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PRESS SECTION GRINDS: UNDERSTANDING THE IMPACT OF AXIAL CONCENTRICITY

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ABSTRACT

Energy efficiency has become a top priority for paper mills when process decisions are made. The goal of this study was to determine if steam usage would be reduced, or if paper machine speed increased, by improving the geometric tolerances of the press roll section. This was achieved by improvement in axle-to-roll face concentricity, roundness, shape, and profile.

An analysis of data over 17 months produced three key findings. Cross-direction moisture two-sigma variation was reduced by 19.08% over seven months when the bottom crown-controlled press roll was installed. Machine speed increased 18 feet-per-minute, however, the lack of system controls made it difficult to determine if the press roll was the direct cause of the machine speed increase. An unexpected result was a 25.10% decrease in vacuum required in the pick-up felt uhle box. This indicates a reduced need for water removal. Future studies will examine how reducing the vacuum needed in the press section impacts felt life.

Keywords: Press Section, Concentric Grinding, Uhle Box

INTRODUCTION

Reduced energy consumption has increasingly become a global priority for making improvements to paper production processes. With the continuous improvement of energy efficient technologies, micro-adjustments are regularly being implemented. One such adjustment is not only improving the profile of the press section, but the shape and roundness of critical positions in the paper making process.

The traditional method used to grind crown-controlled grooved press rolls is to remove the internal bearings from the roll and turn the roll using dummy heads. The problem with this is that when the heads are reinstalled after grinding, the T.I.R. is changed due to the interfering fit of the heads. Another problem is having to heat the roll to reinstall the bearings and axle, leading to additional variation on the roll profile.

Grinding the press roll with the axle installed helps to eliminate variations that can occur within the roll grinding process. This eliminates profile variation in the press section, reducing moisture variation. Traditionally, the water that is removed from the web is transferred to the press felt. The felt then transfers the water to the felt suction boxes, which removes water from the felt and returns it back into water circulation [1]. By concentrically aligning the roll as tightly as possible prior to installation, the moisture is removed through the grooves more effectively. A rule of thumb is that it takes up to 25 times as much energy to remove a pound of water in the dryer section compared to removing a pound of water in the forming section [2]. With the additional water removed prior to reaching the dryer section, the mill will either save in steam required to dry the paper or will create additional product with the reduction in dwell time necessary for paper production.

This study is designed to determine how much of an impact a concentrically ground roll can have on the paper making process. The analysis sets out to answer three questions:

1. How much of an impact will a concentrically ground press roll have on cross-direction (CD) moisture variation?
2. Will there be a significant impact to steam consumption or machine production speed?
3. Are there any other changes worth further investigation?

METHODS

A before-and-after comparison was developed for the replacement of the second press grooved bottom CC roll. Two different rolls were used for this process for the closest before-and-after comparisons possible. The method of grinding and grinding tolerances were not provided for this study; it is assumed the roll is ground to a 0.001" profile using traditional grinding methods.

While the traditionally ground roll was in operation, the second roll, with a freshly installed cover, was sent for grinding and servicing. The roll face was ground concentrically to the bearings using methods proprietary to the grind shop. The face of the roll was ground to a tolerance of 0.00091" and regrooved to OEM specifications. The final product was sent to the paper mill and was installed after the mill determined the initial bottom CC roll had reached its end of life. The paper machine was run for seven months to promote stability in after-set data trends.

Data was collected working in conjunction with the mill staff to create a better understanding of what variables are important in the press section roll swap. The mill runs an in-line PI system, which collects real time data on the paper machine. This system is set up to collect information proceeding the third nip press. To avoid differences in product characteristics a single grade, 27-pound newsprint, was analyzed.

A collection of graphical summaries, line charts, and boxplots were developed to see what differences occurred once the bottom

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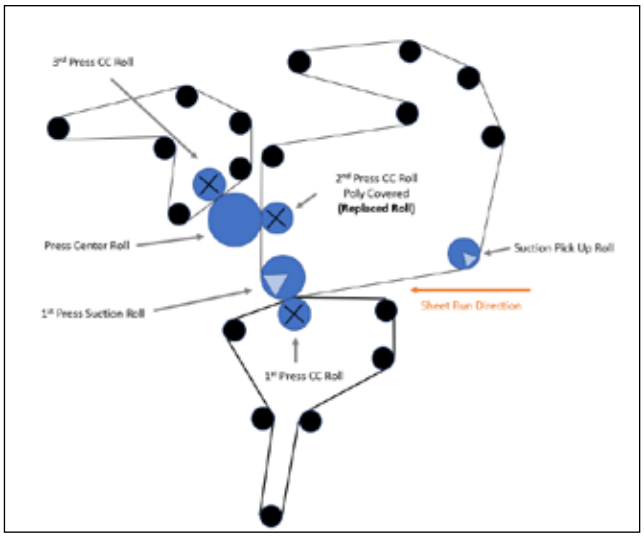

Figure 1. Schematic of Press Section

press roll was installed. Parameters were defined by mill and roll servicing personnel. Once the new roll was installed, the first ten days of data were isolated- allowing for an operator adjustment period. The measurements collected are the collective average of a single reel of paper from the in-line scanner. The layout of the press section can be seen below in **Figure 1**.

