Endurance Testing For Body Scanner Machine

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Abstract-*Endurance testing of X ray machine tests c arm to examine its functioning or movements over its entire lifecycle and hence checks if it functions or movements correctly over its entire useable lifecycle. In medical field X ray machine is having wide range of usage. These include variations in conditions like horizontal, rotational, orbital, wig wag etc. Also, a standard cycle consists of various operating stages such as moving horizontal motion rotational motion, orbital motion and wig wag motion etc. To satisfactorily guarantee the proper functioning of the c arm under all operating stages, under various conditions over its entire lifecycle is the purpose of endurance testing. In the course of endurance testing, the c arm is subjected to the various operating conditions, at different movements' conditions. These cycles are then repeated as many times as necessary to simulate the complete life cycle of the machine.*

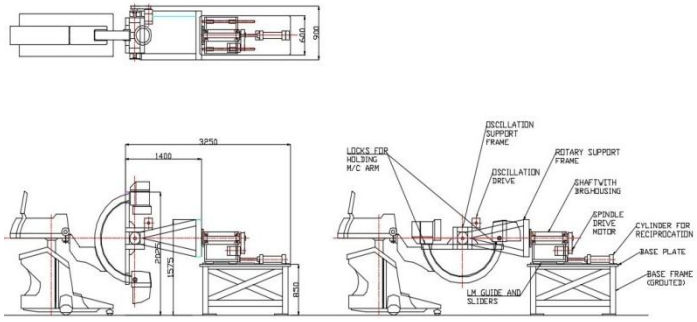
Keywords-endurance, programmer logic controls

I. INTRODUCTION

Endurance testing refers to tests typically done to find out whether an application can withstand the processing load it is expected to have to endure for a long period. During endurance tests, memory consumption is observed to determine potential failures. Performance quality is sometimes also monitored during endurance testing. Endurance tests are used mainly to measure the response of a tested element under potential simulated conditions for a specific period and for a certain threshold. Observations recorded during the endurance test are used to further enhance the parameters of the tested element.

The guarantee/warranty period given for the product is entitled to certain standard operating or usage conditions which the company will mention on the product, In order to decide a life of a product the company will carry out certain standard testing and quality checks, always the testing is conducted under some standard operating conditions in accordance with the type of the product. Based on the standard testing results the product is given with a quality and product life assurance to the customer on certain conditions.

II. WORKING PRINCIPLE



This system consists of rigid base frame fabricated out of heavy tube, on which there is a reciprocating base plate mounted on LM guides. The reciprocation to this plate is provided through pneumatic cylinder. On this plate a bearing housing is mounted with spindle which can rotate and is placed horizontally. To this spindle an aluminium ('Y') frame is attached which will rotate, when shaft is rotated. This aluminium(Y) frame carries a tilting bracket, which can be attached to C-arm X- ray machine as shown in drawing. When operated, this system provides reciprocating, rotary and tilting motion in one operating cycle, thus fulfilling 90% of test requirements. The up/down movement cannot be included in this as the complete system needs to move along C-arm X-ray machine. The system comes with PLC control and HMI for automatic operations, data lagging and automatic switching off of the system, after programmed operating cycle.

III.DESIGN AND MANUFACTURING

BASE FRAME

1 MOTOR CALCULATION

Table shape and dimensions (base frame)
Table type Rectangular Table

- Width A = 550 [mm]
- Depth B = 515 [mm]
- Mass m = 175 [kg]

Drive shaft dimension

- Shaft diameter D2 = 50 [mm]
- Shaft mass m2 = 10 [kg]

Table support

- Friction coefficient between the table and the supporting mechanism μ = 0.1
- Distance from the table center to the supporting mechanism l = 75 [mm]
- System efficiency η = 80 %

Transmission belt and pulleys or gears
Primary pulley (gear) Secondary pulley (gear)
pitch circle diameter (PCD) Dp1 = 153 [mm] Dp2 = 76 [mm]
mass mp1 = 2.8 [kg] mp2 = 0.8 [kg]

Operating conditions

Variable speed operation

- Operating speed V1 = 12 [r/min] V2 = 22 [r/min]
- Acceleration / deceleration time t1 = 0.2 [s]

Safety factor
Safety factor S•F = 1.75

Load Inertia
Inertia table= Jt
Inertia shaft = JS
Inertia of Primary AndSecondary Pulley= JDP1 & JDP2
Jt = (1/12) m ((A × 10-3)2 + (B × 10-3)2)
= (1/12) 175 × ((550 × 10-3)2 + (515 × 10-3)2) = 8.279 [kg•m2]
JS = (1/8) m2 (D2 × 10-3)2
= (1/8) × 10 × (50 × 10-3)2= 3.1250*10-3[kg•m2]
JDp1 = (1 / 8) mp1 × (Dp1×10-3)2
= (1 / 8) × 2.8 × (153 ×10-3)2= 8.1931*10¬-3[kg•m2]
JDp2 = (1 / 8) mP2 × (DP2×103)2
= (1 / 8) × 0.8 × (76 ×10-3)2= 5.7760*10-4[kg•m2]
JL = (Jt + Js + Jl + JDp2) (Dp1 / Dp2)2 + JDp1
= (8.279 + 3.1250*10-3+ 0 + = 5.7760*10-4) × (153 / 76)2 +8.1931*10¬-3

