Report on Consultation Work for Green River Panels., Hat Yai August 2008

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Abstract. This report details observations on the plant inspection carried out over one week in August 2008. It lists the major problems, and gives short and longer term recommendations including a program of future work by the author..

1. Introduction

The Green River Panels plant in Songkhla Province, Southern Thailand produces approximately 500m^3 per day and the press has a design capacity of about 640m^3 per day. The plant is based around a Dieffenbacher continuous press and uses solely rubber wood in the form of slabs from the adjacent sawmill and roundwood from rubber plantations.

1.1. Major Objectives of Visit

The major objectives of the visit were to identify the major issues of a very new plant and to set up systems to optimise production and improve both board quality and costs of production.

1.1.1. *Problems with Particleboard manufacture*

The following major problems in particleboard manufacture were identified:

- Poor surface quality of particleboard in particular dust and glue spots.
- Poor bending strength.
- High resin consumption especially in the core 8.9%
- Blending inefficiencies.
- Poor furnish balance i.e. either too much or too little surface material generated
- Poor optimisation of sanding and sawing

2. Particleboard production

2.1. Flake preparation

This section includes chipping and flake preparation. The Buttner dryer is state of the art and I will look at dryer control on my next visit. The areas mentioned previously are problematic and require urgent attention. All the furnish is rubber wood and is in the form of sawmill slabs, 30 - 50% and round wood directly from plantations, 50 - 0%. All material has bark on and there is a considerable volume of dirt and mud in this raw material. Because all of the slabs and roundwood contain bark this naturally accumulates a lot of dirt. However the real concern is the dirt and mud being scraped up to the log loading area by loaders which is finding it's way into the furnish.. Figure 1 shows the sawmill slabs that come from the company owned sawmill adjacent to the particleboard plant. Figure 2 shows the roundwood from the rubber plantations. All of this material has bark on and all of this material is chipped in a drum chipper currently fed by a grapple crane, (Figs 3, 4 & 5. All chips produced are conveyed to an elevating conveyor and dropped into large piles next to two infeeds hoppers which are fed by loaders (Fig 6). This material is then conveyed to two disc screens where firstly the undersize material is removed (Figure 8) then the oversize material is removed (Fig 7). The oversized material does not return to the chipper. The capacity of both discscreens are insufficient and it can be seen that they are only acting as a conveyor in that only the bottom portion of the chip is being screened, the chip on the top is not being screened at all. It is strongly recommended that the first screen be increased in capacity by adding enough disc rollers to double the length of the screen. The spacing of the rollers in the second screen should be increased as some of the material that is being removed is very good furnish for the flakers. It would be ideal if the large chips removed by the disc screens are re chipped to gain a better utilisation of all of the furnish. All of the accept chip goes to Meier ring mill flakers. If it is not possible to increase the size of the disc screens then vibrating screens with sufficient capacity should be used. However the configuration and capacity of the screen will have to be designed carefully. It need only be a two deck screen with overs being re-chipped and fines going to the furnace.

The Meier flakers have a fixed ring with the knives and wear plates and the beaters rotate. It is essential that the wear knives/plates be regularly changed so that they do not have excessive wear causing poor quality flake to be produced. Figure 9 shows excessive wear on the beater plate and large gaps at the centre of the wear plate. Figure 10 also shows the position of the beaters in relation to the knives and wear plates and Figure 11 shows the general configuration of the flaker. It is important that the radius of the curve of the beaters does not exceed 5mm and that they are rotated regularly to ensure a square face. It is essential that the knives of the flaker are changed at sufficiently frequent intervals, certainly no greater than twelve hours. The way to determine the optimum interval to change knives is to do a flake analysis immediately after a knife change and then every 3 hours. The important variable is the amount of dust produced i.e. <0.5mm. It would be ideal if there is sufficient data for me to analyse on my return to Thailand. At present the fraction of flake >4.0mm varies from 8 to 68% within 12 hours which is too much variability (Fig12). Note also large variability in fines in core flake (Fig13) i.e the amount of surface flake in core fraction varies between 0-20%. This leads to excessive fines in core leading to excessive resin usage and low bending strength and lack of surface material., both of these characteristics are caused by inconsistency of quality of flake from the flakers due to knives being too long in place. I would initially suggest that knife changes every nine hours would be a good interim step. Given the frequency of the knife changes and the fact that production volumes and hence demand for flake will increase, it is desirable that another flaker be purchased so that one can be maintained and two can be running. The other alternative would be to have two sets of rings complete with knives and wear plates that can be readily changed with minimal downtime on the plant. It is also recommended that until all of the chip is effectively screened for fines, the knife projection on the flakers be increased from 0.8 - 1.0mm to give the knives better life and better quality flake. Normally a narrower projection is more desirable but this is predicated upon having clean chip supplied to the flakers. Poor flake geometry is having a negative effect on MOR properties and due to the quality of flake from the flakers it is difficult to maintain consistent core to surface flake ratio.

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Figure 1. Sawmill slabs making up 30 - 50% of total raw material input.

River Panels/Images/Roundwood1.eps

Figure 2. The roundwood sourced from rubber plantations making up 50 - 70% of total raw material input

River Panels/Images/Grapple.eps

Figure 3. Grapple loading chipper infeed conveyor.

