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Manufacturing & Installation of Mechanical Seal for Scrapper Heat Exchanger

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Abstract: The Ebara Pump is a well-liked stainless-steel pump inside the food processing enterprise and the hospitality zone. The foremost difficulty with this pump setup is that product escapes thru the mechanical seal all through the intermediate pauses that occur during the system of shift changes or product changeover. The packing manufacturing unit is dropping quite a few cash due to the oil leak in the cooling gadget. A common problem all through the transport of palm oil or palm merchandise from the refinery to the exceptional downstream processing zones triggered us to increase a prototype of the mechanical seal used in the Ebara Pump. A vulnerable spring will increase the pace at which a mechanical seal would possibly fail. This contemporary mechanical seal for pumps allows cut down on waste that finally ends up in landfills. The annual financial savings for a facility with 16 pumps the use of this approach is expected to be RM 360 000.

I. INTRODUCTION

Leaks resulting from bad sealing among mechanical elements might result in extensive losses within the palm oil region. The approach might regulate the bodily traits and composition of the oil. In different circumstances, along with all through the refining and deodorization approaches, the oil might be liquid and much less viscous. Oil properties shift to a greater viscous kingdom at some stage in the fractionation and crystallization process. Depending on these situations, the sort of sealing for technique gadget components is determined.

There are times in the palm oil enterprise whilst we need to warmth the medium so as for it not to harden so as to shipping oil in a pipeline. Keeping the medium in a positive temperature can be executed earlier than moving through heating the oil in a storage tank and throughout shifting having a steam tracing system alongside the pipe line for the oil to stay warm and not to solidify. A heating approach referred to as "steam tracing" uses copper tubing that has been wound across the pipeline to heat the water.



Figure 1: Steam Tracing Along Pipe Line (Wermac,2012)

1.1 Problem statement.

We have spinning machinery just like the Kombinator within the crystallisation plant, which crystallises palm oil at a completely low temperature to create crystals within the scraper warmth exchanger. To keep the effectiveness of warmth alternate, the scraper is a revolving shaft that scrapes crystallised oil from the floor of the heat exchanger.

The scraper shaft's design includes a mechanical seal to prevent oil leaks. A warm water jacket at the shaft seal affords some external heating, but the temperature should not be too excessive to harm the crystal within the oil.

Due to this restriction, the mechanical seal might leak crystalized oil in the course of manufacturing. Due to the solidifying fats within the mechanical seal of the Ebara pump, the spring has a propensity to seize and oil could leak from the mechanical seal in the prototype mechanical seal. In the plant, there are a total of 15 Ebara pumps in use, and

oil leakage from the mechanical seal as a result of this sort of failure effects in a waste of RM 350 000 in step with 12 months. Only 15% of the RM 350 000 waste may be recovered, leaving the ultimate RM 297 000 as an annual loss for the commercial enterprise.

1.2 Objective

- 1) If a mechanical seal comes into contact with a product all through setup or operation, it shouldn't capture. There are no shaft leaks.
 - 2) Ease of fabric machining and manufacturing. Aimed for production fees of RM 300.
 - 3) Conical springs are designed to convert to straight springs for honest installation and spring casing simplicity.
 - 4) To gain comparable forces and compatibility with the antique ceramic seal, stimulate the conical spring and evaluate it to the instantly spring design.
 - 5) Put the brand new mechanical seal to the check and test to peer whether it malfunctions. A total of two hundred hours should had been spent testing this prototype.
- Pump overall performance ought to suit the manufacturer's mechanical seal design. Pump ought to operate with a discharge pressure of as a minimum 2 bars while the release valve is completely open.
- 6) The new layout should also solve the trouble of product leakage all through pump stoppages and transitional intervals in production.

II. LITERATURE REVIEW

Design of Mechanical Seal for Scrapper Heat Exchanger

All through 119 million tonnes of oil and fats are produced and consumed annually for the duration of the arena, and this quantity is gradually growing at a tempo of 2 to 6 million tonnes each year. (2014) Peter R.N. Childs Currently, 14% of fats and oil output is utilised as oleochemical industry prep fabric, and 6% is used as animal feed. The thoughts-boggling ultimate eighty% is utilised for human meals, together with spreads, frying oils, salad dressings, and cooking fat. (2014) Peter R.N. Childs.

Spreads and culinary fats, such palm oil, are crafted from liquid oil paperwork. The ensuing semi-strong fats are utilised as spreads and cooking fat after being crystallised and texturized. Margarine, butter, shortening, and different products are examples of this product on the market. Crystallisation is the method via which oil goes from a liquid to a semi-solid state.

