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NEED OF QUALITY IN MANUFACTURING OF EQUIPMENT & MACHINES COUPLED WITH PROPER ALIGNMENT, LUBRICATION TO ACHIEVE PLANT RELIBAILITY & SAFETY FOR PULP AND PAPER MILLS

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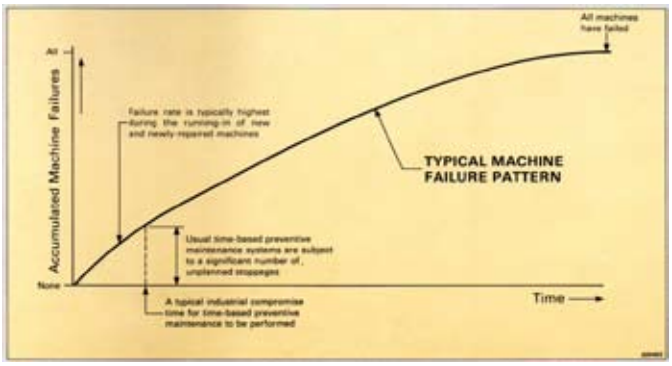
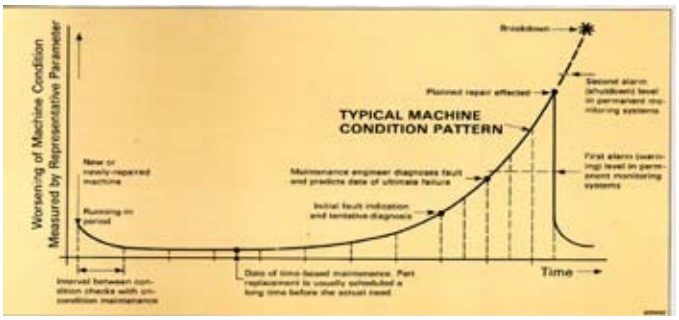
1. Paper Mills generally operate with 330 days availability per annum. Maintenance is a business function that serves and support primary process in an organization. It is therefore defined as a combination of all technical and associated actions intended to retain an item in or restore it to a state in which it can perform its required function.

2. Generally the equipment behavior over a period of operations tend to fail. Chart 1.



3. Typical machine condition pattern with time appears as per chart 2.



Note: Chart 1 & 2 copied from Bruel & Kjaer

RELIABILITY

4. Everybody is familiar with the term "reliability". People often use "reliable" to describe that long time friend that is always there when you need them, that old truck that just refuses to quit running, or that 100 year old rifle your grandpa gave you that still shoots as straight as it did the day it was made. The fact is, all people appreciate reliability: we just don't always understand or recognize the effort that goes into being RELIABLE.

5. Reliability can generally be defined as the probability of someone or something performing what is expected of them at the time and for the duration that is expected. For a business, the reliability of its people, products and assets is of vital importance to the success of the business enterprises. If its people do not perform their required functions, the business will fail to operate, grow and survive. If its products break or fail to function properly, customers will at the very least, take their business elsewhere. If its assets break or do not operate as expected, the company has to invest resources to either repair or replace them, which could be extremely costly and detrimental to the business. The point is, Reliability is important, and how companies manage and maintain an acceptable level of reliability could mean the difference between success and failure.

6. To accomplish this objective the need of quality standard in manufacturing plant and equipment's designed with right fits and tolerances and with proper alignment of rotating machines, good lubrication practices couple with proper safety standards.

7. I therefore touch upon fits & tolerance & alignment which I believe is key for achieving reasonable good life of plant with proper lubrication.

LIMITS, FITS, TOLERANCE AND ALLOWANCES INTERCHANGIBILITY

Interchangeability is the capacity of parts or units to replace those out of order without any additional fitting or treatment.

Interchangeable parts are made without any kind of dimensional variations, that is, they would be exactly the size called for on the blue print or specification.

In actual practice there are factors which make it impossible to meet this ideal condition. The machines which are used to produce these parts have inherent in accuracy

In setting up the machine that is adjusting the tools, skill of operators. Variance in the properties of materials.

NOMINAL SIZES:

Design sizes common to matting parts ACTUAL SIZES: Size obtained in making a part

LIMITS: By the application of tolerance to a design size the two sizes may be calculated between choices the actual size of component may be permitted to vary and these two sizes are termed limits of size

MAXIMUM AND MINIMUM LIMITS: Limits between which the actual size can lie **UPPER SIZE LIMIT:** The difference between maximum limit and the nominal size. **LOWER SIZE LIMIT:** The difference between minimum limit size and the nominal size. **TOLERANCE:** The difference between size limits.

