PROJECT SARJANA MUDA 1

ESTIMATE THE LIFE CYCLE OF ROLLER BY EXPERIMENT AND SIMULATION

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SUPERVISOR DECLARATION

“I hereby declare that I have read this draft report and in my opinion this draft is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Plant & Maintenance)’

Signature:………………………………..

Supervisor: MR OMAR BIN BAPOKUTTY

Date:…………………………

DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged."

Signature: ....

Author: AZLAN SOFFIAN BIN BORHAN

Date: ....

ABSTRACT

This research is to estimate the life cycle of roller by experiment and simulation. The objective are The objective are to investigate the maximum force that roller can sustain. Secondly is too study the fatigue life of the roller. And lastly to estimate the life cycle of roller using computer-aided design (CAD) software. The result of the research will determine by doing analysis using ANSYS sofware and Solid Work sofware after the 3D model is draw using Solid Work software. In conclusion, we can get the result and the objective is archieve.

ABSTRAK

Tujuan kajian ini adalah untuk menganggarkan kitaran hidup untuk roller dengan eksperimen dan simulasi. Objektif kajian ini adalah untuk mengetahui daya yang maksimum dapat ditampung oleh roller. Yang kedua adalah mempelajari kelesuan pada roller dan akhir sekali menganggarkan kitaran hidup roller menggunakan perangkaian komputer. Hasil keputusan dari kajian ini akan dikenalpasti selepas menggunakan perisian ANSYS dan perisian Solid Work selepas model 3D dihasilkan menggunakan perisian Solid Work. Kesimpulannya, objektif dapat dicapai apabila mendapat data yang diingini.

ACKNOWLEDGEMENT

To Allah Almighty belong to all praises and glory. His peace and blessings be upon His chosen Prophet, Muhammad SAW, his family and companions. I wish to record my grateful knowledgeable to the institutions and individuals without whose kind assistance, concern and encouragement the humble effort would not have been possibly accomplished. In the writing of this dissertation.

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CHAPTER 1

INTRODUCTION

This research will focus on the life cycle of the roller. By improve the life cycle of the roller, breakdown in plant can be reduce. Beside that, we also can planning on preventive maintenance from the result and the predictive maintenance.

Background

Coal mining is a huge industry and consume large of electricity. The correct way of materials-handling methods must be concern, therefore materials-handling selection must be take seriously and the decision-making process can be extremely hard. After the mined material pull out from the earth, it must be transfer to a processing site and then to the final location to be use. Depending on the type of mining, transportation in the mine itself can be by rail car, truck, or conveyor. The electrically powered conveyors are an important option for local and long distance materials handling in mining sector. They are highly used in and around mines, in lengths from 20 yards to 20 miles. For the conveyor that use in mining, the rollers used to backing the belt conveyors from fall apart and as the result of a three-body wear process to build abrasive wear under slight stress. Figure 1 show one of the type widely used in our country.

Figure 1 : Carrying roller/idlers

Problem Statement

There are many different parameters that have to be measured on roller and it should be considered in purpose to improve the mechanic of the roller such as fatigue of the material, saiz of the roller and type of material. This helps to prevent breakdown from happen and we can do preventive maintenance before the roller totally crack and not suitable to use anymore.

Objective

The objective are :

1. To investigate the maximum force that roller can sustain.
2. To estimate the life cycle of roller.
3. To determine the suitable maintenace to use.

Scope of study

The scope of this study are:

1. 3D model will be produced to represent the roller.
2. Analysis will cover aspects of mechanics.
3. Analysis the data using ANSYS and Solid Work software.

Gantt Chart

No	Activity	Week													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	-Choose title. -Briefing by supervisor.	■													
2	-Collect data and information		■	■	■										
3	-Identified the objective, problem statement and scope of study					■	■	■							
4	-Submit poster								■						
5	-Proceed to methodology								■	■	■	■	■		
6	-Final seminar												■		
7	-Prepare report draft. -Submit report draft.												■	■	■

Table 1 : Gantt chart

CHAPTER 2

Introduction

In this chapter, all the information related to the life cycle is elaborated. This literature review is importance step to get all the information related to this research.