RESULTS AND DISCUSSION

CROSS-DIRECTION MOISTURE TWO-SIGMA

All moisture measurements were collected using an in-line scanner. Since the goal of the process is to have no variation, the CD moisture two-sigma variation follows a Weibull distribution, shown in **Figure 2**. This required the median to be analyzed, rather than the mean.

Month-to-month CD moisture two-sigma variation pre-tight tolerance grind ranged between 0.332 and 0.229. The average median was 0.287, as shown in **Figure 3**. Once the tight tolerance grind was installed, the maximum range of moisture variation fluctuated between 0.273 and 0.216, with an average median

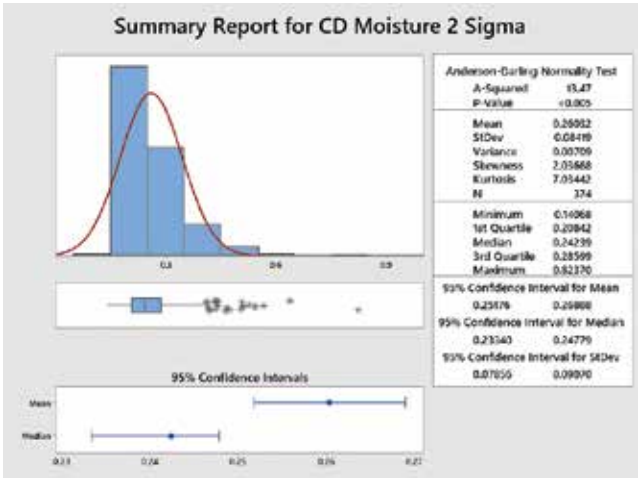

Figure 2. Graphical Summary of CD Moisture Two-Sigma

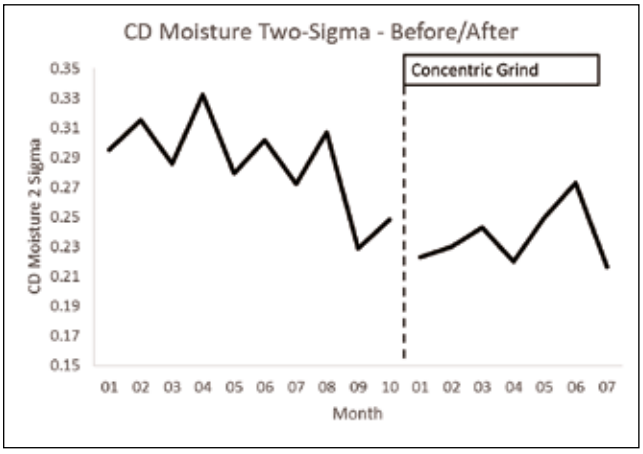

Figure 3. Median CD Moisture Two-Sigma- Before-and-After Concentric Grind

moisture percentage of 0.237. This demonstrates a reduced median moisture variation of 19.08% from the concentric grind.

Another outcome of the concentric grind was a decrease in the amount of variation from month-to-month. The boxplot in **Figure 4** shows a more consistent median per month compared to that of a loose tolerance grind. There was a larger amount of variation per month from the non-concentric grind compared

