A Review on Conditional Monitoring of Traction Motors Fault Diagnosis

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Abstract:- Now -a - days electrical trains have significance than the fuel trains like diesel and coal fuel does not produce emission as like other trains. So, in recent days faults and also increasing in the electric motors and components used in the electrical trains. We have so many methods to detect the faults. In this paper we are mainly explained about the techniques used to detect the faults in electric machines. The main faults are rotor bars, gear tooth surface, vibration caused in shaft, bogie wheel faults etc.

I. INTRODUCTION

Electrical machines are used in many application. Electrical machines are used in locomotive vehicles, trains and industries. Electric machines in vehicles has less noise, high performance and no pollution but in the same case we have different flaws in electrical machine. These flaws are based on vibration, torque analysis, stator and rotor faults, heating of coil, bearings, couplings, gear tooth, shaft couplings, gear defects in industries. These flaws can be detected by following techniques like vibracoustic technique, translation motion, side bandwidth, current /voltage measurements, torsional motion, global fault index.

II. LITERATURE REVIEW

Alberts composer et al. Explained regarding blessings of induction machine by the diagnostic techniques. during this case he chiefly explained regarding the four topics. they're electrical and mechanical faults, signal process and computer science. the most faults in electrical machines area unit mechanical device faults, rotor electrical faults, rotor Mechanical faults and plenty of failures of power electronic part of drive system. He monitored the faults victimisation Non-invasive observation which might be achieved by hoping on simply measured electrical or mechanical quantities. as an example like force, current, speed, voltage. He explained regarding diagnostic techniques for rotor and mechanical device faults terribly clearly. He justify regarding diagnostic of rotor by multiple electrical signals. He explains regarding mechanical faults in varied stepwise like bearing faults, eccentricity faults. He used signal process techniques for the designation of electrical driver. He additionally explained in delineated means for all the techniques for designation of faults. He explained the block diagrams of signal based mostly procedure, knowledge based mostly procedure. The diagnostic techniques area unit classified into 2 they're input signals and signal process. computer science and call techniques for fault designation.

Finally he ended that designation of electrical machines area unit necessary topic for several researchers. He chiefly explained regarding conditional observation of faults and the way to resolve them.

M. Cerullo, G. Fazio, M. Fabbri, F. Muzi, and G. Sacerdoti al.., explained the way to diagnose transiting electrical trains by regarding Acoustic signal process. To discover the failures in railway transition system. the most drawbacks area unit defects on the overhead wires, defects on train mechanical parts. during this defects he explained fatherly into some topics in each the defects. In defects on the overhead wires he explained regarding scratches or different things on the overhead wires contact strip, periodic and irregular loss of affiliation between overhead wires and call line thanks to faults either on overhead wire parts or on the contact line conductor, different damages or failures on the overhead wire components. In faults on train mechanical parts he explained regarding free and abnormal rotation of the compartments that may offer slippage, faults on the shock absorbers of the compartment, thwart wise and lengthwise imbalances of the burden on the compartment. He explained regarding sources of acoustic vibrations therein he explained regarding Vertical Stimuli, Longitudinal Stimuli, and thwartwise Stimuli. He tells regarding affiliation between stimuli and evoked vibrations. Not solely the on top of mentioned topics he explained regarding several fault discover techniques, they're the diagnostic system, signal process and knowledge classification, the popularity system, He conducted associate degree experiment on the acquisition equipment installation and he inspected within the field, thousands of recordings of transiting trains were performed in his experiment. To designation the assorted factors influencing the recorded signals the equipment was put in at totally different places. He noted all his ends up in this paper.

This paper deals with the torsional vibration assessment in mechanical transmission of RTA by a non-invasive technique. He aforementioned that to drive an electrical machine by torsional oscillations and mechanical elements as bearing and case. Once during a RTS train within which the failure in mechanical elements cause the 1939 misadventure .So that he found advanced coupling mechanism to live the ways 071 optical probe system, gage and shaft speed measuring. This the non-invasive techniques area unit most popular to ancient cumbersome sensing element. during this paper we will simply grasp that the study and observation of drugs box characteristics frequencies on vibration force and mechanical device

current within the dealings error and at last shell and teeth contact. A force sensing element is employed between traction motor and case. the most goal of a non-invasive tool for observation of torsional vibration is to terminate magnetism force rather than force sensing element. The vibration signals of the traction motor area unit in 111 sorts they're stationary and non-stationary frequency parts in noise and additionally includes many signal process techniques like amplitude part reception, power spectral density and time averaging. The wave signals area unit analysed in steady state condition. The force of a traction motor is analysed and compared with quick Fourier rework in steady state condition. The stationary random signals area unit analyzed by the facility spectrum density. there's associate degree input intermediate, output stage of drugs box. Through the shaft 2 output governable magnetic brakes area unit joined within the case that permits wheel rail interaction simulation. The induction motor machine speed in V/R constant and shut loop area unit controlled by the ac drives. .so finally he maintained that the mechanical transmission of torsional vibrations through the non-invasive techniques.

