Reduce Rework in Decanter Testing Process

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Abstract— High levels of machine vibrations result in rework and excessive machining of the components. The decanter manufactured goes under various process which might be having an impact on the vibration levels. Decanting centrifuges are machines with a rotating bowl. They have a number of vibrating sources, the most significant being structural vibration, vortex/turbulence vibration and component unbalance. Due to the size, mass and speed of the rotating bowl, the bowl is the main source of structural vibration. The structural vibration is produced by all surfaces that are directly coupled to the bowl's bearings. Due to the speed of rotation of the bowl, the turbulence from the various trailing edges generates broad spectrum vortex vibrations. All the worked components have a specific limit of tolerance, which when goes out of control will have a direct impact on the vibrations. The possible parameters need to be looked upon so as to reduce the rework of the decanter components.
The particular characteristics of the decanter that need to be addressed when there are many vibrations. Even including the air flow around the decanter, establishment of the scanned areas, and the required environment in which measurements are to be done. The fluid used for testing purpose will also have the impact on the readings. Also, the monitoring parameters need to be adjusted correctly and in a proper manner.

Key words: Bowl, Conveyor, Decanter, Rotating Assembly

I. INTRODUCTION

A Decanter is a machine which separates the fluid and suspended particles form a mixture like milk and liquid having small tiny solid particles. It is a machine, which employs a high rotational speed to separate components of different densities. This becomes relevant in the majority of industrial jobs where solids, liquids and gases are merged into a single mixture and the separation of these different phases is necessary. A decanter centrifuge separates solid materials from liquids in slurry and therefore plays an important role in wastewater treatment, chemical, oil and food processing industries. .A centrifuge decanter consists of a solid cylindrical bowl rotating at high speed, a scroll rotating at the same axis with a slightly different speed, a drive group adjusting the speed difference and the body which carries all the rotating elements. Liquid and suspended solids are fed along the center line to distribution room within the bowl and then accelerated into the bowl by centrifugal force through the feeding point. This centrifugal force then causes the suspended solids to settle and accumulate at the bowl wall. Sludge cake is discharged by scroll from the conical part meanwhile clarified liquid flows back along the bowl and is discharged through the cylindrical end of the bowl by plates which can adjust the level of clarified liquid. Centrifuge decanters are applied for due to classification of solid-liquid mixtures and extraction of components.

In decanter after final assembly, unbalanced created due to unbalanced and rotating masses. The Bowl and Conveyor Balanced separately in different balancing machines and sections. The Vibration checking probes are attach to the spindle to the spindle to check vibrations. The limit of vibration is 6mm per sec. If the limit exceeds more than 6 mm per sec rework is necessary to machining of parts. This can be machinated by milling. Every one machine out of five is Need to rework and machine. Structural vibrations can be problematic for a machine. They contribute to the wear of the machine, but can also produce a high noise level.

The decanter consists of main parts such as bowl, conveyor, cone, main bearing and gearbox. Any of the above parts may have unbalanced mass. Due to centrifugal action of decanter the centrifugal force causes unbalance which leads to unbalance due to couple. Along with vibrations noise is also produced which reduces machine life. The vibration may lead to increase in maintenance which leads to increase in running cost of machine and can stop production of applicants like milk dairy. There is a separate balancing method for each of the parts. In case of bowl there is a separate balancing section and in this way the cone and conveyor are also balanced separately. All this parts after assembly have shown vibration or unbalanced which we have to reduce.so instead of doing this rework it is better to take corrective actions. Which helps us to increase production, reduce rework, saves money also for maintaining reputation of the company. Decanter also consist of main bearing, back bearing, pulley arrangement and electric motor. Misalignment of shaft, Misalignment of bearings, bearing fitment, Main Drive and Back drive alignment were major issues. There was need to appropriate fitting method of bearing.

