Report on visit to D & R Henderson, Benalla
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Introduction

The purpose of the visit was to present a training package to managers, supervisors and operators of the laminating operation at the D & R Henderson operation at Benalla. It was also to review the laminating operation, which ran a Dieffenbacher LPM press.

Presentation

The presentation was in four stages;

1. The process of making low pressure melamine panels, specifically impregnation and coating of LPM paper (prepregs).
2. The main causes of defects of LPM panels.
3. The importance of understanding the physics fluid flow and its relationship to the successful production of LPM panels.
4. The affects of the structure of decor paper on fluid flow and the production of LPM panels.

Most individuals understood the first two parts of the presentation however parts 3 & 4 were less understood, only by those with some technical knowledge. Thus it is recommended that if the presentation is to be done again then only more senior technically knowledgeable people be present for parts 3 & 4.

Review of the Laminating Operation

The laminating operation is less than two years old and could be considered “state of the art”. It is based around a Dieffenbacher press with a very sophisticated two pallet paper lay-up each of which can turn paper which is essential for laying up of colours however at the moment the only papers that are pressed here are 75gsm White and 85gsm Pearl, which are not turned. Given that the treater has one, gravure roll and one smooth roll, this is surprising especially for the heavier paper, given the possibility for differential treating for this press given the degree of control of resin application using Gravure rollers.

Treated paper

Treated paper comes primarily from the Windsor treater however some paper has been sourced from Carter Holt Harvey at Mt Gambier. According to operators this paper could be pressed considerably faster than paper from Windsor. A number of pallets of treated paper were examined. It was noted that while some of the paper sourced from Windsor was adequately stacked i.e. variation of less than 5mm, whereas other pallets were very poorly stacked, one in fact had one end square and had the *lengths* of the paper varying by up to 25mm. This would have led to

significant missing paper defects of if the shorter paper were the correct length, then significant defects caused by torn paper lay-up or paper chips.

Another pallet exhibited significant streaking at the edges caused by “flapping” in the ovens. Other defects seen were dry spots in the form of small circles up to 8mm in diameter. Dry spots on the smooth coating roller at the MF stage of the treater cause these. This is usually caused by insufficient wetting agent for the MF coating resin exacerbated by low surface energies on the roller itself.

The paper from Windsor also appeared green and I would suspect would have a fairly low B stage cure. This may be a legacy from the time when paper was made for the superseded press, which suffered from significant pre cure no doubt due to inadequate press hydraulics resulting in slow press closure times. Comments by operators that sticking paper does occur on hotter days. It was mentioned that the company is considering refrigerated storage. There is no doubt that making paper with sufficient B stage cure would solve this issue without the need for any expensive storage arrangements. Volatile measures were from 5.5 to 6.0%. With a 75 gsm White, it would be desirable to reduce volatiles to about 5.0%, which would in turn increase the B stage cures, which would have a number of positive concomitant benefits as already shown with the running of the CHH paper.

It was noted that pallets are usually stored on top of one another. This should be avoided as it can lead to damaged paper and a far greater likelihood of blocked and sticky paper. It is also recommended that after a pallet has been partially used, the plastic wrapping recover the pallet to save on dirt and damage to the top sheets.

Paper from Windsor also looked as though it had a lot of resin on it, however this was an observation in comparison to similar treated papers from other manufacturers.

It was noted that paper from Carter Holt Harvey at Mt Gambier ran well with significantly faster cycle times that equivalent paper from Windsor. This is no doubt due to the greater degree of cure of CHH treated paper.

If the paper from Windsor had extended cure then the press cycles which will be discussed in the next section could be made significantly quicker.

Pressing operation

The press is capable of running at temperatures of up to 230°C and pressures up to 310 N/cm^2. Operators do not normally change pressures however they do change heating times (contact to contact) and to a lesser degree temperatures, which are typically 205°C on the bottom platen and 207°C on the top platen. Typical heating times are 18-22 seconds. The main reasons times are changed are to get rid of porosity caused by insufficiently cured MF resin or boards sticking to the plate caused by the same issue. An example of what could be achieved was when platen temperatures were increased from the above temperatures, firstly to 214°C resulting in a cycle time of 17 sec with no problems with either porosity or press sticking. When further increased to 222°C**,** the heat cycle time was reduced to 15 sec. However as described below temperatures could not be maintained at this level.