River Panels/Images/Infeed.eps

Figure 4. Chipper infeed conveyor

River Panels/Images/Chipper.eps

Figure 5. Chipper

River Panels/Images/Chippiles.eps

Figure 6. Chip piles

River Panels/Images/discscreen.eps

Figure 7. Discscreen removing oversized chips

River Panels/Images/Discsreenunder1.eps

Figure 8. First stage of discscreen removing fines, note screen is grossly overloaded

The flake is then transferred to wet flake storage silos from where it is dried with the Buttner Drier. I did not do a detailed analysis on the drier but will do so next visit with particular emphasis on drier control and constant ex dryer flake moisture contents. It is recommended that water load sprays be included in the drier to ensure that all of the fines removed in flake classification plus all of the sander dust is burnt. This system will also give the flexibility to burn more or less dust depending upon dryer load.

2.1.1. *High grit content of furnish*
A factor noted above is that the furnish raw material contains large amounts of dirt. The log yard area is very dirty. The passage of grit into the flakers and then to the furnish and surface of the board will create many problems with machinability of laminated board. I will discuss testing for grit levels when I am next in Thailand.

2.1.2. *Flake classification*
Flake is then classified using two PAL flake classification screens, with equal amounts of material going to each and the screen configuration is the top screens are shown in Table I.

There is an inbalance between core and surface flake, due to incorrect configuration of PAL screen sizes and insufficient suction on the outfeed of the dry refiner limiting it's capacity to generate enough high quality surface material. The correct core to surface ratio needs to be generated from the PAL screens for the thickest board produced. As board sizes get thinner more surface material is required, which is generated by the dry refiner from core accept flake.

I would recommend that as all of the flake comes from ring flakers, the current square 10.5 x 10.5 get rid of large chips is much too large and these screens should be no larger than 3.5 x 40mm which would reduce the chunky flake that I observed and would increase the aspect ratio

Table I. Screen configurations for the PAL flake screening system

Deck	**Screen 1 (mm)**	**Screen 2 (mm)**
Oversize	4 of 3x40 & 4 of 10.5x10.5	All 3x40
Core accepts	All 0.7x2.1	All 0.7x2.1
Surface accepts	8 of 0.237 & 8 of 0.192	6 of 0.237 & 8 of 0.192 & 2 of 0.11

River Panels/Images/meier1.eps

Figure 9. Close up image of flaker beaters showing wear at the corner and wear plates showing excessive wear

(length/thickness) which would have a significant positive effect on bending strength.. An observation of the flake is that the core flake has too much fine material and the surface flake has an excessive amount of dust and in both cases consuming too much resin. This fine material not only uses a lot of resin but also causes significant reductions in board strength properties, particularly bending strength. Core accepts passing through this and should be held by a combination of 0.7x2.1mm & 1.27mm screens. Ex screens dust in surface can vary between 0 - 5% (Fig14). This can also result in excessive dust in surface which causes dust and glue spots. Surface flake should be sieved over a 0.405mm bottom screen through which passes dust which is sent to the furnace and burnt. This would remove most of the grit that will be a problem to laminating and dust that is a problem with dust and glue spots..

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Figure 10. Image showing relative position of the beaters, knives and wear plates

Given the size of the screens and the resultant poor quality of the core and surface flake it is strongly recommended that the flake classification systems be completely reconfigured along the above lines to remove the fines from the core flake and to remove the dust from the surface flake. This will also enable more dust to be burnt in the drier reduce resin usage and improve bending strength.

When the flake screens are optimised as per recommendations above, it is important to get the surface to core balance correct. Thinner board needs more surface material and thicker board needs less. Thus it is important to be able to generate more surface material using the dry refiner when making thin board and not generating too much surface material when making thick board. The balance of the screens should be set by determining the capacity of the dry refiner and working out how much surface is needed to be screened when making the thickest board.

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Figure 11. General configuration of the static knife ring in relation to the beaters

Then as more surface is required for the manufacture of thinner board, flake is bypassed to the dry refiner mill prior to the flake classification screens to generate the extra surface material. After dry refining this finer material is of course re-screened. The big issue with the dry refiner is that there must be sufficient suction to remove all of the material to ensure productivity of the equipment and in doing so reducing the risk of fire and explosions. It is also important to keep the edges of the beater sharp as with the flakers and also regularly check the screens for holes and dulling of the cutting edges. The more worn the screens, the greater is the friction and consequent risk of explosion. This piece of machinery is the ***single largest source of fires and explosions in particleboard plants***. Figure 15 shows a series of images showing the dry refiner.