ALLOWANCE: Is the difference between low limit of size of hole (female) and high limit of size of mating shaft (male) FIT: A fit is joint classified according to the size of mating hole and shaft fits are of three general types clearances, interference andtransition

A CLEARENCE FIT: Is one having limits of size so prescribed that a clearance is always results when matting parts assembly.

A TRANSITION FIT: Allows for both interference and clearance their size determining the type of fit.

AN INTERFERENE FIT: One having limits of size prescribed that an interference always results when mating parts are assembly, as the shaft is career than the diameter of hole.

MAXMUM CLEARANCE: The difference between max limit dimension of the shaft and minimum limit dimension of the hole

MINIMUM INTERFERANCE: The difference between the minimum limit dimension of the shaft and max limit dimension of the hole

UNILATERAL AND BILATERAL TOLERANCE: The term unilateral tolerance means that the total tolerance, as reacted to basic dimension is in one direction only in case of bilateral, the tolerance were divided partly plus and partly minus.

CLASSIFICATION OF TYPE OF FITS COMMONLYUSED (FORSHAFT)

Type of Fit	Class of Shaft	Holes					Name of Fit	Examples
		H6	**H7**	**H8**		**H11**		
	C		C8	C2		C11	Slack Running Fit	
CLEARANCE	D		D8	D8	D10	D11	Loose Running Fit	
	E	E7	E8	E8	E9		Easy Running Fit	
	F	F6	F7	F8			Normal Running Fit	Bush Baring Seating
	G	G6	G6	G7			Location Fit	Housing's End Covers Etc.
	H	H5	H6	H7	H8	H11	Sliding Fit All Fine Spi Got	Sleeve Bearing Seatings Spi Got
TRANSITION	J	J5	J6	J7			Push Fit (Easy Assly & Dismantling)	Conveyors shafts,Sleeve with Key or threads general brg Seating
	K	K5	K6	K7			Light KeyIng Fit	Impeller Coupling, Pulley,
	M	M5	M6	M7			Medium Keying Fit	Impcouplingpulleyhighersize Bearing
	N	N5	N6	N7			Heavy Keying Fit (Tight Assembly)	Bearings
INTERFERENCE	P	P5	P6				Light Press Fit Easy	Bush Brg Seating With Housing
	R	R5	R6				Medium Drive Fit	
	S	S5	S6	S7			Heavydrivefit(Permanentor Semi Permenant Assly)	Hub For Worm Wheel Seating
	T	T5	T6	T7			Force Fit (Permenent Assly)	Roll Journals
	U	U5	U6	U7			Heavy Force Fit Or Shrink Fit	Roll Journals

ROTATING MACHINES ALLIGNMENT

Misallignment

- Misalignment-" the disease "can be cured, but
- Preventing it is considerably less costly than the cure
- 40 % of mechanical energy between two pieces of equipment is handled through a coupling

Machine foundations

Without adequate foundations, correct machine alignment is impossible. Before installing a

machine checking the followings points can save a lot of unnecessary work . The foundations of both machines must be strong and level.

Concrete foundations must have hardened before the machines are put in place.

Foot plates must be plane level and correctly positioned

All machine feet must be on foot plate, not wholly or partly on concrete.

The surface below the machine feet must be clean and free from rust.

Holding bolts must be strong enough and firmly embeded into thefoundation.

The foundation of MTBS(Machine to be shimmed) should be a bit lower than that of SM (stationary machine the basic amount of him sunder each foot of MTBS should be 2mm

Vibration

Radial vibration in both horizontal and vertical directions should be measured both before and after alignment.

Check the vibration in pipes and other connections Look for vibrations transmitted from other near by equipment.

Load and strain from connected parts

During operations of rotating machinery there is usually a torque which can effect shafts alignment.

Align with regard to the amount and direction of load during normal machine operation. Compensate if necessary

Align after connecting pipes and other part which can put strain on the structural pipes and other machine parts must be properly connected so that changes in weight and load will not effect machine alignment.

