Customised Approach to Electrical Maintenance - Our Experience

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INTRODUCTION

As a part of the recent expansion and modernization programme, SPB installed a second hand,high speed paper machine with winder and sheeter to double it's production capacity from 55000 tons to 115000 tons/ year. The design speed of the machine is 1000m/min. The machine was commissioned in the year 2001 and the present operating speed of the machine is 800-850m/min.

It is said that in the fertilizer and chemicals industry, annual shut down maintenance time has been reduced with a sustained improvement in maintenance practices. A similar pattern is emerging in our Paper and Pulp mill. Customized and focused approach has become the order of the day. Other benefits that have accrued are a change in culture from "Reactive to Pro-active" Maintenance, the emergence of a powerful continuous improvement based on locally developed "root cause" analysis techniques and reduced maintenance expenditure.

SPB adopted the following techniques in their reliability maintenance:

- Root cause Analysis for breakdowns.
- Effective use of trends and graphs for analysis.
- Systematic condition monitoring of static and rotating equipment.

  Example: Off line, & online measurement of temperatures. Monitoring "shock pulses" of rotating equipment.
- Good house keeping.
- Adhering to preventive maintenance schedule.

When the machine and the sheeter were re-erected at SPB site, totally new DC drive system for the paper machine, AC Variable frequency drive for stock & machine auxiliaries were selected. During commissioning we encountered many unique problems. This paper deals with some of the problems faced by us during the commissioning activity and our approach towards resolving those issues.

RESULTS AND DISCUSSION

Paper machine down time analysis

The following gives break up of electrical break down time in the paper machine section. As can be seen, the failures were maximum in DC drives and AC variable frequency drives. Root cause analysis was done for all the failures and we are happy that the most of the issues have been resolved in-house.

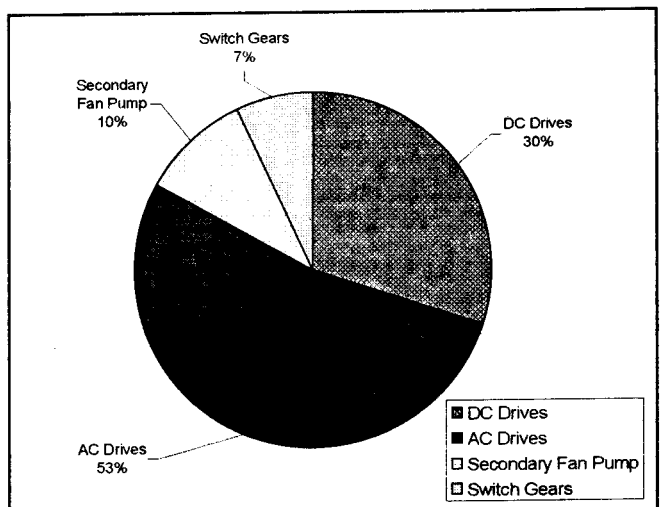

Fig. 1

DC Drives

Digital Drive technology has undergone a sea change in recent years. The latest drives use SCR (Silicon Controlled Rectifiers), Microprocessors, Digital commissioning and maintenance tools. These digital drives are "user friendly", which self diagonize the problems. We have installed latest generation sectional DC drives with Application logic and DCS interface for 32 sections of paper machine. We experienced the following Problems:

- Failure of DC drive power components, i.e. SCR during power interruption.
- Severe knocking sound in the gearboxes.

Calendar logic not changing over to torque/speed control mode, and not getting accelerated as required.

Most of the drives for paper machine dryers require "quick braking torque" for immediate stopping of dryers as and when it is required. This needs DC drive of particular duty-class with forward motoring and reverse braking. Recent day's technology uses Re-generative braking which gives energy saving besides smooth & effective Braking. The complex control required for re-generative braking is a difficult task, particularly in weak supply systems. During Power re-generation(IV-Q-operation) as is Known, kinetic energy is pumped back to the mains, by switching "ON" reverse Thyristor Bridge. During this process of re-generation, if power supply is disturbed, then there will be disturbance in memorized digital electronic logic causing both (I-Q&IV-Q) Thyristor bridge to fire resulting short circuit, thus cause power components failure. The problems were more after speeding up the machine, which need more kinetic energy to be "broken".