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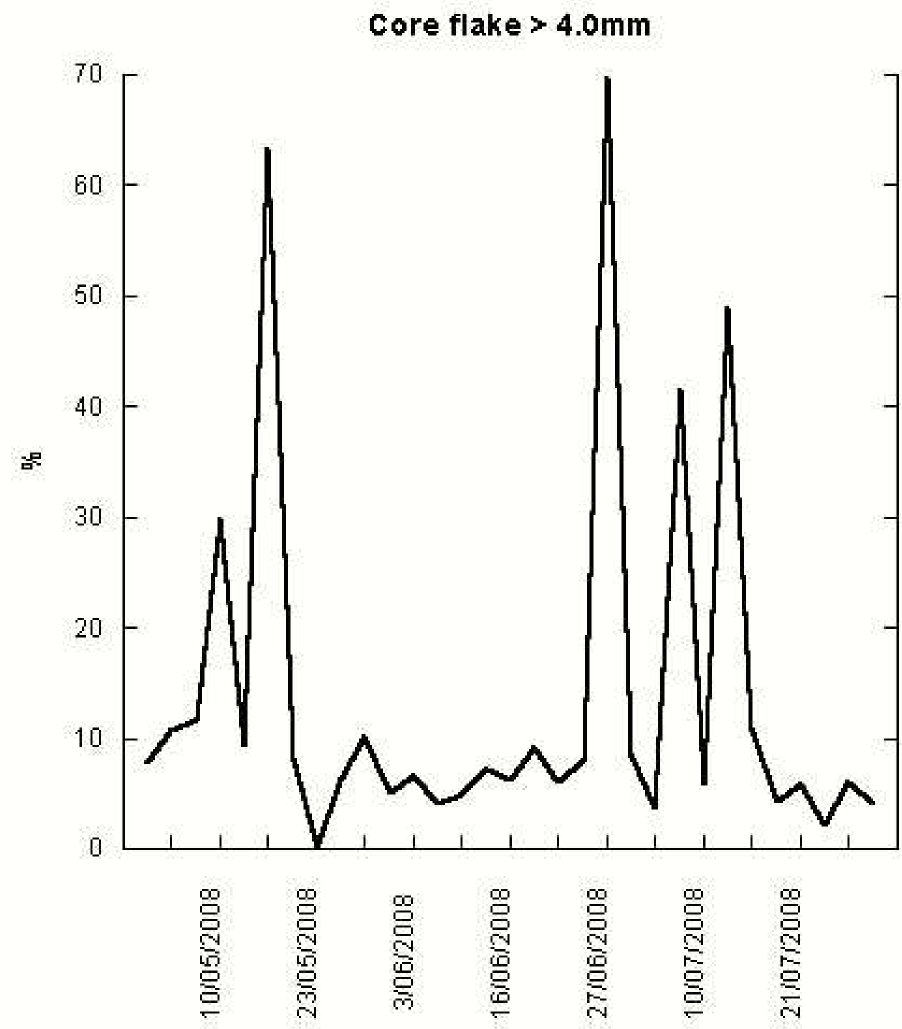

Figure 12. Proportion of flake >4.0mm note large variability

Regular sieve analysis should be done on surface and core flake, as well as regular surface grit tests the method of which I will discuss on my next visit..

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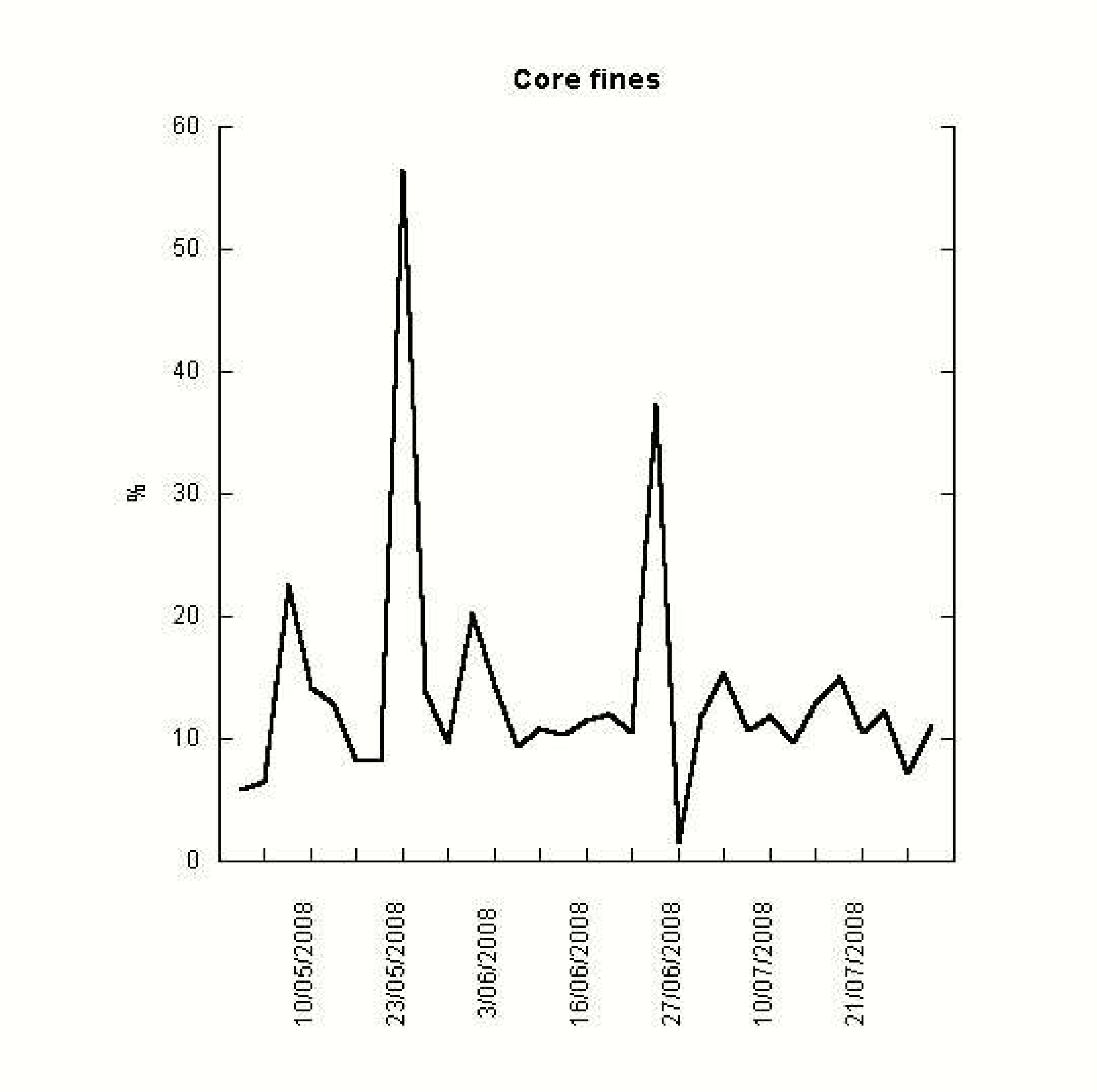