Shahid hedayati Kia, Humberto hanao aforementioned that we will torsional vibration observant utilizing tour machine hardware engaging force estimation. The restrictive checking on substantial mechanical device framework is difficult to stay up in lightweight of the very fact that the few pressure sign following au courant the framework like burden force dynamic varieties, within and out of doors development.so that the frustration happens on the mechanical items of the framework. within the framework mechanical breakage is that the elementary standard flaw leader. The pole torsional disappointments area unit essentially caused due to revolution of twelve rehashed cyclic burdens and unsteady between the strain and also the pressure. The torsion vibration will be delivered by power offer, at the road starting at mechanical disfigurement and force pulsation.so that the mechanical device frameworks area unit galvanized to form instrument to interrupt down the mechanical blames during a framework. For the rotary engine generator, transient pressure is employed because the important equipment for the preventive maintenance. The force sensing element is employed as another wavering observant framework for the rotary engine generators. All the estimation techniques area unit primarily based on the optical take a look at framework. The estimation of the force in mechanical device framework will be belittled by the electrical machine input voltage and flow. In rigging box of electro mechanical framework the wellspring of vibration is during a general sense due to intermittent amendment in tooth surface solidness and within the equipment evolving mistake. The vibration sources turn out at starting and closure Rotation, the frequencies within the add vibration and force signal.

The investigation of observant the mechanical conduct in mechanical device framework by utilizing vibrations and acoustic sign. The mechanical device current investigation is another path for mechanical observant on the grounds that it okay could also be effectively accessible in trade. case

assumes a major job in mechanical application. By and huge placement is that the most well-known disappointment in machine. due to placement, the lattice of pinion and rigging will not work befittingly throughout activity, and this prompts a air mass focus at the skin of apparatuses. The deformities within the case will be distinguished by causing the sign. within the new case demonstrating pinion-wheel contact purpose with damping and solidness. during this tour engine contacts pinion and wheel the transmission mistake within the case is whimsy of the pinion and wheel, tooth profile blunder, non-uniform tooth dividing. By directional bed trial take a look at, the equipment box acquaints force motions connected with the frequencies of pinion and rigging turning. For this case, wheel turning and pinion frequencies and their abundancy area unit immense with the goal that It results set up parameter, capability and mechanical anxieties.

Andrea Stefani, Prince Albert composer, et.al.., aforementioned that the fashionable forty seven applications for stupendous tasks. This engines has exceptionally high rate and high effectiveness. The excellence of the acceptance engine is that the speed depends upon the facility offer. For checking the foremost extreme resistance footing drive is invented. The rotor disappointments will be effectively known by the Vienna strategy in footing drives. the many rotor deficiencies area unit seen in fashionable apparatuses. regarding 2 hundredth usually speaking tour engine flaws area unit seen in enterprises. The shortcomings like breakage of the bar cause high current in contiguous bars. to acknowledge the destroyed rotor bars and finish ring deficiencies in acceptance engine, engine current mark examination is exceptionally useful. Additionally, EMSA is fizzled for current managementled drives because the control circle cowl the wavering of the mechanical device current. Envelope, Hilberp amendment and Park amendment is employed to get rotor disappointments in acceptance engine. Power drives the footing applications to figure in field debilitating mode at the journey speed. The reception strategy is applied to mechanical device current. Presently a days, to remain aloof from this rotor blames in engine Voltage supply electrical converter nutritious is given to the acceptance engine. electrical converter acts sort of a mind for the machine. because it controls the inventory of current and drives with the mandatory field. throughout the MCSA and Spectra Analysis for conclusion of rotor flaws. By utilizing these ways to the tour engine it will create a couple of blames the acceptance engine. thus on defeat this shortcomings, we've got to associate electrical converter to the engine.