We also observed "sag & swell" in the supply network during grid interruptions, causing the drive to switch from motoring mode to "regenerative" mode frequently, resulting in failures. Now we have modified the system program, such that whenever there is "dip in voltage" or power interruption, the drive system shall wait and watch until particular level (say upto 80 %), below which it will block the gate pulses and trip the drive.

We observed severe knocking sound in the gearboxes while in operation. This was predominant when the drive was being accelerated from slow speed to its pre-set speed. After continuous watching/monitoring we felt that this could be due to modulation created by long carden shaft, which was not getting synchronized with drive speed. After consultation with drive supplier, we introduced "Advanced speed controllers" with modified software, which ensured that the drive get synchronized with modulated frequency.

Calendar drive is operating in "Indirect Torque Control (Without Load cells)". During paper break, we observed the drive speed getting reduced phenomenally and remained in "Torque control mode". Even though the drive control was manually changed over to "Speed Control", it was taking long time to accelerate to its reference speed, causing delay in paper passing from Calendar to Reel drum. Our root cause analysis helped us to install a web break sensor in line to identify the paper availability. With the help of this signal the "application software" was modified to change the control mode during paper breaks. After thorough study of Application software, we found out that "Auto slow ramping" was getting enabled during paper breaks. This part of the logic is also modified now, which has helped us to improve the over all availability of machine with paper. Now even after paper breaks, the drive is able to accelerate to set speed quickly with in specified time limit.

The above remedial measures reduced the down time substantially.

Variable frequency drive (VFD)

Solid-state electronic Ac variable voltage/frequency drives are becoming increasingly more common for industrial and commercial application. In SPB these Variable V/F drives are used in Fan pump, Water pumps, stock pumps, Disc filters, and Chemical dozing pumps etc. The increased usage of Variable frequency drive demands perfect understanding of their configuration & operation to minimize down time.

A. Even though the VF drives are reliable, we were experiencing failures in both power and control components. Root cause analysis was made to find out the reasons. After thorough study the attributes were found mostly during power interruption either at SPB side or at on account of TNEB.

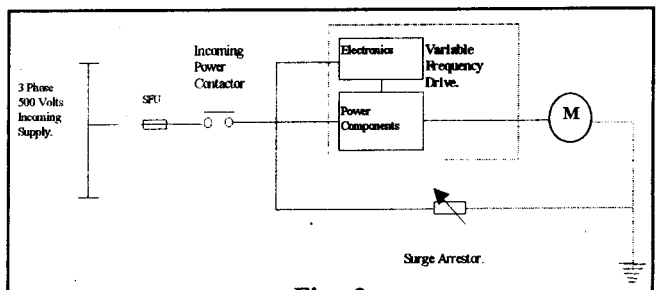

Fig. 2

Under both circumstances, it was seen due to "switching surges"/ "lightning spikes" [invariably due to switching surges]. After power resumption, due to capacitors which are in line continuously, most of the control components particularly electronic power supply card failed immediately in inverter panels. To avoid such failure SPB has introduced incoming power contactor to isolate the supply during power interruption or due to dip-in voltage. Incoming contactor has to be switched ON manually now after power resumption. We have adopted a procedure of switching ON the Incoming power contactor after stability in system voltage and with minimum inductive load "ON". This however cannot avoid lightning surges, which are of high magnitude and short duration (10 / 350 microseconds).

After detail study, we chopped surges reaching control electronics by installing. Metal Oxide Surge arrestors for independent VF drives which keeps the electronic card voltages as per EMC standards.

