wood kiln to a moisture content of 14-18%;
2. hydro-thermolysis stage in a stainless steel reactor (fig. 1), the timber is heated to 150°C-180°C in an aqueous environment at superatmospheric pressure (including saturated steam as the heating medium);
3. drying stage in a conventional industrial wood kiln (fig. 2) using common procedures to a moisture content of 8-9%;
4. curing stage in a special stainless steel curing kiln (Fig. 3), the timber is heated once again to 150°C-190°C, but now under dry and atmospheric conditions; and
5. conditioning stage, the moisture content of the timber is elevated to a level, which is necessary for manufacturing (4-6%). Conditioning is done in the same conventional industrial wood kiln as the drying stage, including the use of saturated steam to increase the moisture content of the treated timber.

In the hydro-thermolysis stage saturated steam is used as the heating medium to increase the temperature of the timber. Cooling down is accomplished by flashing the reactor (a quick but controlled release of the pressure) to atmospheric conditions followed by spraying the inner site of the reactor with cold water. In the curing stage the timber is heated with hot air, generated by heaters and circulated with ventilators. Above 110°C superheated steam or nitrogen is add as a sheltering gas to exclude oxygen and to prevent oxidation reactions.
As can be concluded from the description of the Plato technology, no chemicals are used. Small quantities of organic compounds in the liquid waste steam extracted during hydro-thermolysis (condensate), drying (wood moisture) and curing (wood moisture) are dealt within water treatment facilities. Gaseous compounds extracted from the curing oven are treated in a scrubber system to condense water from the gas stream – including any organic matter and extractives from wood – and to minimise odour.

Fig. 1 Industrial plant for the hydro-thermolysis stage

Fig. 2 Industrial kiln for pre-drying, drying and conditioning of timber during heat treatment

Fig. 3 Industrial kiln for the curing stage