Thermal Expansion

Different rates of thermal expansion in the S.Mandthe MTBS can have a considered effect on vertical shaft alignment for an electric motor the vertical thermal expansion is approximately 0.1 mm per meter for each 100C raise in temperature example

HT of foundation to shaft 0.5 M — Thermal expansion = 0.5 x (50 - 30 / 10) x 0.1

Alignment temperature + 30°C — = 0.5 x 2 x 0.1

Operating temperature + 50°C — = 0.10 mm

What is misalignment:

Misalignment is the deviation of relative shaft position from collinear axis of rotation when equipment is running at normal operations conditions

How is misalignment recognized?

There are several symptoms indicating misalignment keeping our eves open we can find them without any special equipment

- ↙ Premature failure of bearing, seal, shaft, pads / types of coupling
- ↙ Excessive radial and axial vibrations
- ↙ High casing temperature at or near bearings or high discharge oil temperature
- ↙ Excessive amount of oil leakage at bearing seals
- ↙ Loose or broken coupling bolts
- ↙ Excessive amount or grease on the inside of coupling guard
- ↙ The shafts are breaking (or cracking) at or close to in-board bearings or couplings hubs.

The accuracy of each of these alignment methods is subject to the condition of coupling and axis float errors can be further compounded by mechanics who are not knowledgeable and skilled in performing good equipment alignments.

How much misalignment is acceptable

Depends on several factors such as the distance between the driver (Movable) and the driven (Fixed), design of coupling employed and the operating speed

	Rpmall	Excellent	Acceptable
Soft foot (Mills)	All	2.0	3.0
Short Couplings			
Parallel offset	600	5.0	9.0
	900	3.0	6.0
	1200	2.5	4.0
	1800	2.0	3.0
	3600	1.0	1.5
Angularity	600	1.0	1.5
	900	0.7	1.0
	1200	0.5	0.8
	1800	0.3	0.5
	3600	0.2	0.3
	7200	0.1	0.2

	Rpmall	Excellent	Acceptable
Coupling with space parallel offset per inch. of spacer length mil/inch	600	1.8	3.0
	900	1.2	2.0
	1200	0.9	1.5
	1800	0.6	1.0
	3600	0.3	0.5
1 mil = 1/1000thof an inch	7200	0.15	0.25
Coupling with space parallel offset per inch. Of spacer length mil/inch	600	1.8	3.0
	900	1.2	2.0
	1200	0.9	1.5
	1800	0.6	1.0
	3600	0.3	0.5
1 mil = 1/1000thof an inch	7200	0.15	0.25
Coupling with space parallel offset per inch. of spacer length mil/inch	600	1.8	3.0

Note : Follow O.E.M recommendations "Good" alignment to true precision alignment not only continue increase in machine life; better alignment increases are exponential benefits

- Average bearing life increase 5 times
- 7% savings in maintenance budget
- 12% increase in machine availability
- Break down maintenance attributable to misalignment falls down to half.

One of principal causes of misalignment is human error ! Ability to perform good alignment is art !!

Alignment of rotating machine

Shaft alignment:

The process of adjusting the relative position of two coupled machines (eg: motor and a pump) so that the center lines of there shafts form a straight line (co-axis) when the machine is running at normal operating temperature.

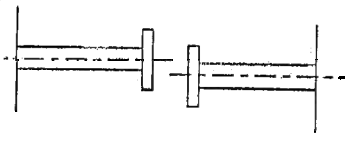
Alignment is achieved by moving the front and or back feet of one machine up, down and side wags until the shaft are aligned with in require tolerances. The other machine remains stationary.

Misalignment:

The condition when the center lines of shafts are not aligned within tolerances there are three types of misalignments

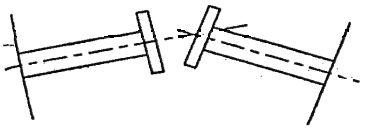
Parallel misalignment (Offset)

This is defined as the shaft center lines being parallel, but in the same plane. This type misalignment can take place in both the horizontal and vertical planes



Angular misalignment

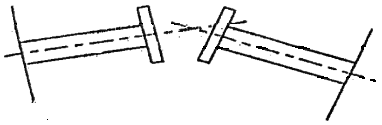
The shat centers are not parallel but they intersect at one of the coupling faces. The chances of the two shafts being in this exact position are very slim



Angular offset misalignment

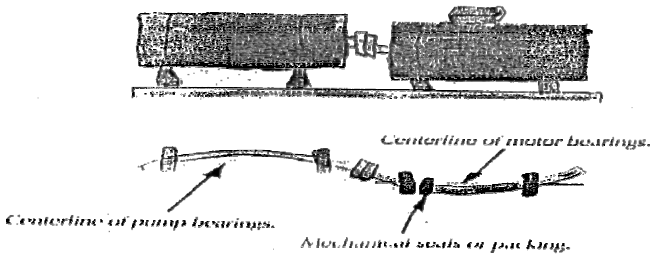
In this case the center lines are not parallel and they do not intersect at one of the coupling faces. This is the most common form of Misalignment found in the real life situations.