2.1 Idler / roller

The idler or roller provides a basic radial support against gravity and belt tension in the case of curved belt, and to force belt bending and material cross section. In doing this the roll also allows longitudinal movement with only a small through accumulating belt tension increace part of which is attributable to the roll torsional resistance and matching the idler roll life to that of the conveyor are the primary design goals at a particular radial load beyond enabling a cost effective and well "behaved" rotating construction. (Alspaugh, 2008)There are many different type of idler. Figure 2 shows type of conveyor.

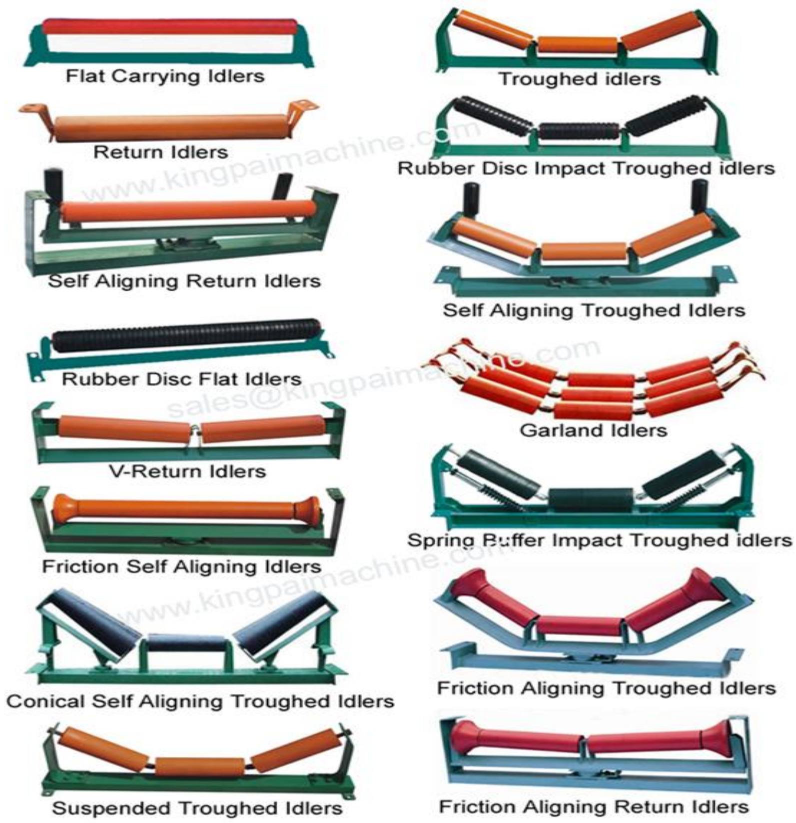


Figure 2: Type of conveyor

2.2.1 Idler/roller life

Life versus design can be thought of as the maximum possibe life of a loaded roll and the factors that contribute to not fully experiencing this life. The following descriptions of common idler components : (Alspaugh, 2008)

Bearing life

- The bearing life is ultimately limited by the contact stresses between the rolling element and the races that they run. Several scenarios can develop that must be addressed in the design of the bearing set.

Seal for bearing life

- Significant cost are commonly added for seal between the rotating andstationary component to isolate the bearing from external contaminants so they can function as intended.

Labyrinth design

- Labyrinth is a general term for non-contacting, frictionless isolation that creates a bending, narrow and usually long path making it more difficult to material to pass to the bearing. Alternating rotating and stationary element create axial and radial passages where the width of the passages is governed by the ability/cost tp prevent contact and whether they are grease filled.

Contact seals

- Used to prevent ingress of contaminant. They can be rotating or stationary and axially or radially acting. Oil type rubber lip seals are common but soft radial washer of felt or foam are also used.