Figure 13. Fines in core flake

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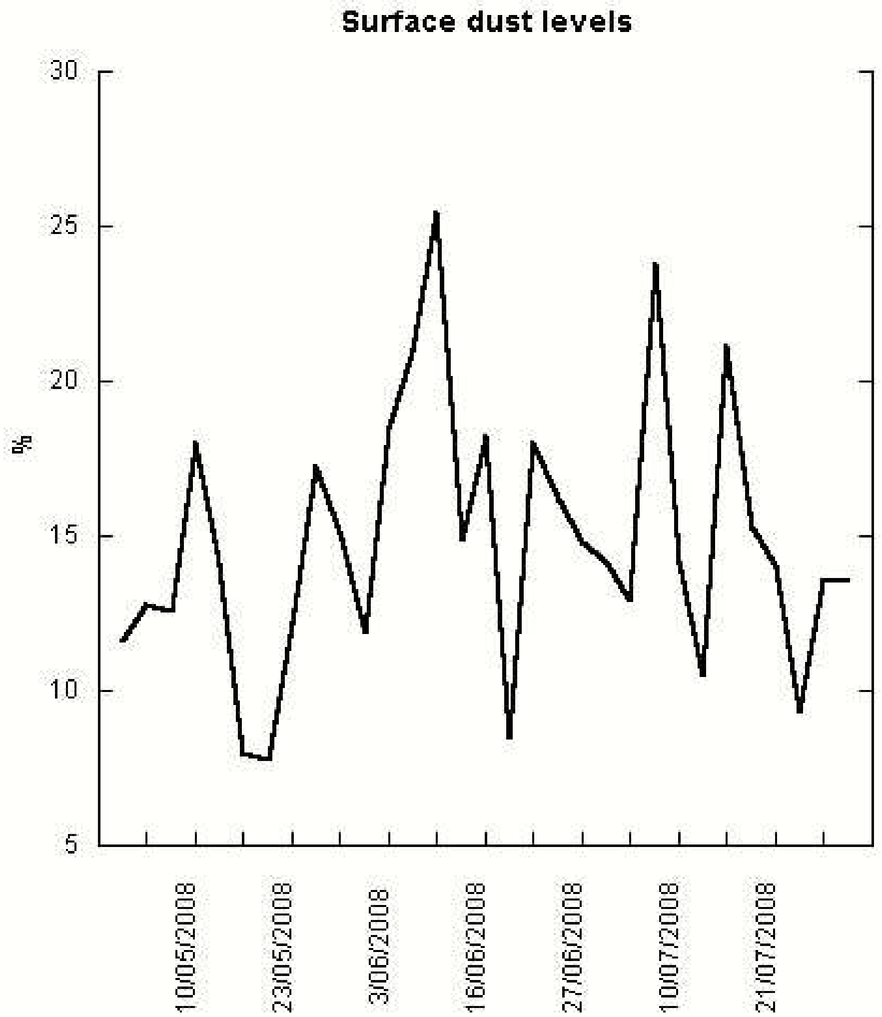

Figure 14. Dust levels in the surface flake

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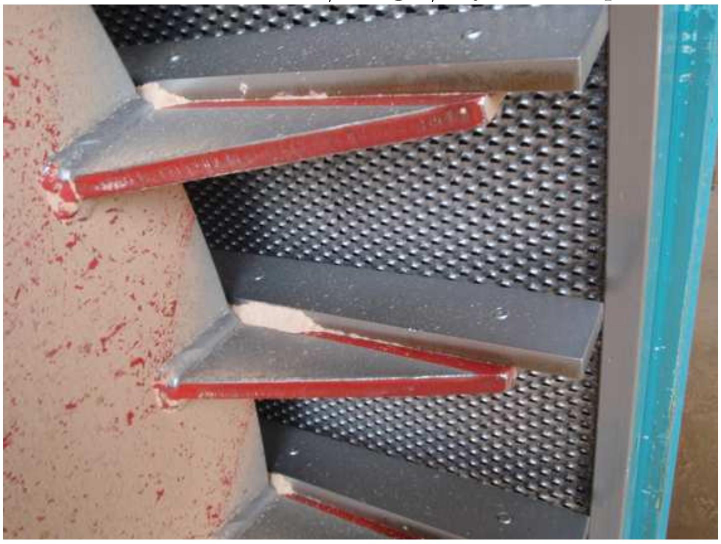