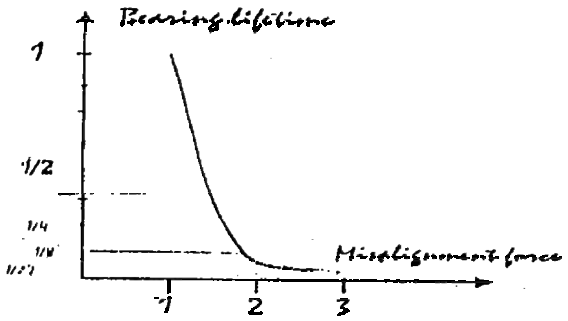
one



Misalignment effects on Bearings and seals

The bearings operating life span is directly affected by the forces it is exposed to. The slightest misalignment can generate excessive forces to the bearings and seals. A misaligned machine causes stress to both bearings and shafts. As an effect of this the seals opens up, allowing lubrication leakage and contamination to enter. All together the bearings lifetime is dramatically shortened.





Doubling the force reduces the lifetime to 1/8th, three times the force reduce lifetime to 1/27the of the original lifetime

Condition for correct alignment

Before starting any alignment work, make sure that there is good chance the machines will stay aligned during operation there is simply no point in aligning machinery which is in poor mechanical condition or which will change position as soon as power is on

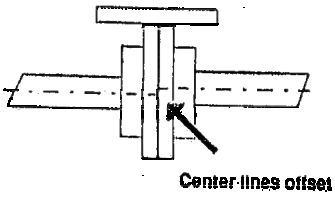
As a general rule:

- Make sure foundation are adequate and correctly prepare make rough alignment and then fine alignment when all the installation work has been done.
- Before re alignment watch how the machine is running check foundations holding bolts, coupling connection vibration, temperature, pipe connection, environment

Alignment methods

The straight edge and feeler gauge and the rim and face methods

The straight edge is used to determine the parallel offset between each coupling half. A feeler gauge is used to measure the gap between coupling halls to determine the angular offset between the face of each coupling



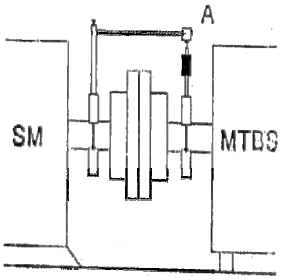
The rim and pace method provides a means to determine the parallel and angular offset between coupling halves with greater accuracy by using dial indicators the air reading determines the parallel offset by measuring the position of coupling half rim relative to the opposite shaft. Also a dial indicator placed on the face of the coupling attached to the opposite shaft is used to determine the angular offset.

The reverse dial indicator method

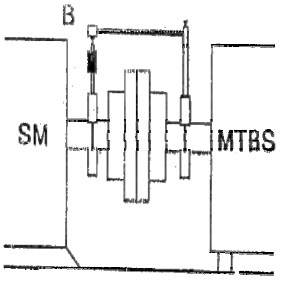
Fixtures are mounted to each shaft along with two dial indicators that read in a radial direction perpendicular to the shaft center line if necessary, in confines spaces, the fixtures can be mounted on the couplings rather than to the shafts.

Accuracy requires determining and compensating for bar and indicator sag, which is normal with any indicator technique and the skills and experience of mechanic performing the alignment. This can be used in 90% of cases it offers several advantages.