Bail Akin, Umut orguner, Hamid A.Toliyat, Mank Rayner clarifies regarding stage touchy discovery of engine blames inside the sight of commotion. He told that in 2 cases flaw analysis of electrical engines turns into a elementary concern. That 2 cases area unit (1) price& update of the machine is additional and (2) the engine price and fix cost most likely will not be in depth, but the expense connected with personal time is high. He aforementioned that sign handling procedures area unit recorded, concentrating on the adequacy and frequencies evaluations

of deformities that usually use line current or vibration data. thus on take a look at the reasonableness of the suggested ways, some of the examination analyses area unit dead utilizing trade microchips. during this take a look at for engine drive management DSP innovation is applied, the improved advantage of the getting ready units area unit being acknowledged in additional applications than any time in recent memory, as an example, deficiency recognition. - request sounds area unit additional to misshape the essential elements, area unit on account of inverter-driven engine line current. He organized his standardize trial results and reenactment results. finally he likely that a simple commotion resistant continuous flaw identity verification equipment is displayed. He processed regarding stage delicate location. At that time he processed regarding his recreation results.in his replica he confirmed the viability of the projected strategy, a standard line current is displayed, he aforementioned that the low.

Alberto composer, Fiorenzo, Givonanni Fraceschini, Carla Tassoni joins along and clarifies regarding the tour engine blames by the shut circle management sway on the coping with of faults.. during this paper he simply clarifies that however the symptomatic framework recognizing the problems in electrical machines thus on spare the aggregation cost process or to displacement elements. He antecedently processed however the imperfections area unit known within the open circle tour machines. during this paper he enclosed real electrical deficiencies and rotor breakage to the open circle acceptance machines analysis method. during this one part a guide sufficiency of express lines bestowed by the failings within the vary of varied factors. He processed the goddamned machine models by stages. initial stage during this is mechanical device shorted circuit model and second stage during this is rotor bar breakage model. At that time he processed regarding management sway on varied factors. He detected the end result on his investigation that directed utilizing on top of processed procedures. Finally he reasoned that to the extent voltage is provided machines area unit involved and also the electrical shortcomings area unit distinguished and assessed by utilizing the segments of flow house vector spectrum**.**

Gaetan Didier, Eric ternisien, role player caspary, and Hubert Razik, et al., Fault location of broken rotor bars in acceptance engine utilizing a worldwide defect list. For the transformation of mechanical device vitality Induction engine assumes a major job. the frustration of this engine causes a real monetary expense. The assortment of deficiencies that happen area unit rotor area unit unessential vibrations, poor starting execution, force vacillations. There area unit varied ways to get the rotor disappointments. one among them were best-known to tell apart the sideband round the spherical offer repeat. during this examination we have a tendency to apply non-parametric (or) there's another strategy that is Bartlett technique thus on discover additional frequencies and size of every sideband created by the rotor shortcomings. research worker have simply utilised the prompt power vary investigation for the interpretation of broken rotor bar. There area unit a couple of focal points of utilizing immediate power vary area unit distance of

additional segments in low repeat and also the low repeat half is located squarely at the speed motions repeat the finding of broken bars will be improved by the fleeting power in low repeat. transcendental pinnacles is employed for additional pointer of finding knowledge regarding the state engine. we will clearly grasp the tousled bar within the engine once the scale record builds, the non-parametric vary or averaging amount grams area unit utilised to minimize the amendment and to enhance the assessment of the components.

satish rajagopalan, Thomas G. Habetler, Fellow, Ronald G. Harley, Tomy Sebastian and Bruno lequesne. Flow and voltage-based investigation of imperfections in equipment coupled to the electrical engine. equipment shapes a major job in varied mechanical device framework. within the majority of the cases the apparatuses is combined with electrical gadgets. Deformities in equipment causes spasmodic in aggregation set up for enterprises, consequently it prompts the lower in gain. it's a territory that a major range of them arrange to center to look at and moreover a substantial heap of them created analysis on wave examination. The measuring device is employed to get the vibration which can cause burden in low delicate zones in such cases the investigation of equipment deserts from the determination of engine current provide a price touchy arrangements that frequencies of rigging tooth lattice will be seen within the gift repeat vary. With the goal that we will grasp the impact on the engine terminal voltage and current of various rigging deserts which includes injured gear-tooth, Blush 345 dc (BLDC) drives area unit extraordinarily valuable to screen the mechanical device voltage as opposition the mechanical device current. There area unit varied states of riggings they're spike gear, voluted equipment, slant gear, worm equipment and straight rigging. throughout the course changes between 2 shafts spike rigging cannot be utilised. Incline equipment area unit utilised to maneuver management between interfacing shaft. it's loud at fast. equipment reddening for the foremost half happened decreasing of teeth and once the film separates to alter the metal to metal contact. Vibration vary {is utilised|is employed|is used} to spot the frustration geared vibrations and moreover most often utilized analysis area unit calculable utilizing measuring device. the foremost unremarkably utilised instrument old-time of the problems frequencies is thru AM**.**