II. CONSTRUCTION

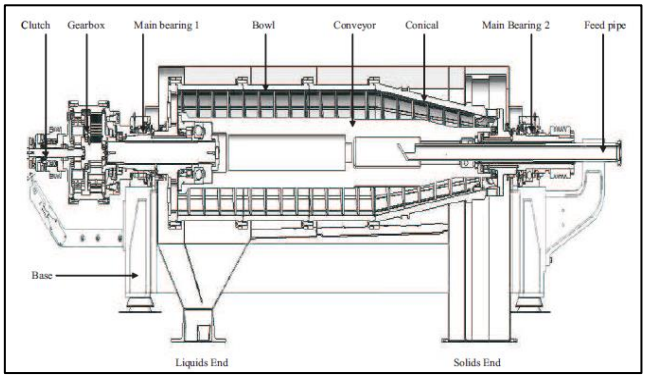

Fig. 1: Construction of Decanter

Components of Decanters:

1) Bowl.
2) Cylinder.
3) Small end up.
4) Large end up.
5) Conveyer.
6) Rotating assembly.

The purpose of balancing is to ensure that the assembled decanter will run with a low vibration level which fulfills the requirement specified in the test run instruction for

decanter. PCD is responsible for defining the balancing requirements. PCD must on all bowl assembly and allows for addition or remove of weight balancing for the unbalanced corrections can be calculated by taking measurement as specified below:

Fig. 2: Cone

- Measure the amplitude and phase angle of bowl vibration on main bearing with empty decanter.
- Repeat it with water filled decanter.
- Add and remove test weight at first at first plane and repeat the measurement.
- Add or remove test weight at first balance plane and repeat the measurement.
- Calculate the correction weight and phase angle and corrected weight which can be remove
- Repeat the vibration measurement and if necessary react steps 3 and 4 time satisfactory result achieve the requirement will follow.

The main purpose of assembly is to ensure that assembled decanter are capable of running with a level of vibration that fulfill requirement specified in the test instruction for decanter.

Responsible for preparation of instruction for the direct operation of the balancing machine, the set-up and mounting in the balancing machine the welding of the balancing weight etc. Responsible for preparation of instruction for the direct operation of the balancing machine, the set-up and mounting in the balancing weight etc. The conveyor should be meticulously prepared for operation of the balancing machine and the corresponding control system.

A set of key parameter must be made for each conveyor. These are normally detected by the decanter size and type of conveyor two balancing planes must be determined for each end of the conveyor. The radius for positioning the balancing weight in each plane must be determined.

Normally the conveyor body radius plus half the thickness of the balancing of a flight the radius will be the distance from the conveyor center axis to the middle of the balancing weight.

These Parameter should be entered in the balancing program for the balancing machine according to the appropriate instruction.

A Summary of this factory test instruction for customer information is available in manual.

This instruction shall ensure that all centrifuges are tested according to the same factory test procedure after assembly. The factory test shall ensure that all decanters we deliver fulfill the quality requirements.

The Factory Test Procedure defined by this instruction must be followed for all decanters production and assembly sites for decanters.

The content and maintenance of this instruction.

Defining the factory test requirements for all decanters and the acceptance criteria for all decanter types and sizes.

For all new product development projects factory test requirements, must be considered and this instruction must be updated with the relevant new requirements.

For all decanters specified with a maximum feed temperature of 100 degrees Celsius in the DSS ordering system, the vibration and balance tests shall be carried out with a water temperature of 80-85 degrees Celsius. For decanters specified with a maximum feed temperature not above 60 degrees Celsius. The test can be carried out with water at ambient temperature.

Initial Problem Statement: Dynamic Balancing of Decanter for reduction in vibration and rework by 50%.

Even after balancing of bowl & conveyor individually as per the standard requirement, we need to do field balancing for most of the decanter while decanter testing causing Time lost, Rework cost increase, ultimately delivery affects.

A. Objectives

- To reduce the vibrations
- To reduce the noise created during operation
- To reduce the maintenance
- To save time spent on rechecking the components.
- Reducing and balancing saves an entire shift which in turns saves an amount upto 22,000.
- To increase the productivity
- To reduce the rework
- To reduce the customer rejection
- To save the man machine and money
- To increase the profit
- To maintain reputation of organization
- To increase quality of the product
- Attraction of more income and high prestige in market.
- Possible for manufacturing of decanter without any defects.