- It is usually 3 to 4 times faster than other
- It offers greater accuracy due to separation of indicators compared with the radius traced by face indicator



Indicator position, first reading



Indicator position, second reading

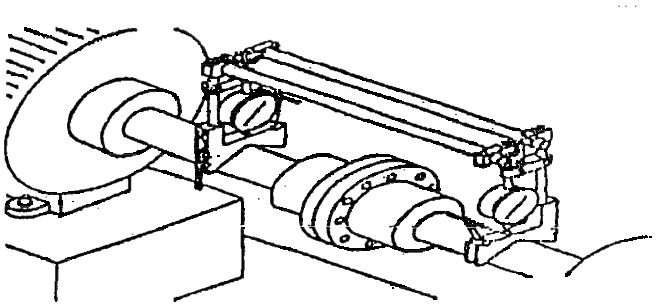
- Coupling in accuracies do not affect
- Axial float will not significantly affect reverse indicator readings
- The method allows the thermal growth adjustment

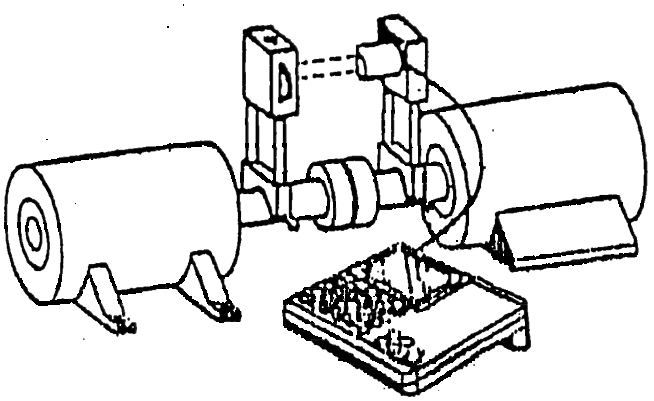
The reverse indicator method

The “reversed indicator method” implies that twosets of shaft run-out readings are taken. For each set of readings, bothshafts, with indicator mounting kit attached,are turned through either a full or ahalf circle attached, are turned througheither a full or a half circle. The coupling is notbroken.

For the first set of readings, thebracket with the mounting post isplaced on the shaft of the SM. The indicator is inposition A on the shaft ofthe MTBS.

Mounting post and indicator are than removed(the brackets remain in place). The shaft is turned 180o, and the indicator is mounted in position B onthe shaft of the SM.





Dimensions and clearance

To use this method, the basic requirements are as follows:

Both shafts must turn together.

There must be at least 21 mm free space on either side of the coupling for the brackets.

To prevent measuring errors, the brackets must be firmly attached to the shafts. With the standard kit, the minimum shaft diameter d is 15 mm, the maximum diameter is 120mm

With the 165mm mounting post, the maximum height h of the coupling is 160mm, measured from the surface of the shaft.

The maximum width w of the coupling (=distance between the insides of the mounting brackets) depends on the length of the indicator target support rod it is:

115mm for rod length 150mm, 265 mm for rod length 300mm, 465 mm maximum with rod length 500mm.

Indicator target support rods of any length can be made from Ø dia 10mm steel rod, up to a maximum length of 500 mm. MAC-10 compensates automatically for the sag in a Ø 10mm rod.

- The minimum free space above the shafts, needed to turn the mounting kit, is a half circle with radius R = 200 mm. R is measured from the shaft surface.
- The minimum free space below the shafts is a half circle with radius r=70mm, measured from the shaft surface

The laser alignment method

The method uses the same geometric relation ships as the other equipment alignment techniques but employs laser beaks, prisms and sensors to determine the relative shaft positions the laser beams are able to span long distance and eliminate possible error resulting from bar and indicator sag. The technique is very accurate and especially useful where long couplings are employees. However the presence of due, steam, or intense sunlight can affect the accuracy of laser measurement also care must be taken in handling the fixtures to avoid a bump which will adversely affect the calibration of the equipment. The laser's fragility and complexity of operation often prevent it from being used by mechanical maintenance dept.

Symptoms of misalignment

The purpose of shaft alignment is to prevent excessive vibration and the premature failure of machine parts

Quite often, bad machine condition is obvious, but repairs are made without correcting alignment faults, or removing the underlying causes for misalignment, such as poor foundations, excessive temperature gradients, strain from connected pipes, etc.,

An alignment check should be made if one or more of these symptoms are noted:

- Excessive radial and axial vibration
- High oil temperature, hot bearings
- Excessive oil leakage at the bearings seals
- Loose foundation bolts
- Loose or broken coupling bolts
- Hot coupling immediately after shutdown
- With elastic couplings, rubber or plastic powder inside the coupling guard
- Frequent bearing and / or coupling failures.

SAFETY IN MAINTENANCE WORKS

Maintenance and Repair work at a Paper Mill involve a great risk of accidents. Conditions during repair work are often are un-favorable because the broken down machine or device must be repaired rapidly without additional production loss. Because of hurry, not so much attention is necessary paid to work safely.