Humberto Henao, Hubert Razik, Gerard-Andre capolino consolidated along and disclosed that the way to distinguish 3 stage tour machine rotor absconds by investigatory philosophy of the mechanical device current repeat sounds count. 3 stage tour machines area unit in addition best-known for dependable and low cost elements. These will be exposed to outer pressure that area unit originating from the framework and corruption will happen even within the electrical and mechanical items of tour engine. The squirrel enclosure structure that speaks to in far more than ninety nine % of the acceptance machine fabricating mechanical device deformities area unit usually known with protection disappointment and that they area unit unremarkably called stage to stage (or) stage to

impartial flaws. The essential drivers of mechanical device disappointment protections area unit high mechanical device center winding temperature, hamper, dampness, and squirrel-confine. The each rotor and mechanical device investigation depends on engine current mark examination. during this twice-slip-recurrence aspect teams area unit utilised round the basic repeat of engine current sensors area unit utilised to approve the current sensors area unit utilised to approve the failings in acceptance engine associate degreed related to similar data getting board through voltage attention to size of extent and low-pass an instating channels to line the repeat band dimension to deal with extend.

Intensive examinations were did obsessed on typical fast Fourier amendment technique was projected for each mechanical device current band outer motion sensors to acknowledge the rotor broken bars and mechanical device twisting shortcircuits to untangle the repeat knowledge. to enhance the fft amendment repeat interjection is employed. This improvement makes the departure estimation increasingly precise. The ZFFT technique focuses on the repeat transfer speed of the actual signaling by dynamic the repeat and devastating thus on see it with high repeat goals. to ascertain the frequencies during a preset transfer speed utilizing of twitter Z amendment is superb. The variance between the sign and also the tones during a similar house will be accomplished by the variance strategy that depends on calculation. it'll offer higher execution to follow the frequencies of the sign. They figure the facility repeat vary thickness (PSD). MUSIC depends on the Pisarenko thought. due to the presentation of averaging the extra clamor eigenvectors it's the most effective exhibitions than Pisarenko strategy. High goals repeat estimation strategy is barely the MUSIC technique. The ZMUSIC calculation contains of 3 steps.it begins with the estimation of the autocorrelation framework. The MUSIC technique is an incredible plus for characteristic frequencies from a brief data record sign lined in commotion. The MUSIC strategy is speedier and actual in extricating frequencies during a preset knowledge transfer capability. For acceptance machine early broken bar deficiency acknowledgment utilizing the vary examination ZMUSIC may be a usually wonderful technique. this method can assist U.S. with sleuthing the deformities within the footing motors.

Conditional observent of mechanical device frameworks assumes a major key job in fashionable applications.. The vibration signal within the framework speaks to the conduct of mechanical framework. Riggings area unit the many elements utilised for mechanical power transmission wherever we have a tendency to area unit amassing within the field of condition checking from not a few years. The wave estimations area unit utilised for condition checking of issue identification of rigging. There we've got varied downsides within the institution of riggings in a neighborhood and important expense and in openness in mounting the wave transducers. The measuring device is employed as a electrical device to determine the mechanical thwartwise vibration .the localisation of rigging tooth impacts the pole and torsional vibrations. previous an oversized range of them take an attempt at the purpose of

mechanical defaults because the heap minute on the mechanical device current vary. the knowledge and yield pivots frequencies of a 1 part case area unit initially distinguished round the stockpile repeat within the mechanical device current vary and plenty of endeavor were completed with enough theoretic foundations with sure functions behind that the equipment mechanical attributes repeat will recognized acceptance machine is employed as force sense to the estimation of magnetism force for condition checking. A 3D model for prod and voluted apparatuses area unit coupled to the acceptance machine together with the 2 shafts and orientation. Damping variable is employed to decide on the repeat knowledge transfer capability wherever important imperfectness connected sounds area unit located. The examination of rigging tooth surface hurt will be seen by a method for non-obtrusive obsessed on the SCS VIF. The non-intrusive issue determination of equipment tooth surface hurt deficiency discovery in one part rigging based mostly electro mechanical framework at varied hub levels.