Roll wear

- The belt contact surface wear can also be the limit to idler life. The driving influence should be considered the belt contact and alignment of belt movement normal to the roll centerline. This can be affected by installation, frame design, belt curves or idling spacing.

2.2 Predictive maintenance / Condition Based Maintenance

The goal of life-cycle design is to maximize the values of the manufacturer's line of products while containing the products' costs to the manufacturer, the user, and society. Engineers must consider performance, cost, and any environmental impact of their designs. Our research develops systematic methodologies that apply to the early stages of product development in integrating life-cycle quality (Ishii, 1995)

By knowing the estimation of the life-cycle, it easy to do the predictive maintenance. Also know as condition based maintenance (CBM). Predictive maintenance keeps us one step ahead of the problems. This because we already collecting and analyze the key parameter to optimize the maintenance schedule. This are some of the benifits :

- Improved reliability and performance
- Minimized downtime
- Extended equipment lifetime
- Reduced operating risks
- Decreased replacement costs
- Improved spares management
- Increased maintainability

In the same time, it also has disadvantage which are :

- Increases investment in diagnostic equipment

- Increases investment in staff training

Applications / Technologies	Pumps	Electric Motors	Diesel Generators	Condensers	Heavy Equipment/ Cranes	Circuit Breakers	Valves	Heat Exchangers	Electrical Systems	Transformers	Tanks, Piping
Vibration Monitoring/Analysis	X	X	X		X						
Lubricant, Fuel Analysis	X	X	X		X					X	
Wear Particle Analysis	X	X	X		X						
Bearing, Temperature/Analysis	X	X	X		X						
Performance Monitoring	X	X	X	X				X		X	
Ultrasonic Noise Detection	X	X	X	X			X	X		X	
Ultrasonic Flow	X			X			X	X			
Infrared Thermography	X	X	X	X	X	X	X	X	X	X	
Non-destructive Testing (Thickness)				X				X			X
Visual Inspection	X	X	X	X	X	X	X	X	X	X	X
Insulation Resistance		X	X			X			X	X	
Motor Current Signature Analysis		X									
Motor Circuit Analysis		X				X			X		
Polarization Index		X	X						X		
Electrical Monitoring									X	X	

Table 2 : Example of prediction technology application

When to use predictive maintenance:

- Assets degrade over an unknown amount of time include cost effective to monitor and repair rather than allow it to fail
- The cost of monitoring is less than the cost of it failing or of carrying a preventive maintenance including the risk of infant mortality
- Carried out on redundant machines, where failure directly impact production/secondary damage.