Blending tanks, a scrapper warmth exchanger, and a filling station make up a crystallising plant. The determine under is an illustration of a fundamental plant format.

III. RESEARCH METHODOLOGY

The concept at the back of the new design is to surround the seal housing in order that the oil is kept away from the spring. There might be no spring seizing if the fluid oil contact with the mechanical seal become eliminated. The current pump design consists of a mechanical seal spring exposed to grease, which may also seize the spring whilst hardened or crystallised. This layout is being examined on a smaller scale utilizing an Inoxpa Pump. The mechanical seal and pump layout because it now stands is proven under.

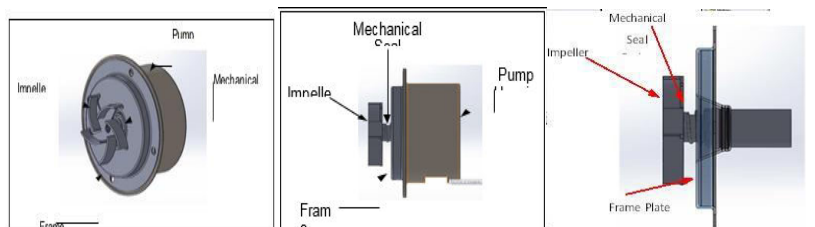


Figure 23: Existing Pump Design

Design 1.

The new mechanical seal design as below, which has an enclosed compartment for the spring

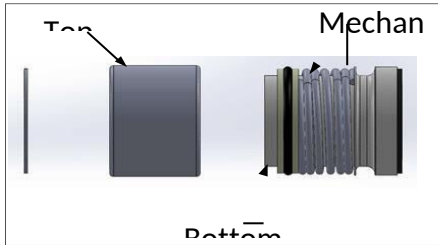


Figure 26: Enclosed Spring Design

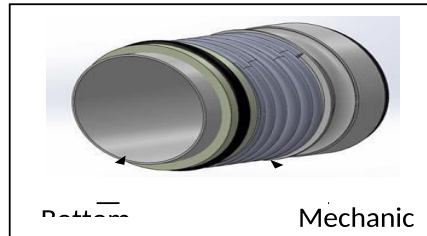
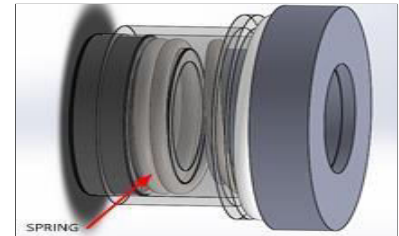


Figure 27: Assembly of Enclosed Spring



The pinnacle enclosure of this layout prevents the spring from shifting freely, even as the lower enclosure covers the spring using the identical ceramic seal casing. When the pump is first set up, there might not be any leaks, however after a few months of operation, the ceramic seal will put on out and the spring might not be able to pressure the revolving ceramic to the stationary seal.

Spring Calculation

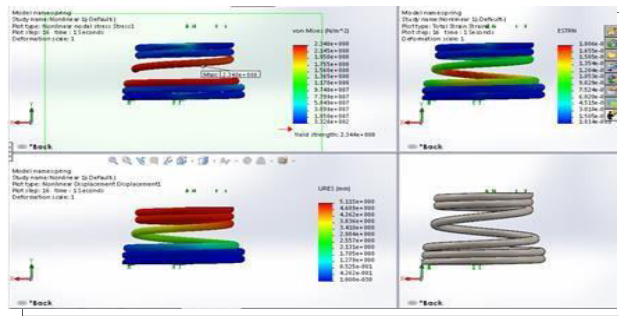


Figure 35: Stimulation result of Inoxpa Original tapered.

In order to examine the stresses in the tapered spring (the spring used in production) and the immediately spring that we will be making use of for our prototype, there may be a strain stimulation whilst the tapered spring is compressed. The inspired springs are both manufactured from stainless steel 304. The mixed overall displacement needed for the two springs to overwhelm the ceramic seal is 5mm. The most stress is two 10Nm2 at a displacement/compression of 5mm.