High voltage and Low voltage wiring are separated, using shielded wires and fused terminals for protection. The reason being control wires are susceptible to any noise generated in the plant (such as Electro-Magnetic

frequencies or EMF), Shielded wires protect electronic components from noises and interference's. One end of the shield is not grounded if the signal is a 0-10 Volts DC, 4 - 20 mA analog signals, and feed back from Tacho Generators. If both the ends are grounded, the ground loops is likely to generate more voltage /current and that would corrupt the signals.

The above modifications resulted in Minimum

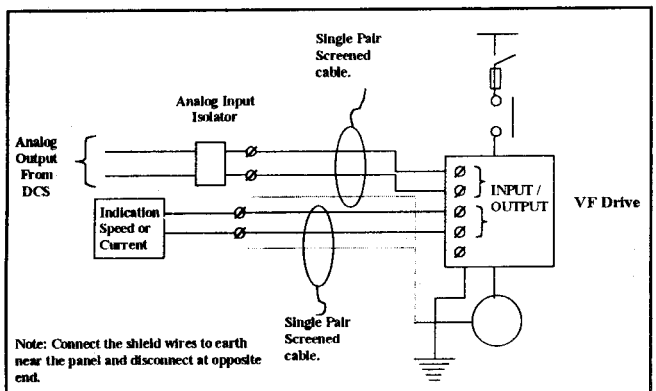

Fig. 3

downtimes due to VF drive failures in the machine for the last six months.

Present days VF drive can be replaced quite easily with spare module, which will definitely reduce down time on repairs and over all cost will be low. Example: Primary fan Pump 260 KVA VF drives failed during power interruption. Power components and control cards got flashed. The machine was started after replacing the spare VF drive module as a whole within one hour.

Secondary fan pump

It pumps pulp from deculator to head box, which is one of the pivotal equipment's in paper making process. Fan pump in machine is driven with the help of Dc motor and its drive. The hardcore problem for any paper machine (Electrical) maintenance engineer is the maintenance of DC motor and in particular commutator,

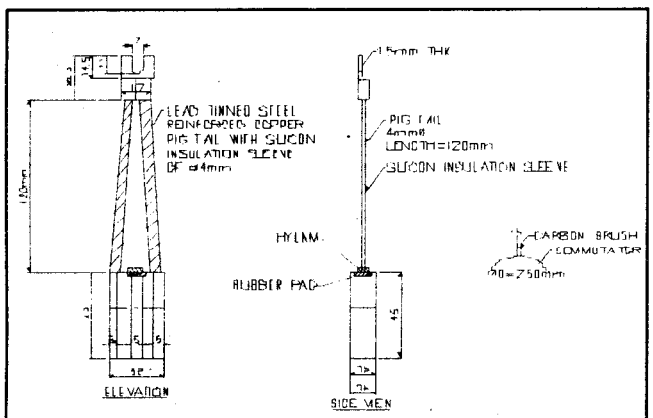

Fig. 4

carbon brushes etc. We were experiencing serious problems in the DC motor. There were frequent carbon brushes pig tail cuttings, brush holder failures and ridging in commutators. Root cause analysis was made with the help of manufacturer and following remedial measures suggested and implemented.

The machine was running with split carbon brush, with four pigtails. After selecting the current density carbon brush design was changed to single brush with steel reinforced lead tinned copper pigtails and by allowing maximum negative tolerance as per IS in brush size.

Since the area around the motor is filled by hot exhaust air from motor outlet, the cooling blower mounted on the machine was drawing the hot air in and around the machine. This hot air further increases the commutator and its accessories temperature.