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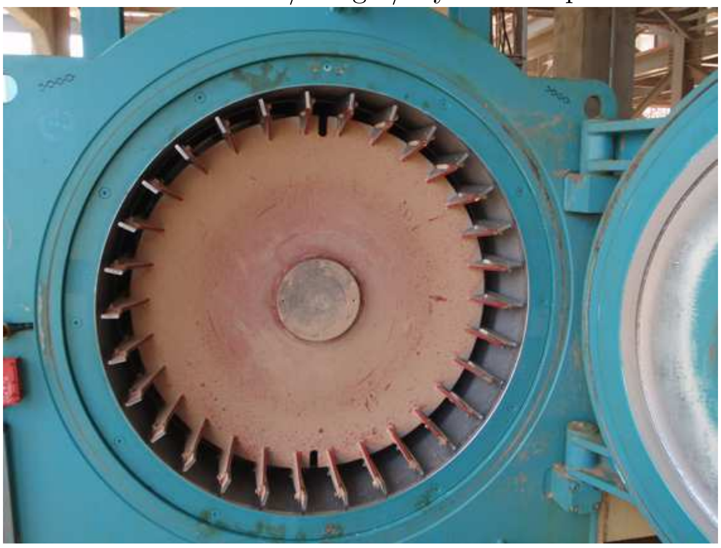

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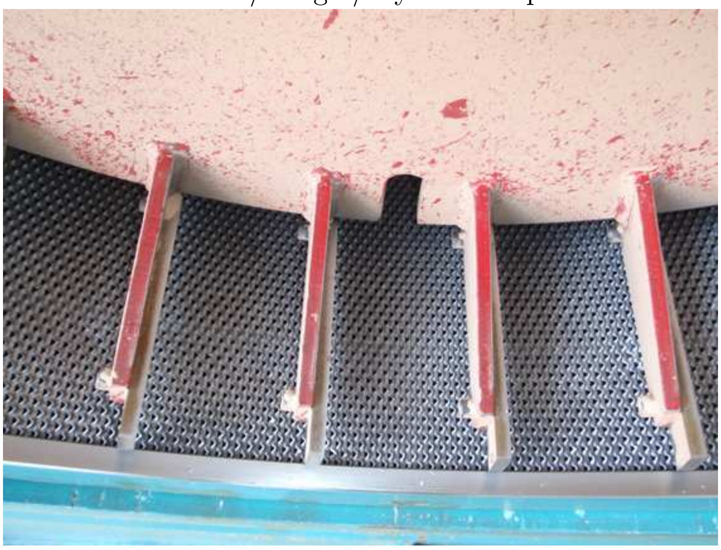

Figure 15. Images of the dry refiner showning screens and beaters

2.2. Explosion and fire mitigation

It is essential in particleboard plants that there is sufficient explosion venting on all dry flake areas. Ideally a Firefly spark detector system along with inert gas extinguisher systems should be installed however the former is much cheaper than the latter and while not preventing explosions will significantly minimise the damage from them.

2.3. Blending

Blender needs to be set up correctly . Outfeed flaps need to be directly controlled to optimise blending.

This is an area that is very problematic due to the type of blenders in use and the insufficiency of cooling capacity resulting in cured resin build up in the blenders as well as pre-curing of the resin prior to pressing resulting in substantial resin overuse and a reduction in board properties. It is also resulting in the blenders having to be cleaned too frequently causing excessive downtime (Fig17). It has also necessitated that the blender horns are set too far away from the blender shell which dramatically reduces the efficiency of blending, in some cases up to 32mm (Fig16). They should be no more than 5mm from the shell of the blender. There are no controls on outfeed flaps to ensure correct motor current and hence blender dwell time. It is also essential to find the correct paddle and horn angles and set accordingly. I could not find any evidence of these in the manufacturers engineering drawings. Figure 18 shows the variation in horn angle setups which is sub-optimal. It was noted that hardener is added separately to the resin in the core blender. It is essential that in-line mixers be used so that the resin is fully mixed with hardener prior to injection. If this is not done resin is overused. It is recommended that PAL blenders be purchased for both core and surface flake as this will significantly reduce resin usage. It is essential for the optimal manufacture of particleboard that blender setups be correct. Blender setups need to be worked on especially positions of the injections nozzles, angles of paddles and horns.

Core resin loading is 8.5 - 8.7% w/w on dry flake i.e. 8.5kgs of resin per 100kgs of dry flake and the surface resin loading is 9.8%.

2.4. Pressing

The Dieffenbacher forming line and press are superb however due to flake quality limitations, and blending inadequacies, there are a number of issues that arise from the pressing operation that bear no relation to the press at all. The most obvious is dust and glue spots (Fig19).

River Panels/Images/horn1.eps

Figure 16. Note excessive distance between blender horn and shell of blender

However there is too much variation in the way operators run the line as evidenced by the graph of variation in linespeed (Fig20). Operating conditions should be set and permission for significant changes to these should only come from senior technical or production staff. Figure 21 shows variation in the properties of internal bond and bending strength. If this variation could be reduced which I will achieve a consequence will be the reduction of resin usage. Note that bending strength is borderline due to poor flake geometry and internal bond is too high.

