Operational Experiences & Process Optimization for Supercalender

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ABSTRACT

Supercalender operational practices were analyzed in a coating plant, and different actions were taken to improve productivity and profitability. Installation of surface winder, bypassing paper rolls, and increase in warm-up time during startup, artificially improved climatic conditions in the vicinity of Supercalender have been found very useful. In this case study, such actions and their advantages have been described in detail.

Introduction

Initially, when a Supercalender is started, more attention is given to achieve maximum gloss with least reduction in thickness of paper. But, cost effectiveness becomes important with increase in time, as recoating (refilling) of the rolls involves a recurring cost. In the present case also, the Supercalender was started, and the operational problems were sorted out one by one.

Conventional Supercalender

The Supercalender being used is a typical 12-roll Supercalender, originally made by ECK Haubold, Germany. The unwind used was a conventional flat disc brake with one side brake lining and the other side of cast iron. The brake was a water-cooled one. At the winder, it was a center winder with a dynodrive motor for tension control. For the purpose of cooling of paper web, 11 paper rolls were provided for the complete paper loop. The unit consisted of a king roll, a queen roll, 4 intermediate rolls and six cotton rolls. All the hard rolls were chilled rolls with water-cooling arrangement at the center. To humidify the paper web on the run, steam showers were provided with drilled hole shower.

Installation Upgrade

At the time of installation, all the chilled rolls were ground and then hard chrome plated and superfinished to 0.25Ra smoothness. This was done by Modinagar Rolls Ltd. by their specially developed method ModFinish. Hard chrome plating does not impart any specific benefit in terms of hardness, but the chemical properties of surface are greatly altered. As a result, development of a thin layer of corrosion products on the surface of Supercalender during a shut for a couple of days is totally eliminated. After hard chrome plating, the rolls were ground again and then super-polished to impart a higher gloss to paper being processed.

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Difficulties Faced

While the commissioning of the calender was an easy, few problems were identified within a few days of operation. These problems identified are being given hereunder-

It was observed that the production capacity was low. The operational speed was to the tune of 60-70mpm only. Calender runnability of the paper was poor. The gloss was relatively low and unstable. Winding at the calender was not very good. It was also observed that tail feeding took a lot of time after every joint or reel change.

It was also observed that the life of cotton rolls between recoating was very low, to the tune of every 600-800 hours. The major reason was that the rolls had to be re-ground after every 120-150 hours as per the manufacturer's recommendation. But, during this period also, there were failures resulting in re-grinding and a significant thickness loss.

Troubleshooting

The major reason for lower production was observed that the operators were not very confident and preferred to run calender at a lower speed. For the same, a magnetic proximity sensor was mounted on one of the paper roll, and it was connected to a counter. The reset button of the counter was disconnected internally. Now, the operators were asked to note down the readings of this counter at the start and at the end of the shift, and the difference, which is proportional to the mileage of paper could be recorded. Within a short time, a competitive environment developed where the operators were trying harder and speed could be increased to nearly 150mpm.

Winder Modifications

At this speed, it was observed that there were frequent joints. Every joint resulted in loss of saleable paper as well as time available for production. For the same, initially the center winder was the source of major problem. A motor driven by eddy current drive in a tension control mode was running the center winder. Necessary modifications were made in the eddy current drive electronic circuit, but satisfactory results were not achieved. To solve the problem, a variable frequency AC drive was tried to operate in tension control mode. But again the problem remained the same. Then a new DC drive was installed considering that the tension control would be better with DC drive. But, the problem remained there.

In fact, the use of center winder could not be successful as at lower tension levels, the winding is a slack. When the tension is increased, paper being so smooth and hence slippery having been calendered, slips on its internal layers and for some time, does not seem to respond in the same way as expected. After some time, when such slippage ceases to occur, as the winding has been tight by now, tension shoots up suddenly, and if it crosses the limit for paper, a break occurs.

That is why; it was decided to install a surface winder for this application. The operators were initially resistant towards this proposal, as according to them, no Supercalender was working anywhere with a surface winder in India. They were explained the concept in detail, and assured that in case the surface winder creates more problem,

we can switch back to existing system. The response was very positive. And they assured to try their best for the **'India's first'** surface winder on a Supercalender.

A pope reel of 1250mm diameter was mounted on the calender frame, connected with a gearbox and the same DC motor. This worked very well and it was observed that even in the very first reel, the winding was much better. Later on this DC motor was replaced by an AC motor driven by AC drive. The pope AC drive was synchronized to calender main AC motor, resulting much better control on winding characteristics of the calendered reels. In fact, the results were so encouraging that for a deckle of approximately 1500mm, trim loss could be reduced by 5-7mm, thus the requirement of base paper as well as coating chemicals were reduced by nearly 3-4kg/ton.