We may infer from the above pie-chart, the major attribute for down time in sheeter is due to problems in Sheet Cutter PIV clutches. Sheet Cutters was driven

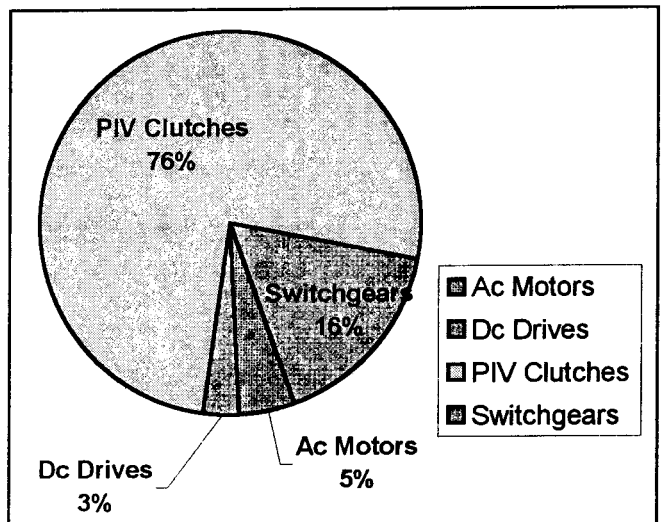

Fig. 5: Sheeter down time analysis from Apr'01 to Mar'02

with DC Drive. The Power from motor to machine is transmitted with the help PIV gearboxes. Based on sheet length gear combinations has to be selected. Gear combinations will be selected with the help of "Electro Magnetic Clutch Coils". Electro Magnetic Clutch coils are housed with gearbox. Power supply to EM clutch coils are given through carbon brushes.

Since this was bought as second hand machine, relevant drawings were difficult to get. During commissioning, the carbon brushes were indigenously purchased and installed. After few weeks of operation, clutch coils in both the Sheet Cutters DC motor started failing. Removal of clutch coil from delicate gear units was a difficult and time consuming job for Mechanical

engineers.

Root Cause analysis was made and attributes were found out. This was mostly because of wrong selection

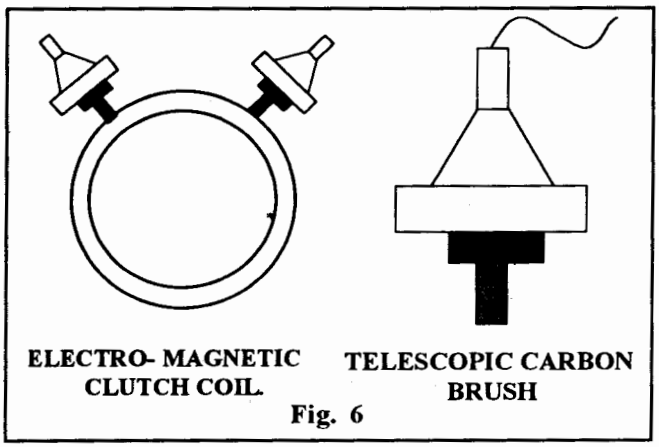

Fig. 6

of brush configuration and material, inductive surges, and drop in voltage within cable and slip rings. To avoid mechanical failure of clutch coil slip rings, "Telescopic Carbon brushes" were purchased which uses phosphor Bronze as base material. In addition it has mesh type brush portion, which itself wear out, and not the slip ring. It also helped in easy "whipping" of oil in between brush and slip rings. Spring type Telescopic brushes also reduced the frequent "Make" & "Break" operation. In order to reduce the voltage drop, the power and control part were shifted near the gearbox , which minimized the voltage drop. Free wheeling diode is also introduced to avoid inductive surges.

The above changes increased the up time of machine and reduced frequent removal of gearboxes, which resulted in saving of man-hours on maintenance.

CONCLUSION

Each problem had to be tackled independently with different approach. The solutions are looking to be simple but to arrive to the conclusion, step-by-step approach had to be developed. Non-availability of imported spare parts were another hardship. Astronomical price obsolete parts/components of imported machine added our difficulties. We had to screen vendor list and choose one among them for developing the part/component as import substitute. There are other issues like life of the consumables, total cost involved in maintenance/material which are being addressed for over all performance of the machine.