III. WORKING

A. Define

In define we started finding out what problem company is facing how it occur at what interval is its happing and what is company goal. we took serve and all company and start observing the various company department.

B. Measure

In this phase of measure, we started collecting data from company various machine reading start observing them and various manufacturing process and their measuring gauge accuracy and precision. also, talked with worker and asked them what is root cause of problem how it can be corrected.

C. Analyse

The purpose of his step is to identify validate and select the root cause for elimination a large no of potential root cause of project via root cause analysis. top root cause are selected by us by deciding on the based on the measure data and according to that further steps are decided by team.

D. Improve

From the data analyses we started taking action on root cause from that we find that balancing of the decanters components are occur differently if component are fall under safe condition it send toward assembly of the decanter but after

that again decanter are tested under machine at that time they find the vibration so we follow them thoroughly we came to conclusion that they balance the component any how without considering after effects whether it is creating the vibration after assembly. They we suggest them to maintain the record of manufacturing of machine part and also worker who manufactured it.

E. Control

Maintain the chart sheet as well as record. find out worker who are not performing well or not maintaining the accuracy. Follow all the instruction which is mention in the sop

IV. ANALYTICAL WORK

Balancing and vibration has a crucial relation in Decanter machine. If the unbalance mass is more there would be maximum vibrations. Therefore, it is necessary to find the vibration and unbalance mass values for further checking whether the parts can be acceptable or not.

Following chart shows Balancing Vs Vibration values, in which by marking our excess or reject able values the rework can be possible in early stages of manufacturing.

A. Causes of Vibration

- Resonance of part.
- Misalignment of bearing housing.
- Misalignment of coupling.
- Fluid turbulence.
- Combine effect due to separate balancing of bowl and conveyor.
- Due to less damping capacity of frame.
- Less tolerance accuracy.
- Due to manufacturing error such as run out, parallelism, concentricity.
- Improper calibration of machine.
- Fool proofing of work.

Milling of decanter machine is necessary in order to reduce vibrations. The Unbalance produced in grams is first determined then by milling in assembly section then standard material removal as per standards charts is removed and the machine is balanced. The maximum balancing weight can be removed is 10 grams.

All the parts, are balanced differently. The balancing takes place on the balancing machine.

It's automated balanced machine.

While the cylinder is balanced on the pillar drilling machine.

While other ratios are fixed for the weight removal.

V. EXPERIMENTAL VALIDATION

Structural vibrations can be problematic part of a machine. They contribute to the wear of the machine, but can also produce a high vibration level. In this report a vibration survey has been performed on an existing design of a gearbox cover of a decanter centrifuge. A finite element model of this gearbox cover is developed to predict the structural vibrations, which has been verified by measurements. By adapting this model with respect to material properties the vibration reduction is forecasted designed the range of decanter centrifuges with a focus on performance, easy access, reliability and low power consumption as well as vibration levels. The rotating assembly is supported on a compact welded box beam frame with main bearings at both ends. The in-line motor is flanged or foot-mounted on the decanter with brackets for belt tension adjustment. The bowl is driven at the conical end by an electric motor using a V-belt transmission. The bowl, conveyor, casing, inlet tube, outlets and other parts that come into contact with the process media are made of AISI 316 and Duplex stainless steel.

To find out deviation in bowl parts which affecting bowl balancing & bowl value high later on.

- Observations – Yes, there are few parameters If found out of tolerance then they can affect during bowl balancing i.e. Heavy unbalance during bowl balancing. Run out on critical diameters, Cylindricity, Roundness Parallelism of all bowl parts etc.
- Operator feedback – We are unable to make true job (Cylinder & Cone) on machine due to high run out on semi finish parts.
- All GDNT parameters will be mentioned on blank drawings of Cylinder & Cone to get the parts within tolerance.
- Objective – to find out effect on bowl vibration value if bowl balanced on higher limit.
- Observations – No, there is no effect on bowl vibration value even after we balanced on higher limit.
- Operator feedback – Try to balance bowl as lower as we can.
- Action decided – After bowl balancing QA person will verify bowl balancing report w.r.t work. Instruction for bowl tolerance & will ensure to release bowl in lower limit as well.
- Correlation – Bowl vibration value & bowl bal. value.