Replacement of Disc brake with air cool drum brake

The installed brake at the unwind stand was a disc type water-cooled one. Even after increasing the water flow through the brake, at higher speeds, the brake shoes got overheated, and the breaking characteristics changed. This resulted in erratic behaviour of the unwind side tension, and sometimes in paper breakage. For the same, one air-cooled drum brake was fabricated and mounted in place of disc brake. Furthermore, modifications were made in unwind coupling in order to facilitate faster roll change. In place of clamped 'C' type bearing housing, an open type 'U' shaped bracket was installed with a set of bearing housing fitted in the unwind shaft, and another set kept spare for the next shaft. This facilitated faster unwind reel change, and the reel change time reduced from 12-20 minutes (average 15 minutes) to 8-13 minutes (average 10 minutes), thereby more uptime could be achieved.

Later on, modifications in center winder side shaft were made in the similar way for faster reel change. Now, the total time required for both the reel change varies between 7-12 minutes (average 9 minutes).

Installation of Static charge eliminator

As the speed was being increased gradually, the problem of static electricity started to appear. For the same, paper moisture was increased, which reduced the problem to certain extent. Later, a brush type static charge eliminator was installed to overcome the problem.

Removal of paper rolls

During the same period, it was appearing that a lot of time is wasted in tail feeding during reel change or after a break. Conventionally, the paper rolls are fit in order to cool the paper between the two consequent nips. Bypassing the paper rolls was a risky trial as due to increase in web and roll there was a possibility of deterioration of paper quality as well as damage of rolls. For the same, initially half the reel was run in the conventional way, and then the second half of the reel was run bypassing paper rolls. Around 10 samples were drawn from each part of the reel and evaluated for Gloss, SOA and bulk. Surprisingly, the results were same. For a couple of days, 5-6 reels were tried in the same way. It assured that bypassing paper rolls does not affect paper quality.

The second aspect was of roll performance. For the same, it was decided to run the calender bypassing all paper rolls, and having a close look on roll condition. For this, during every reel change, the temperature of cotton rolls was recorded using a non-contact type pyrometer. The increase in temperature was only 5-6ºC compared to that when paper rolls were in operation. This problem was solved by the method describe later in this paper.

Installation of lighting for on-line gloss checking

Most of the time, samples are drawn from the calendered roll to check for gloss. The sample is then sent to QC Lab for testing. To avoid the time consumed as well as a joint in subsequent reel at rewinder, a couple of tube lights were strategically installed so that the reflection of these is visible to operator. This acted as a low cost

simulation of on-line gloss measurement, and helped operators to do the needful in case the gloss is low.

Improvement in Cotton Roll Performance

Due to non-availability of sufficient published information on cotton rolls, the starting point was the manufacturer's recommendations. In India, there are two major manufacturers of cotton rolls. They normally recommend grinding of the rolls after 120-150 hours of operation. This means each of the six rolls installed in the Supercalender has to be ground weekly, or one roll every day. While changing of the roll needed nearly 1-1½ hours, many of the times, the rolls got damaged before this period and hence had to be replaced for grinding. After every grinding the diameter of the rolls was decreasing, and the overall life achieved was to the tune of 600-800 hours.

Warming up before Startup

It was observed that many of the rolls were damaged within first two hours of calender startup. From this, it appeared that sudden temperature increase is detrimental to cotton rolls. So, it was decided that after a shut of one day or more, the calender should be run idle without any load for at least two hours. By this, the startup roll damage was totally solved. After this, the average life of the rolls increased to 1500-2000 hours.

Installation of a new grinder

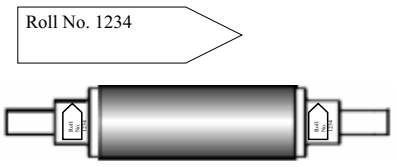
Earlier, the rolls were being sent for grinding to a locally situated leading sugar mill manufacturer. To control the quality of grinding, a new grinder was procured and installed within the mill. Also, nip impressions were taken after

each roll was mounted. By this, the surface properties of the grind roll improved, which reflected in improvement of gloss.

Roll Slicing

Another problem observed that was slicing of discs of the rolls. This can be seen in figure. Most of the time, slicing affects the complete roll, and the roll becomes unusable even after a deep cut during grinding. Normally, this problem developed in previously ground rolls.

Cotton rolls are made by mounting a lot of cotton discs on a central shaft, and pressing it to a very high pressure. When a roll runs in a particular direction, some stresses are developed. If after grinding the roll is made to run in opposite direction, the slicing may take place. For the same, each of the roll was marked in the direction of first run, and it was ensured that care is to be taken that the roll runs in the same direction after it is mounted again. This solved the problem of slicing completely. To avoid any error due to negligence, paper strips cut in arrow shape are pasted on both sides of the journal so that the rotational direction is clearly visible. Identification number is written on these strips.