= 33.58 [kg•m2]
Required Speed
Vm1 = V1 (Dp2 / Dp1
= 12 × (76 / 153) = 5.961 [r/min]
Vm2 = V2 (Dp2 / Dp1)
= 22 × (76 / 153) = 10.93 [r/min]
Required Torque
T = (Ta + TL) (Safety Factor)
= (192.1 + 0) × 1.75 = 336.2 [N•m]
Acceleration Torque
Ta = JL (Vm / (9.55 × t1))
= 33.58 × (10.93 / (9.55 × 0.2)) = 192.1 [N•m]
Load Torque
‘mT = m
= 175 = 175 [Kg]

m1 = No additional load= 0 = 0 [Kg]
TL = (9.8 m1 /2) (r × 103)(1 / (η × 0.01)) (Dp1 / Dp2)
= (9.8 × 0 / 2) × (0 × 103)× (1 / (80 × 0.01)) × (153 /76)
= 0[N•m]
Required Stopping Accuracy
Δθ = Δθ(Dp2 / Dp1)
= 0.3 × (76 / 153) = 0.1490 [deg]

Stopping accuracy
Stopping accuracy ± Δθ = 0.3 °

Torque at input = T/i T = required torque
=336.2/130 i= gear ratio =output speed/input speed
=1410/11
=2.5846 N-m
=128.33-13

POWER CALCULATION
P= T x N1 /9550 x n
= 2.5846 x1410/9550 x o.8
P= 0.4871 KW

IV.RESULTS

If we calculated life cycle of machine is for 10 years. We need to check repeatability of C- arm x ray machine by conducting several cycles. If the cycles are conducted manually the numbers of the hour’s requirements to do cycles are calculated by taking some average usages valve of machine.

Average time taken to perform manual operation of horizontal, angular, orbital and wig wag motions is =3 minutes

An average usage of machine per day is assumed as 10 times a day i e10 cycles per day

Hence total cycles the machine to be operated for 10 years is
=numbers of cycles/day X numbers of days / year X numbers of years
=10 x 365x10
=36500 cycles

Total numbers of hours required to 36500 test cycles manually is

= average time taken / cycles x 36500
= 3x 36500
= 109500 min
= 1825 hours

As per the testing machine result average time taken to conduct one cycle at machine operation is 85 second.

Total number of hours required to conduct 36500 test cycles using machine is

= 85/60x 36500
= 51708.33 min
= 51709 min
= 862 hours.

By comparing the manual and machine test results = 1825/862
= 2.117

Total time taken manual method is 2 times greater than the total time taken by machine. hence machine takes test more than 50% less time than the manual method i e endurance testing machine requires less time to test trails and trails are conducted accurately to get the better life.

V.CONCLUSION

The requirement of the current work was to design and fabricated an automated endurance testing machine and also to have the machine run with 4 different motions thus finally to test the C arm x ray machine with endurance testing machine and validated the life cycle

- The customer requirement has been considered and the cost analysis to confirm to the requirements has been analyzed. Several concepts have been derived and the best concept is selected and designed.
- After the design, the endurance testing machine have been fabricated and finally the machine is utilized for the endurance testing of the c arm x ray machine and found out the cycle time of the machine.
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REFERENCES

[1] Merriam-Webster, "headwords "bearing" and "bear"", Merriam-Webster's Collegiate Dictionary, online subscription version.Paywalled reference work.
[2] Jump up to: a b American Society of Mechanical Engineers (1906), Transactions of the American Society of Mechanical Engineers, 27, American Society of Mechanical Engineers, p. 441.
[3] Jump up ^ Steven Blake Shubert, Encyclopedia of the archaeology of ancient Egypt
[4] Book of Design of machine elements J B DAS
[5] "Proximity sensor on Android smartphones".TheCodeArtist.
[6] Jump up ^ Cho, Youngjun (2014). "US patent: Electronic device having proximity touch function and control method thereof".
[7] Jump up ^ Cho, Youngjun (2016). "US patent: Vehicle Display Apparatus".
[8] Jump up ^ Cho, Youngjun (2015). "US patent: DISPLAY APPARATUS FOR A VEHICLE".".
[9] Jump up ^ "Canline Sensors".