Conditional observant of the electrical framework assumes a major job in varied mechanical procedures. Vibration sign area unit photos of nonstop activity in mechanical frameworks. This could be illustrative of its free and traditional dynamic conduct energized by outer sources. Riggings area unit for the foremost half utilised in varied frameworks to maneuver management beginning with one shaft then onto successive for enlarged force even as force. important sources on vibration for legitimate apparatuses area unit primarily due to rigging network firmness and shift times geared transmission blunders. traditional equipment deformities area unit known with gear tooth anomalies, as an example, tooth breakage, anatomical structure splits, caught teeth, biting hurt and tooth surface hurt that area unit confined territories. These flaws area unit created by the apparatuses at motion repeat which might cause a additional in depth repeat appropriation within the vibration vary. In machines, electrical sign analyze mechanical device flow and surmised magnetism force examination. These area unit 2 non-obtrusive ways that talk to a good choice in distinction to vibration determination with very little changes in machine institution. we have a tendency to notice that the work repeat will be effectively calculable due to the flooded size within the mechanical device current vary. The impact of the pinion rigging harms the work frequencies within the equipment framework. magnetism force estimation shows grease misfortune imperfectness recognition for gear-based engine drives and teeth adhering to the equipment footing framework, gear surface wear surrenders. In distinction to gears, the deformity on the sent tooth imperfectness can produce a powerful impact within the flip repeat cyclicity scrutiny to the deformity space within the vibration signal that's led to by the transmission of mechanical force. A noninvasive procedure for deficiency examination of a pinion tooth surface hurt flaw is displayed. These occasional marks speak to the Fourier arrangement and circularize the repeat house over the vary of the mechanical device current vary. Non-obtrusive issue analysis of pinion tooth hurt is blunder identification during

a solitary stage gear framework worked by a three-stage tour machine**.**

During this paper he clarifies regarding the deficiencies of broken bars in tour engine. The shortcomings in broken bars will be influenced by the heap following au courant the engaging field direction and this will be redressed by the essential plan of apparatus wavering. The bas fifty seven plan of apparatus wavering due to broken bars has been utilised. This strategy s area unit in addition utilised for distinguishing broken bars and moreover for aggregation deserts within the rotor. The engine was unbroken running below varied excitation area unit curving direct-line, beat transfer speed, open circle consistent volts per hertz management and PWM for the advance of rotor enclosure condition observant of acceptance engine aspect band dimension systems area unit unremarkably utilised . Swing edge is careful band on the engaging customary in engaging machines due to the distance of rotor broken bars the investigation of fabric science of apparatus wavering marvel within the rotor engaging field orientation.

➢ *A Table on Summarized Process:*

S.NO	FAULTS	PROCESSES USED FOR DIAGNOSIS OF THE FAULTS	REFERENCE
1.	Electrical faults , Mechanical faults	Multiple electric signals, time domain analysis, time frequency analysis	[1]
2.	Pantographs , electrical contact lines , rail bogies wheels	Vibraacoustic technique to diagnose electric trains and components	[2]
3.	Vibration caused in the rotating shaft	Translation motion , torsional motion ,tachometer , zebra zone tape	[3]
4.	Fatigue of shaft , gear boxes , bearing faults	Different electromagnetic torque estimation	[4]
5.	Gear box defects in electrical machines	Different current measurement	[5]
6.	Induction machines rotor faults	Using side Bandwidth techniques and in time varying conditions by strategy of induction machine drives	[6]
7.	Detection of motor faults	Using phase sensitive in the presence of noise and using signal to noise ration	[7]
8.	Induction motor stator and rotor faults	Using closed faults loops and the spectrum of field current components	[8]
9.	Detection of broken bars	Using a global fault index technique and stator voltage and current technique	[9]
10.	Faults in gear tooth and loss of lubricants	Using current voltage when gear coupled to electric motor and high précised accelerometer and sensors	[10]
11.	Induction machine rotor faults	Stator current frequency components	[11]
12.	Three phase induction machine faults(mechanical faults)	MUSIC technique, FSDO estimation, Z-MUSIC Algorithm, frequency component analysis	[12]
13.	Gear tooth surface damage faults	Induction machine electrical signature analysis (IMESA)	[13]
14.	Gear tooth surface damage faults	Machine current signal analysis, stator current space vector instantaneous frequency.	[14]
15.	Effect of load magnitude on diagnosis of broken bar faults	Pendulous oscillation phenomenon, space vector method	[15]

Table 1

III. CONCLUSION

Finally, We know about some faults that occur in the electrical trains. For that faults detection we are using so many techniques. The technique used are on vibration, torque analysis, stator and rotor faults, heating of coil, bearings, couplings, gear tooth, shaft couplings, gear defects in industries. These flaws can be detected by following techniques like vibroacoustic technique, translation motion, side bandwidth, current /voltage measurements, torsional motion, global fault index. So, We concluded that we explain some of the defects and techniques to detect the faults in this review paper.

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[15]. Effects of Load Magnitude on Diagnosing Broken Bar Faults in Induction Motors Using the Pendulous Oscillation of the Rotor Magnetic Field Orientation Behrooz Mirafzal, Student Member, IEEE, and Nabeel. A. O. Demerdash, Fellow, IEEE