IMPROVING QUALITY OF PLANTATION WOOD
Through
NOVEL DRYING TECHNOLOGIES

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A B S T R A C T

An indepth understanding the problems associated with the processing of plantation wood and development of appropriate drying technologies are important for the economic exploitation plantation woods. Forest Research Institute, Dehra Dun have recently developed novel technologies for the processing of some of the plantation woods by adopting special sawing techniques, proper humidity oriented kiln drying schedules, energy efficient dehumidification drying and press drying under vacuum. Commercial trials cum demonstrations of these technologies have generated a confidence among the timber entrepreneurs and given a new hope in taking these species into commercial use. The details of work done sofar are presented in this paper.

INTRODUCTION

In view of rapidly shrinking natural forests, the country has by and large, to depend on fast growing plantation species for the requirements of wood. Though some species like eucalyptus, poplar, rubberwood etc. have great potential for producing standard quality sawn timber they pose several problems during drying. An in depth understanding of these problems and development of appropriate drying technologies are important for the economic exploitation of these plantation woods.

Presence of high residual growth stresses have been found to be a significant feature of small girth logs from short rotation plantation grown timbers. Such wood is prone to excessive warping, collapse and even splitting along the pith during sawing. Transverse shrinkage anisotropy and excessive longitudinal shinkage are other most striking features of juvenile wood. In mature wood longitudinal shinkage is negligible (0.1%). Where as in juvenile wood it can be as high as 2% depending upon species and presence of reaction wood. Such a high longitudinal shrinkage makes the drying process difficult and leads to serious defects in wood such as splitting, warping, cupping, twisting etc. during drying.

Forest Research Institute, Dehra Dun have recently developed novel technologies for the processing of plantation wood by drying schedule, dehumidification drying and press drying under vacuum. The details of work done sofar are presented in the paper species wise.

EUCALYPTUS HYBRID

The experience gained at F.R.I. has shown that fine end cracks on the freshly cross cut ends of **Eucalyptus** hybrid logs occur almost immediately. However, if the ends of the log are coated with black bituminous paints and stored under shed/shade, extension of these initial end cracks, which otherwise results in extensive damage, is almost completely eliminated.

The normal plain sawing method generally adopted in the saw mill does not suit to this species as the sequence of sawing is highly asymmetrical relative to the log centre about which the growth stresses are more or less symmetrically distributed and in balance. This sequence of sawing disbalances the stresses, resulting in immediate warping (bow) and spring of the sawn timber as it comes out of the saw (Sharma etal 1988). Often dimetral planks have been found to split all along the pith during sawing. To overcome this problem the Institute has developed two innovative sawing methods for **Eucalyptus** hybrid i.e. Modified Radial Sawing and Balanced Tengential Sawing which effectively control sawing distortions and minimise degrade during subsequent kiln seasoning.

Radial sawing can be adopted to advantage if wider material for doors and windows is required and the logs are available in larger girth (more than 1 meter). Required width of material for furniture use may be obtainable by this procedure even from smaller girth logs (Pandey etal 1984). Balanced Tengential Sawing procedure is adopted if wider material for door and window use and furniture is required to be obtained from smaller girth logs (Sharma etal 1988).

Freshly sawn timber should be properly stacked over batten ensuring verticality of each line of battens. The stack inside the kiln should be uniformly weighted on its top using a load of atleast 400 kg per square meter to control warping during seasoning. Indian Standard kiln drying schedule No. VI of IS:1141-1993 is used for kiln drying radially sawn material whereas 5 percent high relative humidities compared to this schedule is used for material obtained by balanced tangential sawing technique. The seasoning results have indicated that nearly 10 to 12 days (working 24 hours a day) are required to kiln dry 25 mm sawn planks from green condition to 12% moisture content (Pandey etal 1984).

In rapidly dried material drying stresses and steep moisture gradient can persist for long periods and cause considerable trouble from cupping in further wood working operations. A combined moisture conditioning and stress relief treatment is an essential part of kiln drying practice for **Eucalyptus** hybrid. It has been found that nearly 4 hours steaming at 50°C at the final stage of drying is essential for removing the stresses and steep moisture gradients in 25 mm planks of this timber (Pandey etal 1986).

Based on the above findings, number of commercial trials-cum-demonstration have been given recently in the different places in Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh & Gujarat State. This has generated a confidence among the timber entrepreneurs and given a new hope in taking this species into use for joinery and furniture works.

POPULOUS DELTOIDES

Populous deltoides is another extensively planted agroforestry species on which studies have been done extensively. Major problem encountered in seasoning of plantation grown poplar is severe warping due to release of inherent longitudinal stresses. When logs are sawn by conventional cant method to get the desired size of planks, growth stresses cause crook to occur at the headrig. Further additional crook develops in drying because of non-uniform longitudinal shrinkage and the inherent low resistance of planks to drying stresses.

Earlier studies on air and kiln drying behaviour of **Populous deltoides** revealed that though it is not difficult to dry, the material is prone to severe distortion. The reason for the tendency to warp is predominantly the presence of residual longitudinal growth stresses. The major defects observed in all seasoning are bow, crook, honeycombing. In conventional kiln seasoning also, as per the usual schedule, the species has shown severe bow, spring and twist. The values of degrade observed in on of the kiln drying experiments were recorded and are presented here in table below alongwith permissible values to demonstrate the ineffectiveness of conventional seasoning method for this species (Pandey etal 1991).