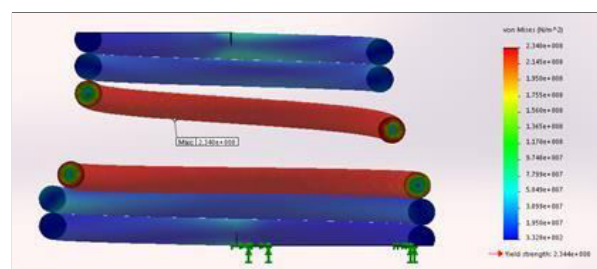


Figure 36: Cross section of the tapered spring internal stress

Figure 37: Stimulation Result on spring for Prototype Mechanical Seal

Maximum stress acting to the prototype spring when deformed is $1.14 \times 10^8 Nm^2$ which is lower than the original tapered spring.

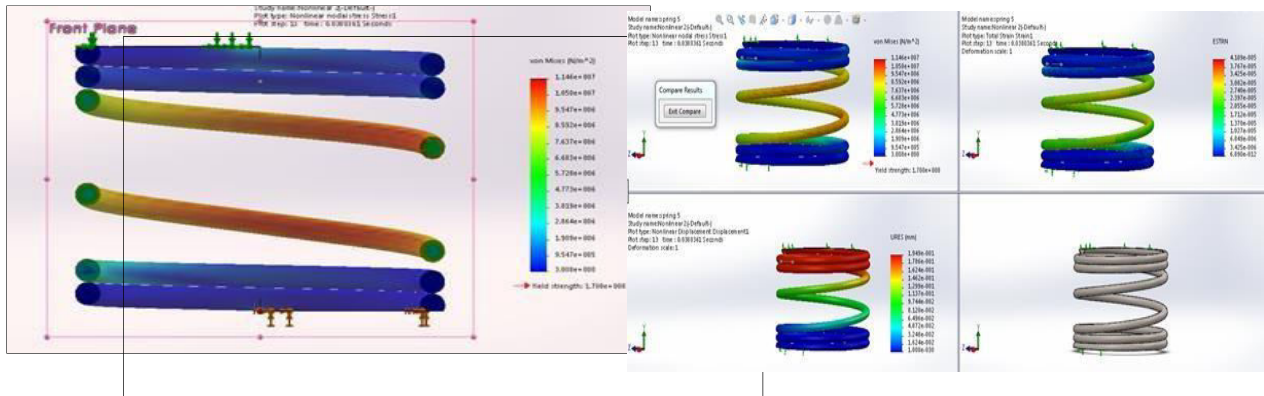


Figure 38: Cross section of the straight spring internal stress

The prototype mechanical seal might also employ a instantly spring design for the reason that spring did not budge for the duration of the stimulation method. Model 2. The pump motor might be loaded to the factor of overheating and the coil would burn out if the spring's stresses were no longer calmly dispensed or if there was a robust pressure pushing on the ceramic face. Rotating the spring with the aid of hand and detecting resistance is one way to evaluate the anxiety. Less pressure must be required to spin the impeller, making it loose.

Performance Monitoring.

Following the pump's installation inside the manufacturing line with the prototype mechanical seal, the running parameters for the aforementioned state of affairs are stated. The analyzing of the pump with the authentic mechanical seal and the reading with the changed mechanical seal have to be tracked one by one. The overall performance of the new mechanical seal may be assessed via evaluating the two of those numerous standards.

The pump motor would be in an strange kingdom if the studying of motor cutting-edge become extra than 50% from the original set up. If the motor temperature is extra than 50 ranges Celsius, a new mechanical seal may be rubbing towards the pump casing in some way.

Pump functioning is shown by way of the release stress, which also suggests if the pump is performing as intended. For this application, pump pressure ought to be among 1.7bar and 2.5bar.

The ceramic face shouldn't lose greater than 1mm of face thickness throughout the a hundred and fifty hours of testing the brand new mechanical seal. This could be a signal that the pump is operating abnormally, inflicting a great stage of damage and tear on the ceramic seal.

The discharge valve of the pump might be completely open at some point of regular operation for the primary set of assessments on the new mechanical seal. For the second one set of checks, the release valve may be throttled until it is absolutely closed, and overall performance readings will be amassed as proven in Table 1.

III. RESULTS AND DISCUSSION

Installation of Mechanical Seal Prototype.

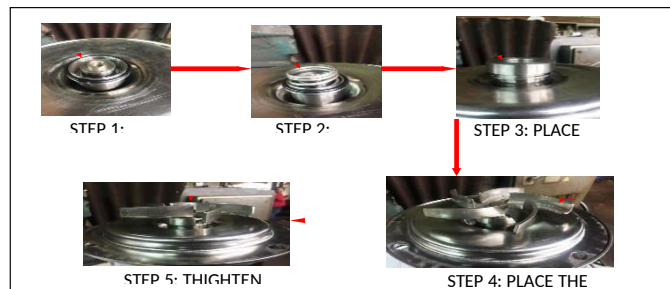


Figure 39: Steps in installing Mechanical Seal Prototype

It is essential to perform the pump with palm oil product in a state stimulated as in our actual production so one can examine the new design of the prototype mechanical seal.