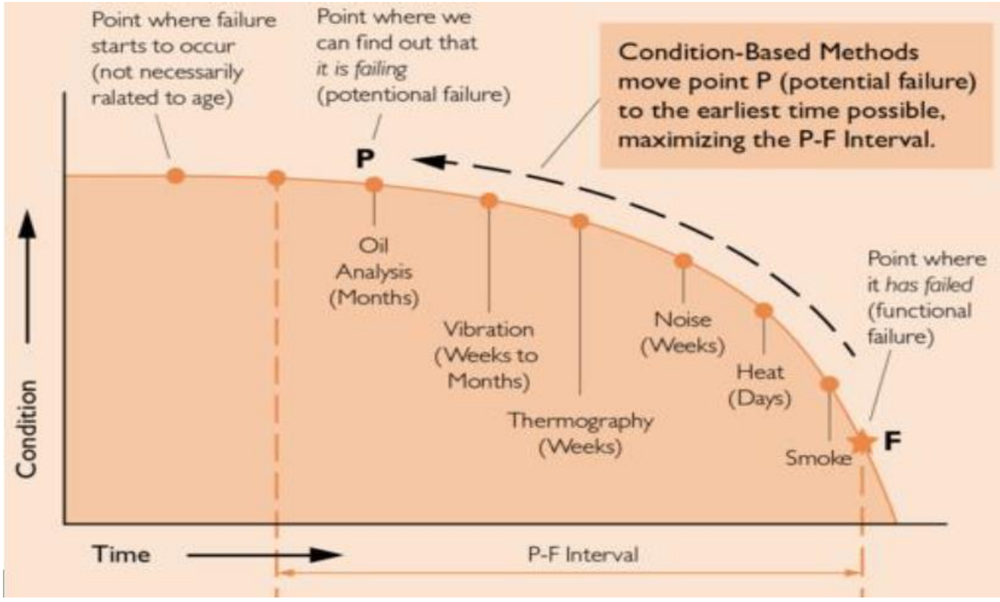


Figure 3 : P-F curve

As we can see from figure 3, before the machine or component get functional failure, it will gives warning. CBM is done to know the earliest time possible that can cause failure happen and to maximizing the P-F interval. CBM implemented to reduce the breakdown happen in industry. When breakdown happen, the industry will have a lot of loss of profit and waste time for waiting to be repair or the spare part to order.

There are various technologies are employed to monitor the sign of problem which are

- Thermography
- Wear debris and oil analysis
- Ultrasonic testing
- Vibration analysis

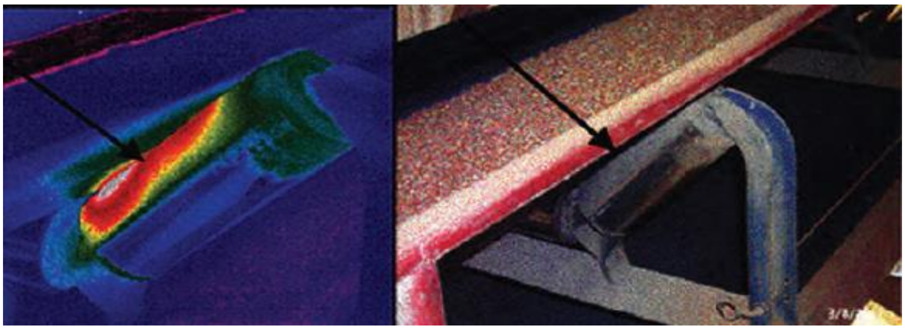
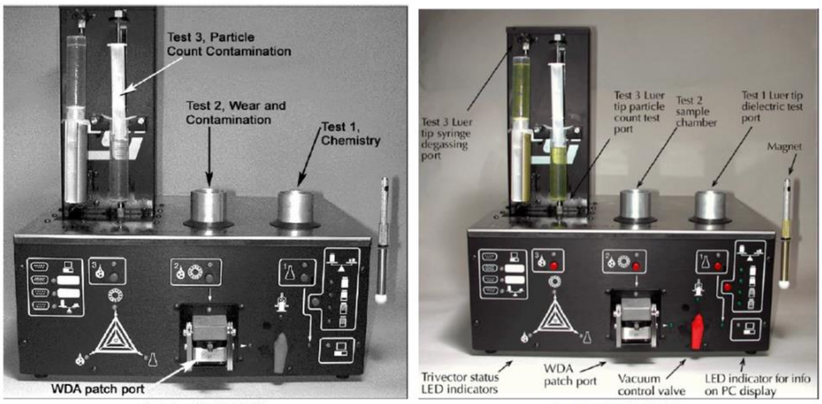


Figure 4 : Thermography testing on conveyor's roller



Front view of the Model 5200. Front view of the Model 5200.

Figure 5 : Oil analysis equipment

Figure 6 : Ultrasonic equipment

Figure 7 : Vibration analysis equipment

2.3 Fatigue

The most major failure in engineering is cause by fatigue. Fatigue failure is defined as the posibility of a material to fracture by means of progressive brtittle cracking under repeated applied loads. Fatigue cracks are very slow to develop initially but their rate of growth increases dramatically as the crack grows. In essence, this acceleration results from a localised increase in the stress at the top of the expanding crack, which comes about quite naturally because the forces on the object are supported by an ever-diminishing cross-sectional area. Some materials have a fatigue limit. For example, mild steel will not normally admit fatigue crack growth if the applied stresses are below about 10% of the strength of the material. However, other materials, such as aluminium alloys, do not have any such limit. If a cyclic load is applied, aluminium alloys will always fatigue. As a consequence, aluminium alloys cannot be used for roller where an infinite fatigue life is specified. The maximum stress values are less than the ultimate tensile stress limit, and may be below the yield stress limit of the material. (refer figure 8). Fatigue life is determined by a many factors, such as temperature, surface finish, and presence of oxidizing or inert chemicals. (Burgoynes Consulting Scientists and Engineer)