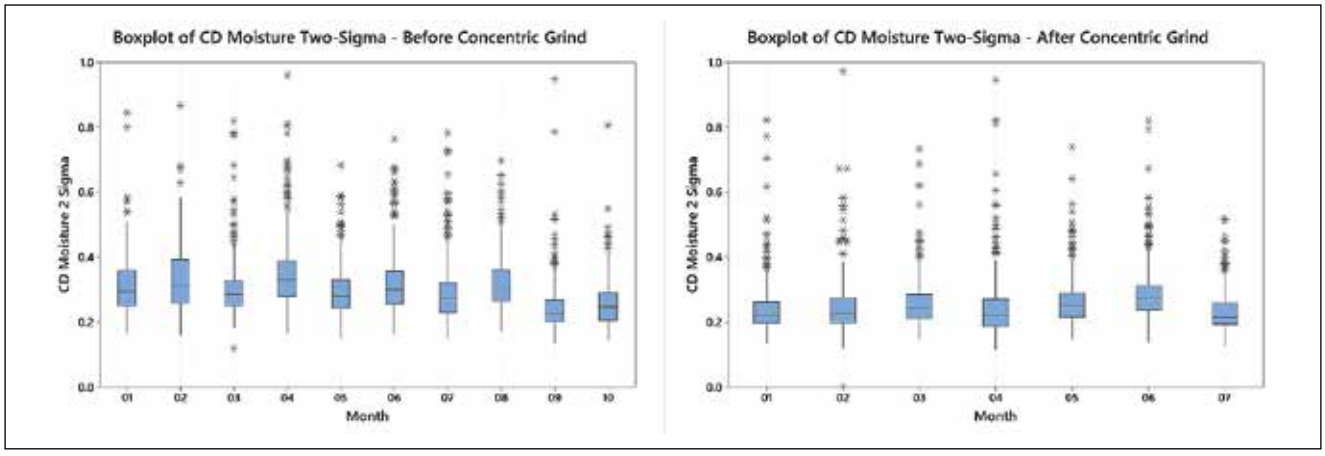

Figure 4: Boxplot of CD Moisture Two-Sigma – Before-and-After Concentric Tolerance Grind

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to that of the concentric grind, indicating a lower median variation per month with less variation per month.

STEAM CONSUMPTION

Steam consumption was analyzed to determine if there was a significant drop in usage once the concentrically ground roll was installed. Unfortunately, the system was deemed too unstable to analyze whether there was an appreciable change in steam values and any resulting differences in energy usage. However, if a paper machine would need less time to dry because of a reduction in moisture entering the machine, an increase in machine speed and creation of additional product might result instead of a reduction in steam usage.

MACHINE SPEED

After the bottom roll was installed into the paper machine, an 18 foot-per-minute increase in machine speed occurred as shown in **Figure 5**. However, due to the instability in paper machine speed, it is difficult to gauge whether the machine speed improvement was a result of the replacement of the bottom second press roll, better conditions within paper machine, or a combination of the two.

PICK-UP FELT UHLE BOX VACUUM

A positive outcome from the study was the sudden drop of uhle box vacuum level after the bottom press roll was replaced. **Figure 6** shows a uhle box vacuum level maximum of 12.48 inHg and minimum of 10.41 inHg, with an average of 11.66 inHg. Once the bottom press roll was installed, the maximum and minimum over a seven-month period were 10.03 and 9.06 respectively, with an average of 9.58 – a 25.10% drop in vacuum.

Figure 7 shows the dramatic shift in average vacuum per month drop once the concentric roll is installed. There is also a significant drop in variation of vacuum from month-to-month with the bottom roll installed. This leads to the conclusion that more water is being removed mechanically from the paper, rather than by the uhle box.

CONCLUSION

The purpose of this study was to determine if grinding a press roll to a tighter specification concentrically, on shape, and profile would lead to benefits of reduced steam consumption or increased paper machine speed.

- CD moisture two-sigma variation was reduced by 19.08% over seven-months once the bottom crown-controlled press roll was