It is recommended that the only variable changed is heating time using the following protocols:

1. The maximum pressure should be set to so as to be just below the crush point of 16mm medium density fibreboard, as this will enhance heat transfer and resultant resin cure. Particleboard especially made at the densities at Benalla should not crush. Once set this should never be altered.
2. The closing time of the press should be set as quickly as possible. It is capable of 0.7 sec however due to hydraulic issues this is not currently achievable.
3. Platen temperatures should be set 3 – 5°C below the point at which precure occurs. The faster the press closes the higher can be this temperature. The higher the temperature, the faster is the resultant heat cycle. Note this temperature will also need to be changed based on the degree of cure of the treated paper, which will be dealt with below. There also appears to be a capacity problem with the heat plant at temperatures over 215°C. The platen temperatures dropping 1.5°C from 220°C in 5 pressings evidenced this.
4. Heating times should be based on the steam cure test grade 2 in the Australian Standard for the manufacture of panels AS/NZS1849. Over cure must be avoided especially for companies who wish to post form the laminated panels.

It is noted that porosity problems were primarily in the middle of the board. Given that the press is so new I would doubt that it would be as a result of poor heating distribution and I was assured that the mats were only halfway through their effective lives. That leaves the probable cause being an uneven resin distribution across the web. This is very easy to test for by measuring 100 cm^2 pieces of treated paper and measure the variation. If the variation exceeds 2 gsm then the treater needs to be adjusted accordingly.

As stated above, I believe that the treated paper from Windsor is too green, with insufficient cure of the MF resin to fully optimise the capability of the new press. As stated above this could be a legacy for the old press however it is a common misconception that you need to treat paper for slower presses to a lower degree of cure (this has been disproved by the author elsewhere), notwithstanding the obvious fact that the Benalla LPM press produces 75% of the company's decorative product, and it is mainly White Thus paper from Windsor should be treated to maximise the capacity of the press.

I believe that this would result in at least 5 seconds being taken from the heat cycle, which would give much greater productivity from the line with a consequential reduction of fixed costs, not to mention greater revenue from increased production. In addition it is understood that 2 – 2.5% of total production are defects related to paper lay-up issues, mainly revolving around sticking paper causing torn paper lay-up and missing paper and poor stacking causing an paper chips on the surface. These are entirely preventable.

Opportunities for improvement

There are significant opportunities to improve the quality of paper from Windsor firstly to reduce the paper related defects at Benalla currently running at about 2 – 2.5% of total production and secondly to optimise the operation of the LPM press by

significantly reducing press cycle times. This could be done by improving the first stage impregnation resin system to ensure better saturation with resin solids resulting in lower use of MF resin. An example of this would be to use the Hexion UF impregnating resin BR200. Then the cure of the MF coat could be optimised resulting in the advantages to the operation detailed above. In addition reducing the amount of MF resin will also actually make pressing faster as it is easier to cure smaller amounts of MF resin.

It would be surprising if reducing defects by 2 – 2.5% and reducing press cycle times by up to 5 seconds would not save the business in excess of $500,000 per annum. This has been achieved elsewhere by the author using identical techniques.

It must also be remembered that the MF resin need only plasticise rather than flow. All it has to do is to match the pattern on the caul plates, which at most have deviations of only 40 microns. Thus if one can see resin flow i.e. resin spreading out from the paper in a test pressing, it is flowing far too much and is likely to find it's way to the core of the paper as described in my presentation and published in; Effects of Manufacturing Variables on Surface Quality and Distribution of Melamine Formaldehyde Resin in Paper Laminates. Roberts R. J. and Evans P. E. *Composites - Part A: Applied Science and Manufacturing Vol. 36 No.1 Jan. 2005*

The dry spots coming from the smooth coating roller need to be addressed by properly optimising the use of wetting agents in the MF resin. There are considerably better wetting agents than those that are being currently used (which are mainly anionic surfactants) and these should solve that problem.

It was observed that rawboard line 3 had a significant dust problem and the comment that machinability of laminated particleboard was not good on flat bed routers. This issue is not related to treated paper at all and is a rawboard issue that I am very familiar with. The company should think of improving the capacity of dust removal from the surface furnish by increasing the size of the dust screens from 0.4 to 0.6mm.