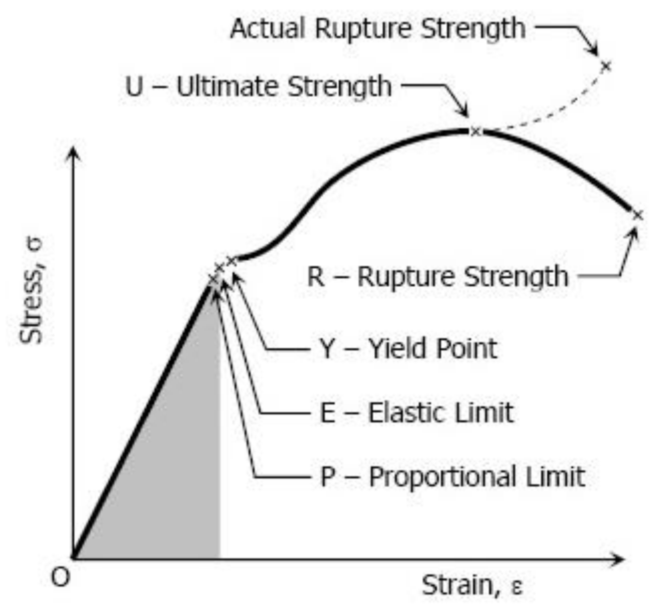


Figure 8 : Stress vs strain graph

Elastic Limit is

- the abilty of material to return to it original shape after load is removed.

Yield Point

- is the point at which the material will have an appreciable elongation or yielding without any increase in load.

Ultimate Strength

- the maximum ordinate in the stress-strain diagram is the ultimate strength or tensile strength.

Rapture Strength

- the strength of the material at rupture. This is also known as the breaking strength.

We can learn a lot about a substance from tensile testing. As you continue to pull on the material until it breaks, you will obtain a good, complete tensile profile. A curve will result showing how it reacted to the forces being applied. The point of failure is of much interest and is typically called its "Ultimate Strength" or UTS on the chart. Different type of material has different value of fatigue. Figure 9 show different type of material that has different value of fatigue.

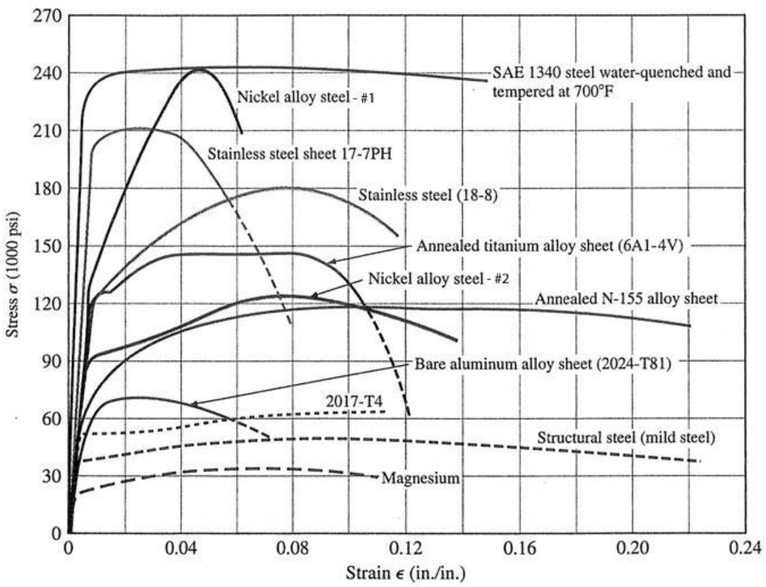


Figure 9 : Stress vs strain diagram of different type of material

Hooke's Law is measure of the stiffness of an elastic material and is a quantity used to characterize materials. It is defined as the ratio of the stress (force per unit area) along an axis to the strain (ratio of deformation over initial length) along that axis in the range of stress.