2.5. Sanding/sawing

The three sanders with grit sizes of 60, 100 and 120 (per inch). The sanded board has a large amount of dust marks. The main issues with sanding and sawing are:

River Panels/Images/horn2.eps

Figure 17. Image showing buildup of resin on blender horns due to insufficient cooling.

- Master boards ex press should be to the maximum size that the saw can handle i.e. 6m this will increase productivity at the cut to size saw.
- Boards going through the calibrating sander should be but to but, a solid ribbon of board being sanded. This will increase the productivity of the sanders which will be essential when the press operates at maximum capacity.
- There is a lot of opportunities to increase productivity through the saws the main one being dont stop line when unloading packs. Have two A grade bins and one B grade bin. When one A grade bin is full and unloading, the second can be used without shutting down the sanding/saw line.

River Panels/Images/horn3.eps

Figure 18. Image showing variation in horn angles.

- Saw infeed conveyor needs to return in upper position enabling next board to be immediately ready for sawing. This will have a major impact on the productivity of the saws and consequently sander.

- Need to use plastic staples on WIP board to minimise thumbtacks destroying sander belts. This reduces the potential of thumb tacks being sanded and destroying very expensive sander belts.

- Testing of the surface of sanded boards should be done on a regular basis. There are two potential test methods;

1. A low gramage (40gsm) colored paper should be laid across the full board width, this would involve a number of sheets of the paper. The paper is then rubbed with a large crayon at least 75mm in

River Panels/Images/dustspot.eps

Figure 19. Dust spots in the mat prior to pressing.

length. The sheets of paper should be examined in the light for any sanding or surface defects.

2. A large piece of chalk again 75mm in length should be rubbed across the board. This chalk mark is removable and it is a good method to check for pinholes in the surface or any sanding defects. This method is more discriminating than the paper/crayon method.

3. The diagonals of boards need to be measured after sawing to ensure squareness of the boards.

It is essential the test methods above be introduced at the sander grading station and conducted on a regular basis. This will uncover sanding faults as well as pinholes. The crayon test is for the quality of the sanded finish i.e. looking for tramlines, grit, dust holes etc. and