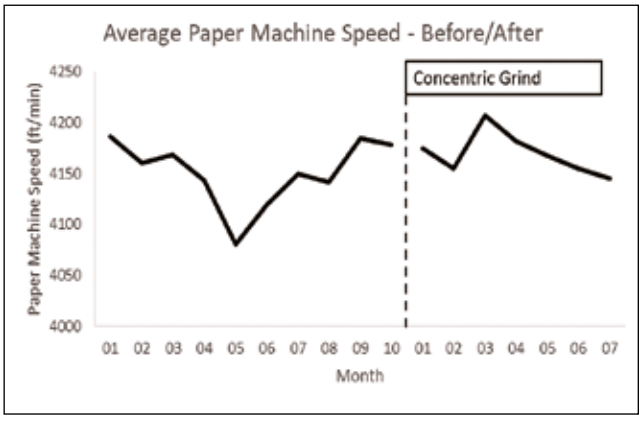

Figure 5. Machine Speed - Before-and-After Concentric Grind

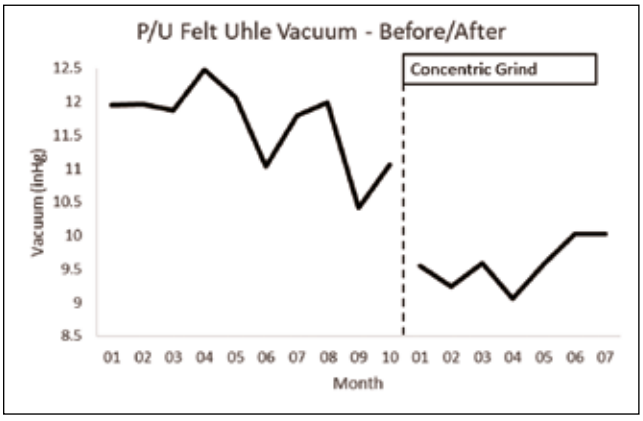

Figure 6. Pick-Up Felt Uhle Vacuum - Before-and-After Concentric Grind

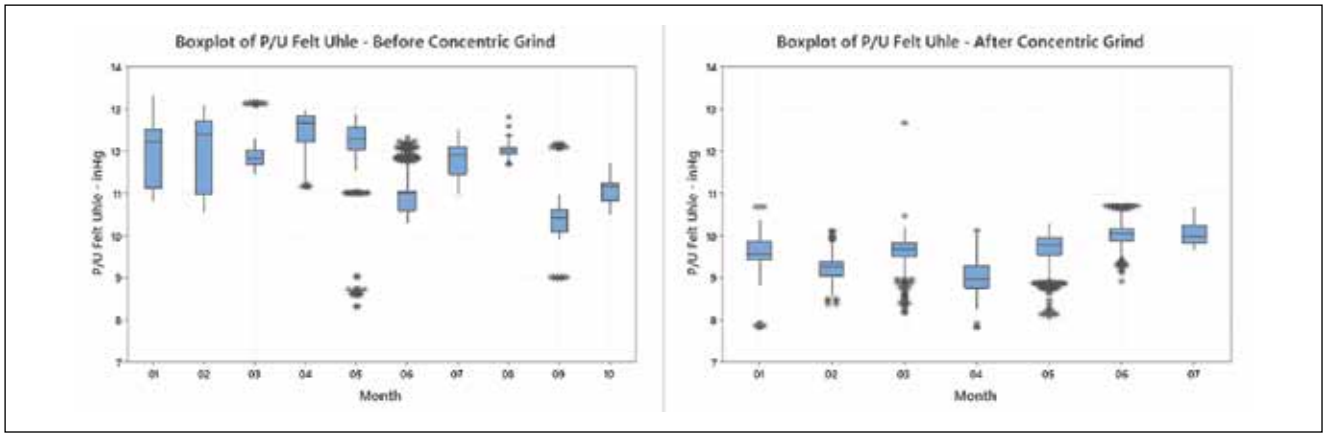

Figure 6. Boxplot of Pick-Up Felt Uhle Vacuum - Before-and-After Concentric Grind

installed. This indicates that the concentric alignment of the roll had a significant impact on reducing moisture variation.

- Steam consumption proved difficult to measure and analyze due to lack of control in the system.
- Machine speed increased 18 feet-per-minute. However, the lack of control in the system made it difficult to determine if the press roll was the direct cause of the machine speed increase.
- Pick-up felt uhle box vacuum required dropped 25.10%, indicating a reduction in water pressed through felt. A 2013 study states the global average paper machine energy that is consumed in friction between the suction boxes and fabrics is 16.1% of the total drive power and 5.2% of the total energy consumed in the press section [1]. A reduction in vacuum required would reduce energy required to produce paper and reduce wear on felt clothing. Extending the life of felt clothing by even one week could eliminate one outage from the paper machine per year. Elimination of one 5-hour outage would create an estimated $77,760 [3] of additional product. This can be an even higher impact in different branches of the paper industry- with an estimated additional product of $362,880 [4] in the linerboard industry and $318,938 [5] in coated board – see **Appendix A**. ■

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APPENDIX

Additional Product Produced With Removal of Five Hour Shutdown				
	Newprint	42# Kraft Linerboard	SBS	
Sheet Width (Inches)	300	300	300	
Sheet Width (Feet)	25	25	25	
Machine Speed (Ft/Min)	3200	1800	1500	*Values based on individual mill data
Additional product (sq ft/min)	80,000	45,000	37,500	
sq ft/hour	4,800,000	2,700,000	2,250,000	
sq ft/5 hours	24,000,000	13,500,000	11,250,000	
Mill Efficiency (Uptime)	90%	90%	90%	
Sq ft/5 hours After Efficiency Factor	21,600,000	12,150,000	10,125,000	
Pounds of paper produced (five hours)	194,400	907,200	455,625	
Tons of paper produced (five hours)	97	454	228	
Selling Price per Ton	$800	$800	$1,400	*Reduced values for discretionary purposes
Additional product value/month	$77,760	$362,880	$318,938	

Appendix A: Five Hour Shutdown Calculations