RISK BASED MAINTENANCE IMPLEMENTATION AT THE DRYING PART OF THE PAPER MACHINE

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Abstract  
In the paper the authors present some characteristics aspects regarding the implementation of Risk Based methodology in S.C.Somes Dej company, and their experience in this field.  
Key words: risk, risk based maintenance, paper machine.

INTRODUCTION  
In the drying part of the paper machine it takes place the evaporation of the water from the paper paste, with other words the drying of the paper. The drying part is composed of five drying groups. Each drying group contains a certain number of drying cylinders and a number of leading and guiding backing rolls.  
The drying of the paper is realized by passing the paper paste over the drying cylinders from each group, with the help of the steam leaded through the drying cylinders.  
The leading and guiding backing rolls have the role of leading, and guiding the baize which realizes the pass of the paper sheet from a group to another, and from a drying cylinder to another.  
The drying part of the paper machine is presented in Fig.1.

Fig.1 Drying part of the paper machine

In the last years, at the pulp and paper S.C. “Somes Dej” Company, in the field of proactive maintenance, was successfully implemented risk based maintenance of installations with high level risk, such as the paper machine.

The implementation stages of risk based maintenance at the paper machine are the following [3]:  
- identified the component elements and functions of the equipments;  
- identified the probability that this component element functions not accomplished, and the possible damages of the equipment elements;  
- the analysis of probability and risk produce at the equipment elements of paper machine;  
- identified the causes of damage risk appearance and solutions to avoid the risk appearance;  
- establish maintenance process for equipments protection avoiding the failure risk appearance and planning the specific demands for avoiding risks.

The risk based maintenance and continuous monitory of equipments stage are in close interdependence, which is the only counterwork solution of unexpected breakdowns appearance. The determination produced risk of damage and technical unexpected breakdowns are realized with the risk matrix depending on gravity and probability of damages appearance [5].  
The risk matrix is presented in Fig.2.
The risk analysis of damages is based on equipment analyze and the following components of society integral management [1]:

- the security and health of workers;
- the process safety of installations equipments;
- the actual environment legislation;
- the technological aspects;
- the economic-financial aspects.

Fig. 2 The risk matrix

Fig. 3-7 presents the five drying groups, with the displacement of the drying cylinders of the leading and guiding backing rolls [2].

Fig. 3 I-st drying group

Fig. 4 II-nd drying group

Fig. 5 III-rd drying group

Fig. 6 IV-th drying group
IMPROVING THE BACKING ROLLS RELIABILITY FROM THE DRYING AREA, DUE TO THE RISK BASED INSPECTIONS

The optimal functioning of the backing rolls from the drying area is an essential condition for a good functioning of the paper machine.

A particularity of the rolls from the drying area is that the drying groups are covered by an exhaust hood of the paper machine, and the temperature from the hood of the paper machine during functioning is 60 – 80 °C.

So the intervention at the backing rolls is impossible until the paper machine is chilled.

Another particularity of the leading and guiding backing rolls is the difficulty of changing them in the case of accidental damage, because the access of the bridge crane at the backing rolls is not possible, just after the partial dismounting of the exhaust hood of the paper machine.

In practice any intervention at these backing rolls in the case of accidental damage takes 14-18 hours, leading to approximately 45,000 € production losses [2].

During 2006 and 2007 the length of the accidental stands due to the backing rolls from the drying area of the paper machine was 280 hours.

Analyzing the causes of the faults at the backing rolls there was identified the following principal causes:

- damage of the bearings due to:
  - inadequate greasing or lack of bearing grease
  - big vibrations in the housings
  - inadequate execution of the baking rolls spindle
  - wrong mounting of the bearings
    - damage at the spindles due to:
      - the bearings adapter sleeve circumgyrates on the spindle
      - the spindle breaking because of the vibrations
      - the bearings damage
    - The bearing damage represented the main cause of the accidental stops of the backing rolls, 70% from the standing hours were because of this phenomenon.

The greasing of the bearings from the housing of the backing rolls from the drying area of the paper machine is made with consistent grease. Considering that during the functioning of the paper machine the greasing of the bearings is not possible, a huge part of the bearings damage occurred because of the lack of greasing or an inappropriate greasing of the bearings from the backing rolls housing.

After reconditioning the backing rolls, this means the changing of the spindles, the backing rolls are statically balanced, the dynamic balancing being impossible because of the lack of technical support.