$$young\ modulus = \frac{stress}{strain}$$

$$E = \frac{\sigma}{\varepsilon}$$

The modulus of elasticity is a measure of the stiffness of the material, but it only applies in the linear region of the curve. If a specimen is loaded within this linear region, the material will return to its exact same condition if the load is removed. At the point that the curve is no longer linear and deviates from the straight-line relationship, Hooke's Law no longer applies and some permanent deformation occurs in the specimen. This point is called the "elastic, or proportional, limit". From this point on in the tensile test, the material reacts plastically to any further increase in load or stress. It will not return to its original, unstressed condition if the load were removed.

One of the properties you can determine about a material is its ultimate tensile strength (UTS). This is the maximum load the specimen sustains during the test. The UTS may or may not equate to the strength at break. This all depends on what type of material you are testing. . .brittle, ductile, or a substance that even exhibits both properties. And sometimes a material may be ductile when tested in a lab, but, when placed in service and exposed to extreme cold temperatures, it may transition to brittle behavior.

The fatigue process is usually divided into three phase which is phase 1(crack initiation), phase 2(crack growth) and phase 3(final fracture).

Phase 1 which is the crack initiation usually takes place on the surface of the metal in the vicinity of a notch. The mechanism is explained by a slip band mechanism at a microscopic level driven by the maximum shear stress. When the load is imposed, some grains will be subjected to plastic deformation invilving the sliding of someof the crystallographic planes. The mechanism is limited to a few grains where these crystallgrophic planes have an unfavorable orientation with respect to the local maximum shear stresses. When the load is reserved, the planes will not slideback to their initial position due to the cyclic stain hardening effect. Hence, in the reserved part of the loadcycle, it is the neighboring planes that will suffer yielding by sliding in the opposite direction. The final result is microscopic extrusions and intrusion on the metal surface. The intrusion act as a micro-crack for further crack extension during the subsequent loading cycles.

After crack initiation has occurred within a few grains, subsequent microscopic growth will extend the crack to pass several grain boundaries. When the crack front reaches over several grains, the crack will continue to grow in a direction perpendicular to the largest tensile principle stress. It is importance to realize that whereas the initiation phase is related to the surface condition of the metal and governed by the cyclic shear stresses, the crack growth depends on the material as a bulk property and the crack is driven by the cyclic principal stresses.

In the growth phase, the crack growth process is explained by crack opening and front blunting mechanism followed by a subsequent crack losing and front sharpening mechanism during each load cycle. After one complete cycle, the crack front has advanced a small increment which may be traced by microscopy on the fatigue surface. This advancement corresponding to oneload cyclic is the distance between two so called striations. These striation are shown for a high strength steel. The advancement depends on the range of the range of the stress intensity factor.

The final fracture in phase 3 will take place when the crack becomes so large that the remaining ligament of the cross section is to small to transfer the peak of the load cycle, or when the local stresses and strain at the crack front inflict a local brittle farcture. (Tom Lassen, 2013)

2.3.1 Factor that affect fatigue

The factor are : (EPI inc.)

(a) Surface Condition (k_a): such as: polished, ground, machined, as-forged, corroded, etc. Surface is perhaps the most important influence on fatigue life

(b) Size (k_b): This factor accounts for changes which occur when the actual size of the part or the cross-section differs from that of the test specimens

(c) Load (K_c): This factor accounts for differences in loading (bending, axial, torsional) between the actual part and the test specimens;

(d) Temperature (k_d): This factor accounts for reductions in fatigue life which occur when the operating temperature of the part differs from room temperature (the testing temperature)