River Panels/Images/linespeed.eps

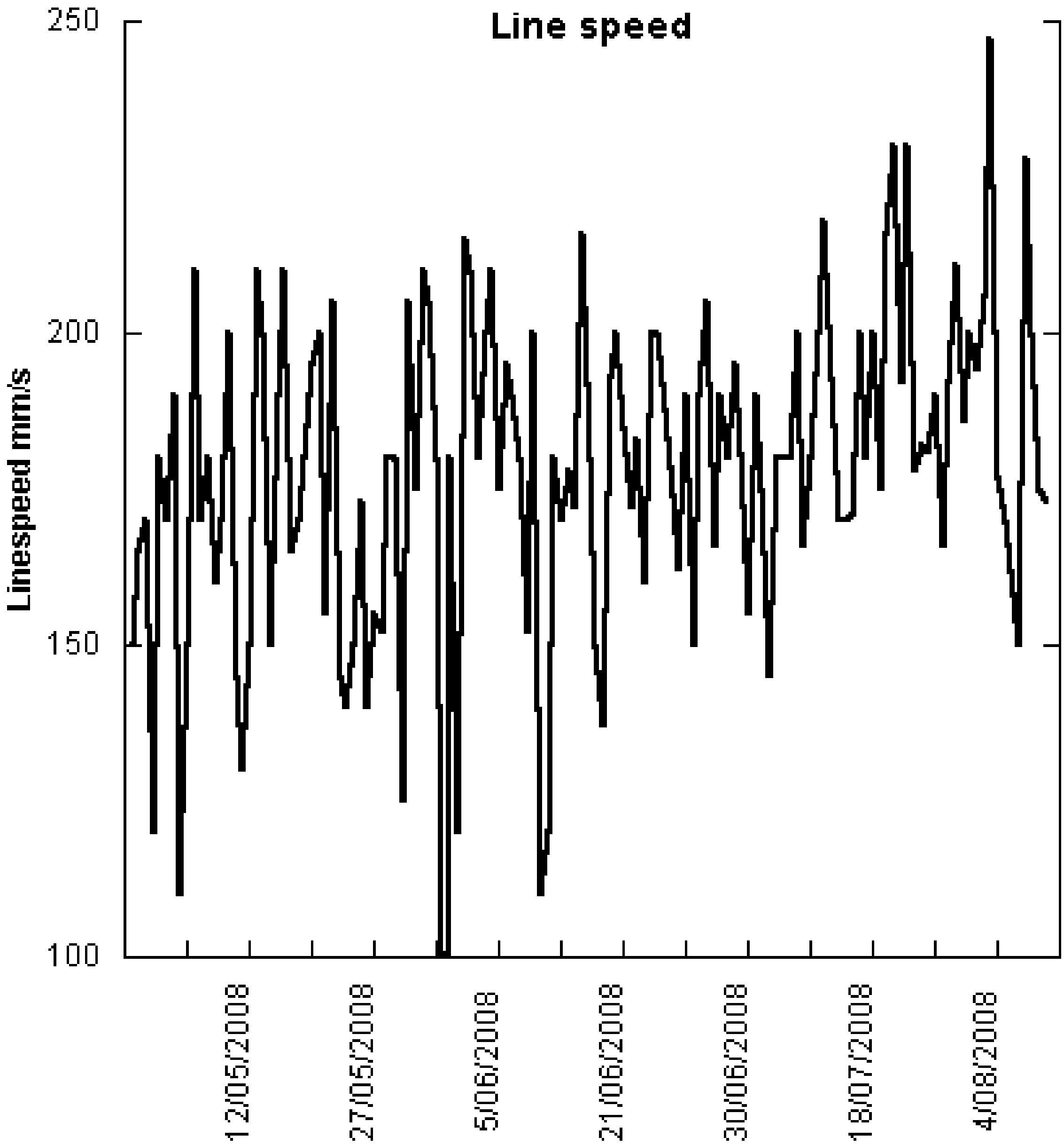

Figure 20. Graph showing variation in linespeeds on the press.

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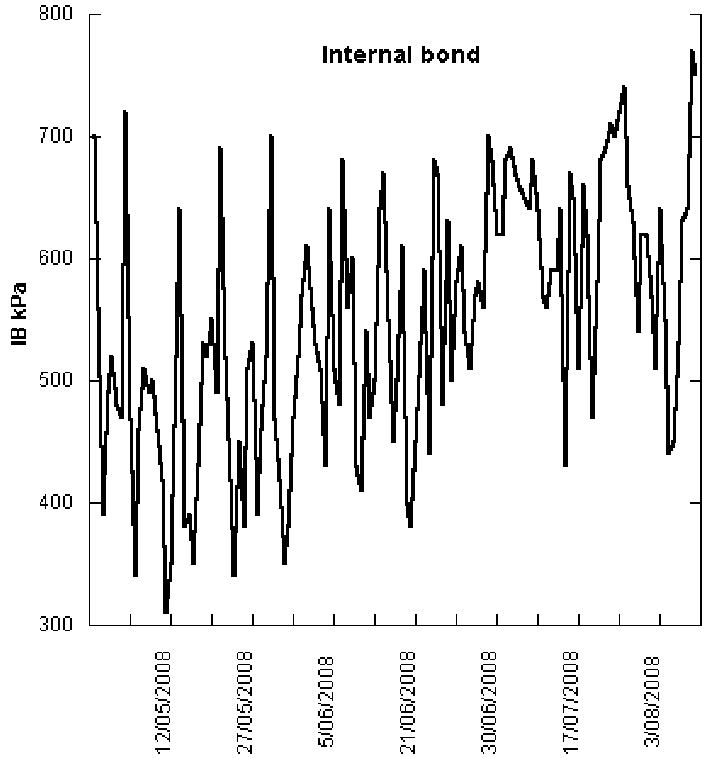

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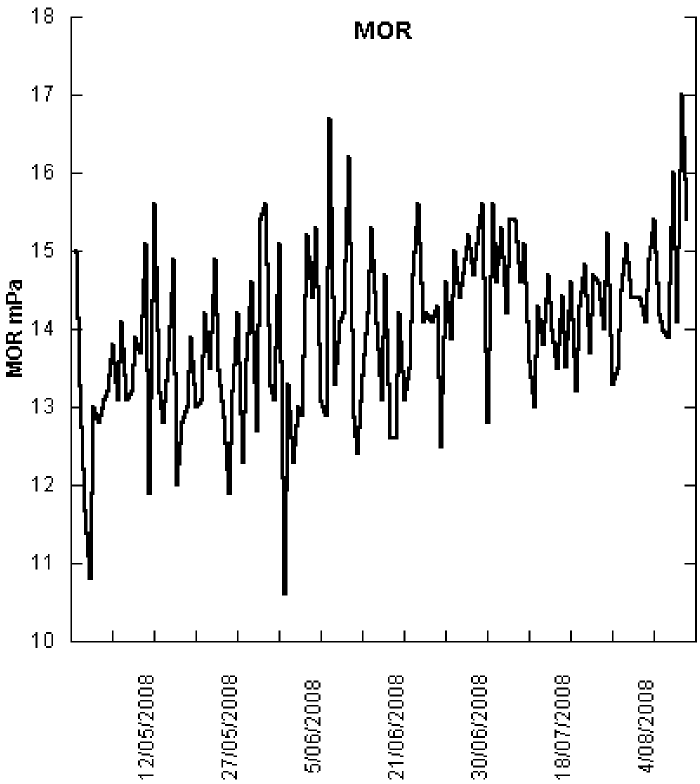

Figure 21. Variation in internal bond and bending strength.

should be done across the full width of the sander. The chalk test is done to test the effectiveness of the pressure bars, i.e. once they start to wear a wave pattern appears after the sander which the chalk test will pick up. These tests should be done twice per 8 hour shift and records of the crayon test should be kept.

Sanded board was observed where there was a significant imbalance of the amount of surface on each side. This is a major cause of warp especially after laminating. As such it is also important to determine that the board is sanded equally on both sides. This is especially important when the amount of surface is reduced as I hope will be the case in this plant. The method is simple, with a router rout to a depth of approximately 4 - 5mm every 300mm across the board for a length of approximately one meter. Do this on both sides of the board. Measure the depth of the router exactly using Vernier calipers. Sand the board and again using vernier calipers measure the depth of the routed lines ***in exactly the same spots*** as before sanding. The difference between the two is the amount of material removed by the sander. To adjust the sanding depth on both sides, it is the first sander that needs adjustment. The method is to raise or lower the calibrating rollers immediately before the sanding head to ensure even sanding on both sides of the board.