A label (above) and a roll with labels pasted on its both side journals.

Sponge Humidification: frequency increase

Cotton is basically a fiber that tends to stabilize itself according the atmospheric humidity. In case of high humidity environment, it absorbs some moisture and in case of low ambient humidity, it loses some of its moisture. During operation, temperature in the vicinity of supercalender increases, and hence the humidity decreases. This results in loss of moisture form cotton rolls. For the same, sponge humidification is a conventional technique for moisturizing roll surface. This serves various purposes-

1. This immediately reduces the surface temperature of roll.
2. Due to increased moisture cotton swells, and nip uniformity is improved.
3. Due to increase in roll moisture, the risk of cotton pyrolysis and hence roll damage, is reduced.

Due to varying climatic conditions, many a times, both atmospheric temperature as well as humidity is low. As a result, operators should be very careful in sponge wetting of rolls surface as and when desired. Analyzing that the lack of moisture could be a possible source of rolls damage, frequency of roll moisturizing was increased. As a result, roll failures reduced significantly.

It must also be noted that roll surface monitoring for temperature and moisture is very important particularly at high speeds.

Modification in Shaft Design

The conventional paper rolls were having one shaft keyway. It was noticed that the problem of roll damage was mainly at the keyway side of the roll. For the same, all the rolls shafts were modified to grooved shaft; in fact, the shaft began appearing as a gear. Due to the modified design, the localized stresses were distributed evenly throughout the roll circumference, and hence roll failure reduced significantly.

Application of Roll Conditioner Chemical

A roll conditioner chemical (TECHZYME bowl conditioner) was tried on roll surface in place of detergent water solution. Earlier, conventional detergents like '*Nirma*', 'Surf', '*Wheel*' etc. were being used after dilution in water for roll moistening with sponge. After some time, trials were taken with '*Ezee*', and '*Sunsilk*' (commercially available liquid detergent and shampoo), and the results were somewhat better. Later on, TECHZYME was tried, and it was found very useful, as the number of roll changes required due to surface deterioration reduced significantly.

Roll Material Changes

Feature	Paper Rolls	Glosvax (Cotton) Rolls	Effect
Composition	Cotton / Wool / Linen	Cotton + Wool	
Process	Die Cutting / Pressing	Carding / Caking	Better interlocking and hence low possibility of slicing.
Assembly	Fast Pressing	Slow Pressing	Better interlocking and hence low possibility of slicing.
Finishing	Turning / Grinding	Turning / Polishing	Better surface of roll and hence better gloss.
Hardness	80-92 Shore D	72-82 Shore D	Increased nip width resulting in better results even at high speed operation.
Flexibility	Low	High	Better resistance to score marks
Mark Resistance	Moderate / Low	Excellent / Moderate	Frequent grinding is avoided.
Cut Depth	Low Depth	Deep Cut	Grinding time is reduced significantly.
Grinding Frequency	Very High	Moderate / Low	Lesser downtime for fewer roll changes.
Costing	Moderate	Economical	

Table -1: A comparison between Paper and Glosvax Rolls.

Considering the surface properties of cotton rolls, new roll filling under the brand name GLOSVAX was tried. Against the conventional rolls of paper, these rolls are made with a mixture of cotton and wool. In general, the difference with the conventional paper rolls can be illustrated as in the table-1.

Practical Problems & Troubleshooting

As the speed was being increased from 80-100mpm running earlier to 350-400mpm (with the use of GLOSVAX, a speed of even 425mpm was achieved without any problem), it was being observed that it took a lot of time to moisturize the rolls every now and then. Furthermore, removal of paper rolls had already resulted in increase of

roll surface temperature. For the same, it became necessary to find out a suitable solution for temperature reduction and humidity increase. For the same, three coolers were installed in front of Supercalender. Using these proved very helpful. On the same Supercalender, the production could be increased more than three times without any problem.

Overall Results

Using the above steps proved very helpful. The benefits can be listed as under-

1. Supercalender productivity increased by more than three times.
2. The life of rolls increased more than four times.
3. Calendered reel winding improved, resulting nearly 0.5% yield increase.
4. Time required to change reels (both unwind and rewind) reduced by 40%.
5. Joints at Supercalender reduced to almost nil.

Future Scope

To avoid the reduction of roll surface moisture, particularly during long time stoppage, say due to non-availability of base paper etc., it is planned to apply a dilute moisturizing agent like sorbitol, calcium chloride or magnesium chloride onto the roll surface. This treatment is planned to be done initially on one roll, and depending on the results obtained, the applicability will be considered. Use of calcium chloride and magnesium chloride may create problems in humid atmosphere, so this type of treatment will be suited only during dry weather.

Conclusion

In absence of availability of sufficient published information on care, handling and use of cotton rolls, different actions have been tried, and found very useful in productivity improvement and operating cost reduction.