Recommendations

- The measure of B stage cure of MF resins should be implemented at Windsor to improve the control of the treater and resultant quality of the treated paper. This method is attached as an appendix.
- The B stage cure of the paper should be set between 70 and 90% non-water extractable resin.
- A high solids low MW UF resin be used in the first stage to minimise the use of MF
- The pressure of the LPM press be set at just below the point at which crushing occurs on 16mm MDF.
- The temperature of the LPM press be set at a point 3 - 5°C below the point at which pre cure occurs.
- Length of the heat cycle is the primary variable used to ensure adequate curing of the laminate occurs and this to a Grade 2 of the Steam Test in AS/NZS 1849.
- Stacking of the treated paper ex the treater should be improved so as to minimise paper related faults at the press.

- The capacity of the heat plant supplying the hot oil for the press be improved.
- Do not stack pallets of treated paper on top of each other.
- Wrap up partially used pallets of treated paper with the existing wrapping to minimise dirt and damage to paper.
- Regarding rawboard from line 3, a detailed examination of the size of the grit in the dust fraction needs to be carried out using microscopy the information from which can be used to reduce the amount of dust in the surface. To reduce this, the dust screen should be increased in size from 0.4 to 0.6mm however the size of the grit also needs to be taken into consideration.

Conclusion

I have no doubt that I could save the business in excess of $500,000 per annum by optimising the treating and laminating lines. I also could improve the specifications of the treated paper especially with dark colours to improve their performance at both treating and pressing. I am familiar with both Technocell Decor and Munskjo operations and personnel.

Method for measuring "B" stage cure of MF resins

Equipment

Sample of treated paper
Sample of raw paper from the same roll
Calibrated disc cutter preferably 100cm^2
Pencil
Weigh scales to 0.001g
Timer clock x 2
Thermometer
Water bath set at 30°C
Paper towel
Oven set at 160°C

Method

1. Fold the sample of treated paper roughly in 6
2. Cut 6 discs
3. Number the discs 1 – 6 using pencil
4. Weigh each disc and record (1)
5. Put 3 of the discs in the oven for 5 minutes and set timer
6. Dip the other 3 discs, ONE AT A TIME, in the water bath for 1 minute each set timer
7. Keep the disc moving and fully submerged for the whole minute but DO NOT rub it
8. When each disc has been dipped, lay it on the paper towel
9. When all 3 have been dipped, place more paper towel on top and press gently to remove excess surface water
10. When 5 minutes is up, remove the first 3 discs from the oven, weigh and record weights (2)
11. When oven temp has returned to 160°C put the other 3 discs on for 5 minutes and set timer.
12. Calculate the volatiles
13. When 5 minutes are up remove the last 3 discs from the oven. This has to be done carefully as they can stick to the oven racks. Weigh each disc and record (3)
14. When oven temp has returned to 160°C put the disc of raw paper in for 3 minutes
15. When 3 minutes are up remove the raw paper discs from oven, weigh and record (4)

Calculations

Volatiles:

$$\frac{\text{Ex treater weight (1)} - \text{Dry weight (2)}}{\text{Ex treater weight (1)}} \times 100 = \text{Volatiles \%}$$

B-stage cure:

$$\frac{\text{Dipped dry weight (3) – Raw dry weight (4)}}{\text{Dry weight (2) – Raw dry weight (4)}} \times 100 = \text{result}$$

B-stage cure % = average of 3 results

An alternative method of calculating the results is as follows, using a water bath at 60°C and submerging and agitating paper for only 30 seconds:

1. Prepare water bath at 60°C
2. Cut sample discs as per
3. Cut 6 discs
4. Number the discs 1 – 6 using pencil
5. Weigh each disc and record (1)
6. Put 3 of the discs in the oven for 5 minutes and set timer
7. Dip the other 3 discs, ONE AT A TIME, in the water bath for 30 seconds
8. Keep the disc moving and fully submerged for the whole minute but DO NOT rub it
9. When each disc has been dipped, lay it on the paper towel
10. When all 3 have been dipped, place more paper towel on top and press gently to remove excess surface water
11. When 5 minutes is up, remove the first 3 discs from the oven, weigh and record weights (2)
12. When oven temp has returned to 160°C put the other 3 discs on for 5 minutes and set timer.
13. Calculate the volatiles
14. When 5 minutes are up remove the last 3 discs from the oven. This has to be done carefully as they can stick to the oven racks. Weigh each disc and record (3)
15. When oven temp has returned to 160°C put the disc of raw paper in for 3 minutes
16. When 3 minutes are up remove the raw paper discs from oven, weigh and record (4)