A. Lubrication To Bearings

- Objective – To find out effect of improper lubrication on bowl vibration
- Observations – Improper lubrication will either damage bearing OR will increase noise in machine which easily caught during testing hence it will not affect that much on vibration.
- Operator feedback – There is no chance of improper lubrication as they systematic chart with them for amount of grease to be filled before & after testing. But after all its manual activity.
- Action decided – Random audit will be conduct by QA to ensure the proper lubrication.

B. Hot/ Cold Water used for Testing

- Objective – To find out effect of hot/ cold water on bowl vibration
- Observations – Yes there is bit variation observed in hot and cold water testing & it is up to 1 mm/sec.
- Operator feedback – Yes, There is variation of 1 mm/sec approx. in Hot / cold water testing, but past machines was tested as per the customer requirement.
- Action decided – Temperature cut off sensor set on control panel to maintain water temperature.
- Operator verifies feed temperature on "Name plate" & keep water temperature accordingly.
- Wherever Feed Temp mentioned 100°on nameplate, we need to test the machine on 80°water temperature & If it is 60°on name plate then we need test machine on

ambient temperature. Same instruction given to all operators & following the same.

C. Before/ After Improvement

8 machines Reworked after improvement (In two months) i.e.4 machines/ month. After Implementation of actions data taken for Oct-15 & Nov-15, Only 8 machines reworked i.e. 2 machines/ month.

VI. TEST RESULTS

A. Wide-Ranging Performance

After balancing within limit decanter centrifuges provide exceptional performance when separating solids from liquids, and make it possible to do so continuously, efficiently and controllably. Decanters are invariably the first choice to meet such separation needs by virtue of their high reliability, continuous operation, low capital cost/capacity ratio and low maintenance costs. With this decanter centrifuges are designed able to handle a wide range of solid particles with diameters from 5 mm to a few microns.

B. Process Optimization

The decanter centrifuge can be adjusted to suit specific requirements by varying:

- The bowl speed to ensure the exact force required for the most efficient separation.
- The conveying speed for the best possible balance between liquid clarity and solids dryness.
- • The pond depth in the bowl for the best possible balance between liquid clarity and solids dryness.
- The feed rate is design is such that to handle a wide range of flow rates.

C. The Four Main Sections

Decanter centrifuges feature four main sections, each optimized for maximum performance and still research going on this area.

D. Inlet Zone

The inlet zone accelerates the feed slurry up to the speed of the bowl. A properly designed inlet zone keeps any degradation of the feed solids to a minimum as well as avoiding disturbance of the sediment in the bowl. A number of feed zone specifications are available for decanter centrifuges, each designed to ensure maximum performance in conjunction with a specific process.

E. Screw Conveyor

The key to good decanter performance lies in the efficient, effective scrolling of the sediment solids. The design of the screw conveyor is therefore crucial. Has the expertise needed to match the demands involved in specific industrial processes with specific configurations of flight pitch, lead angle and differential speed, in order to secure the best possible results.

F. Solids Discharge Section

Depending on the application, the consistency of the separated solids can vary from a dry powder to a paste. The configuration of the discharge zone is therefore chosen to enable such “cakes” to exit as effectively as possible. Innovative design enables erosion-prone components used in the solids discharge zone to be replaced on site at low cost and with a minimum of disturbance to production.

G. Liquid Discharge Section

In a two-phase decanter, the liquid level is regulated by dam plates. When operating in a three-phase mode, each phase discharges over a set of dam plates into separate baffled compartments in the casing. In certain applications, a centripetal pump discharge that utilizes the pressure head developed by the rotating liquid phase is used to pump the liquid from the decanter.

H. Nonstop Performance

In modern industrial processes, efficient, well-planned service plays an important part in maintaining profitable operations.

I. Full Control

operates with a highly sophisticated Nonstop Performance concept made possible by our worldwide network of service and spare parts distribution centers in more than fifty countries throughout the world. Has full control over the entire supply chain, which means that we can provide customers with response times, availability and lead times that are second to none.