The new mounted backing rolls weren’t rectified, the tolerance range in which where executed the dimensions of the bearing being to large.

The backing rolls are being equipped with oscillate radial bearings with barrel rolls on two rows, 22314 CCK series.

The bearing is conic and it is fixed on the spindle of the backing roll by an adapter sleeve. The adequate mounting of the bearing in the housing is difficult because of the non-observance of the dimensions of the bearing and of the designed tolerance.

Also in many situations the mounting of the binding nut in the Mechanical work shop was easily realized during the probes, but at the paper machine, at the scene, the binding of the nut was impossible because of the temperature differences.

This is the reason of the wrong mounting of the bearing, without respecting the fit from the bearing, or without assuring the proper binding of the adapter sleeve on the shaft, according to the designed demands in the technical documentation [2].

Due to this human errors of execution and mounting, many times the bearings blocked quickly after restarting, producing the damage of the bearing, causing new unwanted stops. The inappropriate binding between the adapter sleeve and spindle, during the functioning the adapter sleeve whirl round the spindle, produces the damage of the bearing and spindle.
From the ones presented above, it is obvious that it is necessary to take some urgent measures for eliminating these drawbacks, including reducing the number of accidental stops.

During the planned repairs from November 2007 the main purpose was to remedy the ascertain drawbacks, in order to grow the reliability of the backing rolls and to reduce the accidental stops.

For this reason were taken the following improvement actions [4]:
1. Modifying the housing of the bearings for the automatic greasing system

   The housings of the backing rolls were equipped for the automatic greasing with solid grease, eliminating the possibility of damage of the bearings in the case of lack of greasing, also the human error regarding the periodical greasing of the bearings from the housing of the backing rolls from the drying part of the paper machine. Also the housings were equipped with vibration sensors on two directions in the horizontal and vertical plane.

   The sensors are linked through some derivation boxes to the paper machines’ process computer PLC. This way the state of the bearings will be continuously monitored by the operator that leads the production process, and when it will be achieved the alarm levels, he will announce the maintenance team [5].

2. Reconstruction of the backing rolls spindle

   During the one month planned repairing period the spindles of 30 backing rolls were changed. The spindles were made at the designed dimensions and tolerances from the technical documentation, after this the spindles were rectified and dynamically balanced on a testing stall, with the help of external specialized services. The equipping of the backing rolls was made using bearings provided by the same producer.

   In the foregoing period of the planned repairing, five new backing rolls were made, as a reserve stock, which gives the possibility to recondition the damaged backing rolls, without working against time, this way eliminating the human error that could appear inherent regarding the reconditioning of the backing rolls, the mounting and fixing of the bearing in the housing.

   Advantages obtained due to this works [4]:
   - accidental stops were reduced with 78%
   - growth regarding the reliability and safety in the backing rolls functioning
   - human error eliminated from the current maintenance process
   - continuous supervision of the state of the backing rolls
   - the time period for the planned repairs was reduced, because it is not necessary to open and to verify each backing roll, but we can interfere punctually just at the problematical backing rolls according to the functioning state of the backing rolls
   - the maintenance cost were reduced
   - growth of the reliability in functioning of the paper machine, without the appearance of vibrations that can lead at a slower functioning of the paper machine
   - growth of production by reducing the length of stops and by a high speed functioning of the paper machine, without dangerous vibrations for the state of the machine.

A NEW CONCEPTION REGARDING THE HOUSING OF THE DRYING CYLINDERS AND THE YANKEE CYLINDER DUE TO THE RISK BASED INSPECTION

   The zone of drying cylinders is a vital zone for the well functioning of the paper machine, because any defection appeared at the drying cylinders leads to the total stop of the paper installation. In this case, another special problem is the huge time length (approximately 3 days) needed to remedy the fault, and this leads inevitably to huge production losses.

   Because of the huge duration of the accidental stops and the huge production losses, we considered that it is necessary to pursue especially the functioning of the drying cylinders in order to reduce or eliminate the accidental stops.

   Analyzing the frequency and length of the stops, also the causes why they appear, during 2003-2007, some important aspects can be emphasized:
   - The accidental stops occurred at the drying cylinders appeared due to the bearings damage.
   - The total standing hours because of changing the bearings from the drying cylinders, in one year is an average of 180 hours.
   - The length of revisions and repairs at the drying cylinders during the planned repairs was 8 days for a 4 workers team.