3. Summary of opportunities for improvement in Particleboard

- Improve flake classification by removing dust from the surface flake, removing grit (ash) from the surface flake currently >1.0% should be <0.05%, and removing fine material from the core flake.
- Improve the management of the logyard especially rotation of stock, i.e. consume oldest stock first.
- The logyard must be properly maintained with dirt and mud holes cemented over so that loaders and trucks do not spread mud.
- Discscreens must be increased to correct capacity.
- Flaker mills; new wear plates and increase knife projections to 1.0mm and collect data time knife change 0, 3, 6 and 9hrs for me to do an analysis on correct knife changing protocols and PAL flake screen configuration
- The flake classification screens must be checked monthly for blockages and holes.

- Remove dust leaks and improve overall cleanliness in the particleboard area to reduce the serious risk of explosion.
- Reconfigure PAL flake screens to correctly balance core: surface and remove dust and grit on basis of above I will provide advice on screen sizes. Improve the surface to core balance, currently 40% surface : 60% core, should be 35% surface : 65% core for an average size board such as 16mm.
- Regular sieve analysis should be done on surface and core flake, as well as regular surface grit tests.
- Implement correct blender setups: and install new chillers, Correctly set paddle and horn angles Set correct distance between horn and blender shell Correctly set outfeed flap pressures
- Improve blending efficiency through examining blender setups including way resin is injected into blenders without pre-mixing. This includes the use of inline static mixers to improve the mixing of the catalyst and the resin. Blenders must be setup according to the specifications. For the blending of surface flake, the water should be added in the drop chute before the blender.
- Forming station at each stop over 15min, check and clean screens. This will reduce dust spots dropping off the screens causing glue spots.
- Rebalance calibrating sander to achieve even surface spreads at formers (saving of 7% surface flake) using the router test method to measure depth of sander cut
- Increase master panel size
- Butt to butt sanding of board
- Modifications of saw loading conveyor required
- Outfeed bins at saw when unloading stops sanding line. There is a huge potential to improve sanding/sawing productivity and this will be needed if line is to perform at 200,000 cubic metres per year
- Use plastic staples instead of thumbtacks as the latter will destroy sander belts and the former wont
- Flake data ex knife mill collected by lab staff should be fed back to production in order to optimise knife changes This can be done ex drier and drier m.c. measured at same time

- Resin C of A data should be plotted including Viscosity, gel times, solids content, temperature at despatch (must be lower than 20C)
- When making a product only need to collect samples every 6hrs. Currently over-sampling, very expensive. Data should be plotted and made available to production
- Flake data ex screens should be collected twice per shift
- Need to do gel times on resin mix at blender to determine adequacy of hardener addition. This is more important than carrying out tests on raw resin in the lab
- Investigate and improve rawboard properties, this to be done on subsequent visits by author.
- Improve the surface quality of the board to make it more suitable to laminate.
- Testing of sanded boards according to the methods above should be done twice each shift and at each product change.
- The amount of material removed during sanding should be equal on both sides and this should be checked with the method detailed above.

3.1. Measures required to confirm problems and opportunities for improvement in Particleboard

1. Flake classification measures (sieve analysis)
2. MOR, MOE & IB
3. Board profile measures
4. Resin distribution
5. Direction of warp and measure mm/m
6. Surface grit/ash content
7. Blender dwell time
8. CEN thickness swell and 1 hr boil
9. Amount of sand-off i.e.precure

10. Measure of post cure
11. Glue bond durability i.e. MOR A test 2 hr boil followed by MOR test
12. Resin consumption per 100kgs of flake.
13. Machinability based on spindle moulder test i.e. chipout per 100 lineal meters. A new tool should be used for each test and up to 500 lineal meters must be machined.

3.2. Longer term improvements

- Explosion vents need to be placed on all dry cyclones, bag houses and dry flake bunkers, especially after dry refiner.
- In longer term should investigate Firefly/Halon system given the amount of drag chains in use in the process.
- Need to measure density profile of the board so as to optimise resin recipes and press profiles
- Need to undertake a suction system audit plant wide. Improved suction will improve performance of dry refiner.
- Introduction of a moisture resistant board using melamine fortified UF resins.
- To consume all sander dust and fine material at furnace may have to put water load into drier.
- Need to institute formaldehyde analysis for board or regularly get board tested for formaldehyde
- Need to test for surface grit levels especially if board is to be laminated
- Make board to E1 and ultimately E0 and super E0 formaldehyde standards

4. What value I can add to the business

- At 200,000m^3 resin spend is US$11.5m. With my technology on wetting physics and ability to increase blending efficiencies I can save the company US$2m per year on resin expenditure alone.

- Set up technical systems to ensure plant is run to full potential
- Train key personnel in technology of particleboard and how to run process
- Optimise machine settings.
- Suggest improvements to operation
- Set up meaningful process measuring and control systems
- Ensure suppliers of resins have processes in control
- I have access to technology that is unique in world to enhance the efficiency of the process
- With my knowledge of paper impregnation and laminating I will be able to assist the company in this direction.