J. Service When It Fits In

The service requirements for decanter centrifuges are minimal, and planned preventive maintenance is the key to making sure this always remains the case, worldwide service capabilities and vast experience with the contract maintenance and service of decanter centrifuges ensure that any service work required involves the absolute minimum of disturbance to operations.

K. Reduction in Power Consumption

The bowl can be equipped with specially developed power plates or tubes that harness and exploit hydraulic energy to reduce power consumption still further, while the unique control system ensures easy, reliable process optimization. Some of the discharge velocity from the liquid leaving the unit is captured and re-directed in order to contribute to the bowl rotation. This results in a reduction in the velocity of the discharged liquid, which in turn reduces overall power requirements. Reducing power consumption also means being able to live up to new environmental regulations and helping to support a sustainable environment such as reduction in CO_2 emissions.

VII. ADVANTAGES, LIMITATIONS AND APPLICATIONS

A. Advantages

- Low noise and vibration so no need of vibration isolator.
- Required less maintenance.
- No need to provide baffles.
- Low cost due to less number of accessories
- It is energy efficient.

B. Limitations

- Able to work in particular range of viscosity.
- Limited capacity.
- Designed for particular application.

C. Applications

- Water treatment plant.
- Sugar industries, food processing industries.
- In ice plant to make the brine solution.
- Pharmaceutical industries.
- Paper mill.

VIII. CONCLUSION

In this way the various objectives by reduction in vibrations were achieved, with new technological instruments were appointed which results in reduce in rework, customer satisfaction, reduction in noise, reduction in maintenance, saving time on inspection of products, possible to manufacture decanter with less defects, increase in quality of the product, increase in profit of the organization with maintaining and increasing huge reputation in the market. These vibrations can be reduced by further investigating the decanter balancing checking machine and software, Frame and some components which are not found until that causes vibration. This will save nearly Rs.2.7 crore per year. Also, will reduce time and Rework. The main fact is the life of the machine is increases due to reduction in vibrations, there will be no machine failure. It also increases the Reputation of the organization as well as It will save energy and rejection by the customer also reduce indirectly it will increase the demand which help to get maximum profit.

IX. FUTURE SCOPE

Main drive belt tension Adjustment by Belt tension measuring device:

For adjustment in main drive belt tension it is necessary to use modern instrument or method. The robust, handy Top-Laser TRUMMY2 is an optical-electronic manual measuring instrument belt tension (strand force). The correct belt tension is an essential prerequisite for achieving the maximum life of the belt drive. Therefore it is optimum can be used in many locations and comprises a cable less measurement probe, a measurement probe with a cable for difficult to access locations and a microprocessor that displays relevant measurable for belt tension as a frequency (in Hz) or force (in N). It has given simple and reliable user menu is given in several languages. Before measuring the belt tension, the belt mass and length must be entered. Vibration of the belt is then induced. The device measures the natural frequency by means of clock pulse light and uses this to determine the belt tension. This technique is less prone to disruptive influences in comparison with measurement sound waves.

A. Lubrication and Lubrication System

Lubricators and lubrication systems automatically provide bearings with the correct quantity of lubricant. This prevents the most frequent cause of rolling bearing failure: inadequate or incorrect lubrication. Approximately 90% of bearings are lubricated with grease. For manual re-lubrication, grease guns are suitable.

A single-point or multi-point lubrication system can supply lubrication points precisely and irrespective of temperature. The dispensing times can be set individually. Automatic lubricators convey fresh grease in the defined quantity at the correct time to the contact points of the rolling bearing. The devices adhere to the lubrication and maintenance intervals and prevent undersupply or oversupply of grease. Plant downtime and maintenance costs are reduced as a result. The lubricators are matched to the bearing position. They have a wide range of applications, for example on pumps, compressors and fans, in conveying equipment, machinery etc.

1) Lubricators have the following advantages

- Individually configured, precise supply to each bearing position.
- Fully automatic, maintenance free operation.
- Reduced personnel costs compared to manual re-lubrication.
- Different dispensing times can be selected. Pressure build up max 50 bar, thereby overcoming any obstruction.

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