Table - 1

Observed Vs permissible degrade of different kinds over length of 215 cm.* during kiln drying.

Type of Degrade	Extent of degrade & (No. of planks)				Permissible deviation
	Insawing		After kiln drying		
Bow	7-8 mm	(2)	16 mm	(2)	8 mm
	3-5 mm	(5)	8-11 mm	(6)	
	Nil	(5)	3 mm & below	(4)	
Spring	Note recorded		15-18 mm	(3)	10 mm
			10-11 mm	(4)	
			3 mm & below	(5)	
Twist	Nil	(12)	20 mm	(1)	63 mm
			10-12 mm	(5)	
			4-6 mm	(2)	
			4 mm & below	(4)	
Cup	Nil	(12)	4-5 mm	(3)	
			2.5 mm	(2)	2.54 mm
			Nil	(7)	

** Estimated on proportional basis from permissible norms for 300 cm. length.*

In the conventional kiln drying, degrade in the form of bow, spring and cup was the most serious defect. hardly any plank was free from warping degrade of one kind or the other. In addition several planks developed moderate to severe collapse. Planks free from collapse or having slight collapse belonged to outer positions in the log. However, a reconditioning treatment for 6 hours showed appreciable recovery in the collapse.

To over come this problem Forest Research Institute, Dehra Dun has now developed a new system of sawn wood manufacturing process known as Saw Dry Rip (SDR). In this method first the logs are sawn in thick section slabs keeping the thickness of slabs equal to the width of desired ultimate planks. These slabs are then rough edged and are dried under high temperature drying as per schedule given below. The slabs thus dried are ripped into planks of desired width (Pandey etal 1993).

High temperature drying schedule :

Initial moisture content	:	more than 50%
Dry bulb temperature	:	102°C
Wet bulb temperature	:	96°C
Duration	:	96 hours

Followed by reconditioning :

Dry bulb temperature	:	60°C
Wet bulb temperature	:	86°C
Duration	:	6 hours
Final moisture content	:	12 - 15%

When the material is dried at high temperature, it is theorised that the lignin, which naturally bonds fibers together, is plasticized and the stressed fibers slip to a neutral or unstressed position. The lignin then rehardens and wood is stress free.

THE COMPARATIVE PERFORMANCE OF DRYING BY DIFFERENT METHODS

Air seasoning	**Kiln seasoning**	**High temperature drying**
25 mm thick planks 40-45 days	25 mm thick planks 6-7 days	100 mm thick slabs 4 days
Prone to severe distortion	28-57% rejection due to warp and honey combing	5-8% rejection due to warp

On the basis of above discussion it can therefore be concluded that SDR and high temperature combination is much better suited for the processing of **Populous deltoides** as the percentage of rejects due to warping were minimum.

The SDR and high temperature combination is successful for the degrade free seasoning of plantation grown **Populous deltoides** due to the following facts.

1. Stress is balanced by live sawing.
2. Wide planks restrain warp.
3. Drying stresses offset growth stresses.
4. Lignin is plasticized at high temperature.

TECHNOLOGY OF VACUUM PRESS DRYING

Research over the past few years has produced significant advances in the seasoning of sawn timber from plantation wood species. However, drying of timber like eucalyptus is a very slow process involving a long period of drying under conventional mild drying conditions. Even under best control of drying conditions fine surface cracks, and collapse degrade some portion of the timber. Recent improvements in wood drying technology such as vacuum press drying can offer substantial benefits over conventional wood drying techniques due to the reduction in drying times and the increased seasoned wood quality. This drying technique works on the principle of lowering of the boiling point of water and the subsequent generation of an over pressure within the wood. This pressure gradient causes an acceleration in the internal liquid migration rates, enabling water to be driven off efficiently from the wood.

Preliminary drying trials carried out recently on 40 mm thick planks of plantation grown **Eucalyptus** hybrid using vacuum press drying kiln have shown very encouraging results. It is found that the timber could be dried in short time of 96-100 hrs with much lower degrade levels than with conventional drying where it takes nearly 25-28 days. Almost all the planks thus dried were free from warp. The total energy consumption per kg of removed water in vacuum drying is about half in comparison to conventional kiln drying. This drying system is also pollution free though the initial costs are higher.

CHEMICAL DEHUMIDIFICATION BASED WOOD DRYER

The Forest Research Institute has also recently researched on another pollution free efficient wood seasoning system and designed and developed a desiccant type dehumidification drying kiln in collaboration with a private organisation M/s. Bry-Air (Asia) Pvt. Ltd., Gurgaon. Drying trials carried out in this kiln have shown that drying time saving to the tune of 20-25% may be achieved in comparison to conventional drying system. Being a very compact, mobile and eco friendly unit, and not very costly, it is highly suited to timber manufacturing entrepreneurs operating within city municipal limits where installation of boiler based kiln may be prohibitive due to environmental reasons (Pandey etal 1995).

Similarly seasoning technologies and procedures have been developed and perfected for most of the plantation species like rubber wood, acacias etc.

Thus it is evident that good quality sawn and seasoned wood can be obtained from otherwise problematic plantation species by adopting appropriate technologies developed for these species at Forest Research Institute and this plantation wood could be successfully used replacing conventional natural forest wood with economic advantage.

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