I requested consent for this trying out from the manufacturing branch and the packaging production head, Mr. Azam, after outlining the advantages and layout of using an enclosed mechanical seal.

According to the production making plans agenda, Packing Plant three will trade its product at 2:00 PM on April. The Inoxpa pump serves as a procedure feed pump for Packing Plant 3. The manufacturing features a stress gauge after the feed pump for monitoring pump performance. The pump stress is monitored within the range of one.8-2.0bar, which ends up in a glide rate of 4m³/hr-five.2m³/hr.

The feed pump's task is to transport produced oil from the mixing tank to the processing equipment where it is going to be crystallised or cooled.

Normal production could start up the Feed Pump as soon as the Tank Isolation Valve and Valve 1 are opened. If the Tank Isolation Valve is closed, the pump might dry run and spoil the mechanical seal if repeated often. If Valve 1 is closed at the same time as the pump is running, excessive strain can be created on the pump discharge side. Both of these valves need to be open earlier than beginning the pump.

Figure 41: Mechanical Seal Spring with Solidify Fats



The motor for this Inoxpa Pump EFI-2222 type is 2.2 Kw, with a five amp most current.

The motor might overheat and burn out if the cutting-edge turned into at eighty% of the most, or around 4 amp.

The load or resistance appearing at the motor might be ascertained by way of measuring the temperature and motor

Recommended for General Machinery Turning from 600 to 12000 RPM
(Based on ISO IS 2372)

RMS Overall velocity Level Measured in 1000 Hz Bandwidth		Vibration Severity Criteria			
Mm/s	In/s	Class I	Class II	Class III	Class IV
0.28	0.01	Good	Good	Good	Good
0.45	0.02				
0.71	0.03				
1.12	0.04	Satisfactory	Satisfactory	Satisfactory	Satisfactory
1.8	0.07				
2.8	0.11	Unsatisfactory	Unsatisfactory	Unsatisfactory	Satisfactory
4.5	0.18	Unacceptable	Unacceptable	Unsatisfactory	Unsatisfactory
7.1	0.28				
11.2	0.44				
18	0.71	Unacceptable	Unacceptable	Unacceptable	Unacceptable
28	1.10				
45	1.77				

C.I.P. LINE (CLEANING IN

Class I. Small-sized machines (powered from 0 to 15 KW)
Class II. Medium-sized machines (powered from 15 to 75 KW)
Class III. Large-sized machines (powered > 75 KW) mounted on "Rigid Support" structures and foundations
Class IV. Large-sized machines (powered >75 KW) mounted on "Flexible Support" structures

current. When this 5kW motor is beneath heavy load, it'd particularly warm, measuring inside the range of 80–a hundred°C and 4-5 amps for the motor modern-day. The motor winding could short circuit and overheat in this situation. Rendering the motor vain
 When Valve 1 is open and in ordinary manufacturing mode, the release strain is two bar; but, beneath some occasions, along with whilst an operator accidentally closes the valve, the release strain may boom to four bar. The mechanical seal might be subjected to this degree of strain, which it might want to resist without failing.
 A new mechanical seal might be 9.5mm thick, but with fallacious set up, its thickness could quickly lower and it might subsequently break.
 Cost of fabricating prototype mechanical seal
 The cost of an original mechanical seal = RM 680.00

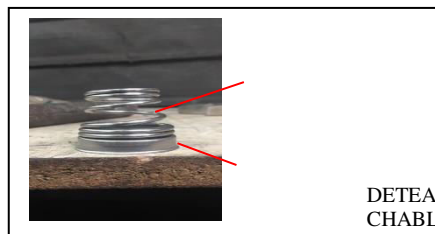


Figure 44: Original Mechanical Spring Assembly

The authentic Inoxpa Pump Mechanical Seal is offered on the market in a set of one as a spare element or consumable object. Two O-ring devices, a conical spring, a chrome steel housing for the ceramic seal, and the ceramic seal itself are protected on this package deal. The whole set of mechanical seals is shown within the above determine. Prototype mechanical seals are priced at RM a hundred forty five.00 for one unit.