   The cause of these accidental stops at the drying cylinders, after analyzing the risks, was the blocking and damaging of the bearings. In order to reduce the fault risks it is imposed the necessity of a detailed analysis of the drying cylinders bearings from the mounting phase, during functioning until the damage and replacement of the bearings.

   The existent situation:
   - the entering housing for the steam in the drying cylinder, considered to be the axial bearing, contains an oscillate radial bearing with barrel rolls
on two rows with conical interior hole, 23052CKWC4 series with tapered bushing H3052.
- the housing from the exit part of the condense from the drying cylinder, considered to be the angular bearing, contains an oscillate angular bearing with barrel rolls on two rows with conical interior hole, 23048CKWC4 series, with tapered bushing H3048.

The new technical solution adopted is the following:

The bearings of the drying cylinders were designed especially for the drying cylinders and for the Yankee cylinder. They were designed for a great diffience and small calmminess of the lubricate oil. Also the bearings are equipped with a special dwelling for the vibration sensors probe in order to observe the bearings condition.

Right bearing.

The bearing from the entrance part of the steam in the drying cylinder is an axial bearing equipped with a oscillate bearing with barrel rolls on two rows with interior conical hole, the inner ring of the chilled bearing is an HA3 classes ring, the interior loose of the inner ring in C3 classes, and thermal treatment for stabilizing S1 classes for a working temperature of 200 °C.

Left bearing.

The bearing from the evacuation part for the condense from the drying cylinder is an angular bearing equipped with a toroidal CARB bearing, with the inner ring of the chilled bearing in class HA3, the inner loose of the inner ring in class C3, and thermal treatment for stabilizing S1 classes for a working temperature of 200 °C [7].

The bearing with toroidal bearing allows the thermal expansion on axial direction. In practice, the majority of cases, the bearings damage occurs due fissures and also due to the damage of the inner ring of the bearing.

Analyzing the causes of the housings damage for the bearings of the drying cylinders, we marked out mainly the following types of damages: the damage of the spindle surface mainly in the bearings area, the surfaces corrosion, forming hollows and slashes on the spindle surface, manufacturing faults like mounting fault.

The fissure of the inner ring of the bearings can lead to unplanned stops for the paper machine for a long period (approximately 3 days), because usually the bearing with the fissured inner ring will block. More, a chapped inner ring of the bearing will rotate on the shaft, producing severe wears on the shaft surface.

The stresses on the shaft determine the spread in a very short time of the fissures from the inner ring of the bearing.

During mounting, the inner ring of the bearing expands and introduces supplementary stresses in the axial direction on the shaft.

During the functioning of the drying cylinder these stresses amplifies producing a more pronounced heating of the shaft regarding the inner ring of the bearing [4].

![Figure 8. Thermal expansion of the bearings inner ring](image)

The CARB bearings and the oscillate bearings with barrel rolls on two rows, used in this case have a crystalline bainite structure. The best solution for avoiding the fissure of the inner ring of the bearing is to apply a thermal treatment of improvement for the inner ring [6].

The temperature difference between the inner and outer ring of the bearing reduces the initial loose from the interior of the bearing. For the drying cylinders and the Yankee cylinder, during functioning, the inner ring temperature is considerably higher that the temperature of the outer ring because the steam circulates in the interior of the shaft.

The highest temperature difference appears when the cylinders are set to work. The inner initial loose is determined by the hole from the shaft and the inner ring of the bearing, also by the existent temperature difference between the inner and outer ring of the bearing.

Choose of the inner loose C4 was made considering to avoid the bearings block during functioning.

Advantages of the chosen solution:

- grows the drying cylinders reliability during functioning
- longer life period of the bearings
- realizing optimal performances during functioning
• reducing the maintenance costs
• improving the paper quality by reducing the vibrations from the housings
• reducing the accidental stops with 70%
• reducing the revision periods and repairs with 50%
• bigger carrying capacity of the housings which allows the paper machine to function at higher speeds

CONCLUDING REMARKS
Applying the risk based maintenance, after identifying and evaluating the risks of faults, damages or accidents, the maintenance team can focus their efforts for finding technical solutions in order to reduce or eliminate the unacceptable risks, to grow the reliability and safety during the paper machines equipments and installations functioning.

REFERENCES

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