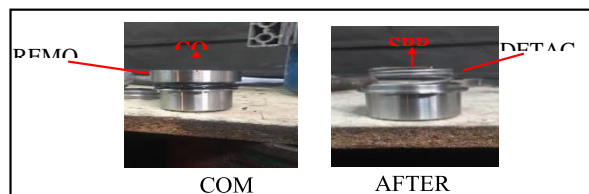


Figure 45: Prototype of Mechanical Spring Assembly

The fabrication price for this design is RM 1450.00. If the mechanical seal at the pump fails due to a damaged O-ring, spring, or ceramic seal, the protection man or woman most effective needs to replace the failing elements in place of the complete meeting, which includes the ceramic seal, that is detachable from the seal housing, O-rings, and spring. This three-piece set can be bought as a mechanical seal meeting repair package.
 For this prototype, a repair kit would set you lower back RM 450.00.
 From the RM 450.00 fee of the restore kit, the spring prices RM 250.00. If I located an order for 20 portions, the fabricator instructed me he may want to lower the spring's cost to RM 180.00. For this prototype, 3 O-ring units from the hardware store value RM 2.00. The fabricator introduced a income margin of RM 198.00. If the prototype changed

into mass produced by using a neighborhood manufacturer, this price may be reduced.

In assessment to the authentic mechanical seal pricing per unit, that is RM 680.00, the anticipated value of the repair package with a minimum buy of 20 sets might be RM 182.00. The cost of spare components is lower with this layout.

Summary of objective achieved:

1) Despite being in contact with the product, the mechanical seal did not capture throughout startup and operation. There are not any shaft leaks.

2) Ease of material machining and production. Targeted fabrication cost changed into much less than RM 3000.00, and prototype was created at RM 145.00.

Three) Developed a directly spring layout for straightforward meeting and a truthful spring casing layout that had an effect on the manufacturing cost.

4) The maximum pressure for a tapered spring is 2 Nm², while a immediately spring's maximum pressure is 1.14 Nm². This results in much less strain being positioned on the revolving ceramic seal.

Five. Test the pump for one hundred fifty hours underneath normal operating situations and 50 hours underneath peculiar operating conditions with the substitute mechanical seal. 200 hours were spent trying out this prototype average. Pump capable of 2 bar discharge stress with absolutely open discharge valve.

6) Because no oil was leaking via the mechanical seal at startup, the new design have to have removed the product leakage trouble all through intermediate pump stoppages and at some stage in manufacturing changeover intervals.

Other Application of New Design Mechanical Seal

Beyond solving the issue of the mechanical seal of this pump failing because of hardened fats. The enclosed seal can be used to the meals and pharmaceutical industries.

Pharmaceutical Process

By now not having to get rid of their procedure pump to undertake cleaning, the C.I.P process for the pharmaceutical line may be sped up. As in the food zone, where cleaning fluid circulates into the tank and manufacturing gadget, this procedure often includes flushing continually to clean the manufacturing line.

When residue will become caught within the mechanical spring and cannot be eliminated by means of flushing, huge potential pumps will fail. The sports might definitely deconstruct the use a pump to soak and smooth with caustic or hot water. The C.I.P Pump might be utilised for circulating the cleaning fluid in the course of the manner plant's disassembly. After the CIP manner is over, there might not be any infection way to a included mechanical seal. The cleaning manner could no longer need the set up of a CIP pump, and the cleaning fluid may be pumped using the manner pump.

III. CONCLUSION

New design mechanical seal has proved its concept, preventing product leaking due to spring failure cause by seizing of fats. For batching plant in palm oil it is commonly used for crystalizing the oil by cooling. Even we have find major problem of oil leaking during the stop and start of pump, when production face problem at the filling process the product oil will circulate in processing plant where cooling is still "ON" causing formation of fats in the oil. These fats by time would seize the spring causing minor leak at the mechanical seal. Eliminating the contact of process oil with the spring has solved this problem. As for the cost of manufacturing the mechanical seal cost of fabrication is RM 1,450.00. This cost represent the prototype cost but if mass produced by a manufacture, cost of material and process can be reduce to match the existing mechanical seal cost. Since this Inoxpa Centrifugal Stainless Steel pump is commonly used for palm oil production in many refineries, oil packaging plant, pharmaceutical and food and beverage processing plant such as F&N and Pepsi. This product has potential in saving for plant design where C.I.P pump can be eliminated and on the maintenance cost due to low cost of spare part. Supplier can offer the customer two types of spare part the whole mechanical seal or mechanical seal repair kit for the housing of the ceramic seal and spring if it is not damage by bent shaft due to other reasons.

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