ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 1, Issue 5, September 2016

Design of Pipe Inspection And Cleaning Robot For Horizontal And Vertical Pipelines (A concept)

Gowtham.S
Department of Mechanical Engineering,
PES Institute of Technology,
Bangalore, India.

Abstract: **— a report is a machine capable of carrying out a complex series of actions automatically, especially on programmable by a computer. A recent development of a robot is a pipe inspection robot. This is a robot that is used to check the damages that occur in pipes, where human reach is literally impossible. Pipe inspection robot is mainly used to check the deformities that occur in pipes during a long duration of its application. To counter all these defects, constant repairs is required. Since human reach is literally impossible in huge industrial as well as commercial pipelines, pipe inspection robots have come into existence. In our design of pipe inspection robot, it captures the entire video of the pipeline as well as it helps in clearing the clogs present in the horizontal as well as vertical pipelines. Initially the robot is inserted within the pipeline. Led is activated and the video is captured. The BO motor helps in providing 360^{o}rotation of the video. While moving through a vertical pipeline, Vacuumed rubbers are present activated by alever in turn by a remote which is externally handled. The mechanical arms for the robot to cleanse the waste along its way. Once it comes out of the pipeline, the video captured is processed and suitable actions are take to counter the defects in the pipeline. The advantages of these robots are: In most cases, it is difficult for the inspectors to examine the pipeline for an effects, However with this robot it is easier to detect the pipe defects in horizontal as well as vertical pipelines: relativs cost of manufacturing the robot is less and image capturing and processing is easier; The robot is very less in weight as it acrylic materials as its supporting linkages.**

Keywords**—bo motor, image processing, linkages, pipe defects, robot, vacuumed rubbers.**

I. INTRODUCTION

A robot is a machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer.[1] a recent development of a robot is a pipe inspection robot. This is a robot that is used to check the damages that occur in pipes, where human reach is literally impossible. Pipe inspection robot is mainly used to check the deformities that occur in pipes during a long duration of its application. These deformities can be classified as geometrical defects, metal loss defects and change in metal defects.

Geometrical defects can be further classified as buckling, ovality, wrinkle, tube expansion and angularity. Buckling is a residual deformation of the pipe wall inside the pipe, with or without a sharp edge extending over an area.[2] ovality is a nearly symmetric deviation of the pipe cross section from the circular shape resulting in an ellipse cross section without sharp breaking points. [3] Wrinkles are defined as a slight line or a fold in pipes. Tube expansion is the elimination of the diameter difference between the two pipe ends to be joined with welding. Angularity is the deviation of center lines of pipe sections joined by welding.[4] further metal loss defects can be classified as corrosion, rupture and leak. Corrosion is the metal loss extending over a significant area of pipe resulting in decrease of wall thickness.[5] rupture is longitudinal discontinuity caused by superficial or nearly superficial manufacturing defect. Leak is a total loss of pipe wall extending over a small area.

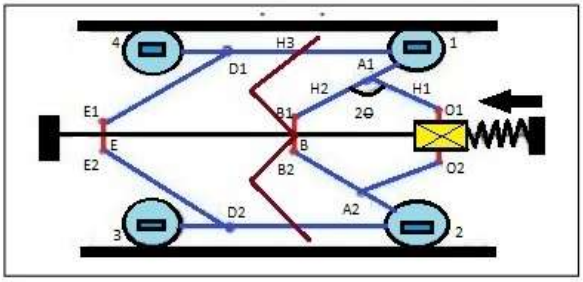
Change in metal defects can be further classified as arc drawing and strain aging. Arc drawing is defined as the burned surface of the pipe wall extending over a small relative area caused by any part of the electrical circuit by the welding apparatus due to improperly applied welding technology.[6] strain aging is wherein a metal becomes brittle due to dislocation blocking effect due its nitrogen content and improper material selection. [7]

To counter all these defects, constant repair is required. Since human reach is literally impossible in huge industrial as well as commercial pipelines, pipe inspection robots have come into existence. In our design

ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 1, Issue 5, September 2016

of pipe inspection robot, it captures the entire video of the pipeline as well as it helps in cleansing the clogs present in the horizontal as well as vertical pipelines.

II. BASIC DESIGN OF THE PIPE INSPECTION ROBOT



***Elements Of The Pipe Inspection Robot*:**

1. Length of the link from O1 to A1= H1= 50mm.
2. Length of the link from B1 to wheel 1 = H2 = 141.61mm.
3. Length of the link from wheel 1 to wheel 4 = H3 = 174.93mm.
4. S=SPRING
5. The central element is from the spring connecting B, E and the end box.
6. Translational elements are fixed along D1, D2, E, A1, A2 and B.
7. Wheels are of 120mm diameter denoted by 1, 2, 3 and 4.

Average hieght of the robot

$H= 2r +2d +2*H2*\cos\Theta$

Where,

H= height of the robot
r= radius of wheels= 60mm
d= E-E1 length = 46.64mm
H2= 141.61mm.
$\Theta = 50°$.

Thus, H= 390mm.

III. DESIGN OF VARIOUS COMPONENTS OF THE PIPE INSPECTION ROBOT

Spring:

It is mounted on the front of the robot. This facilitates the increase and reduction in height of the robot. Thus it can travel within a pipe of 340mm to 425mm. This spring is actuated by a motor, which is controlled by the operator from the station outside, so as to adjust suitably to sudden contraction and expansion of the pipe. The specifications of the spring are:

1. ***Inner diameter- 30mm***
2. Outer diameter- 33.3mm
3. Pitch – 8mm
4. Length – 100mm
5. Material – mild steel
6. Spring stiffness- 1.5N/mm.
7. Spring force – 7.5N/mm².

The Central Element:

It is the central frame of the robot wherein the different supporting members are connected to it. The central element is from the spring connecting B, E and the end box (from above figure). The spring and the camera along with the motor are attached to it. The central element is hollow in nature. The specifications of the central element are:

1. Inner diameter- 25mm
2. Outer diameter- 33.3mm
3. Length- 366.5mm
4. Material- mild steel

Translation Element:

It is the supporting element along the hinges which help in translational movement of the linkages. The specifications of the translational element are:

1. Inner diameter- 30mm
2. Outer diameter- 38.3mm
3. Length- 41.6mm
4. Material- mild steel

Wheels:

Wheels help in motion of the pipe inspection robot inside the pipelines. The specifications of the wheels are:

1. Diameter- 120mm.

Linkages:

Various links used in the pipe inspection robot are:

1. Length of the link from O1 to A1= H1= 50mm.
2. Length of the link from B1 to wheel 1 = H2 = 141.61mm.
3. Length of the link from wheel 1 to wheel 4 = H3 = 174.93mm.

There are 2 links of H1 used and 2 links of H2 used. Further, there are 2 links of H3 used also. These links provide rigid support and stability to the entire system.

ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 1, Issue 5, September 2016

***Accessories*:**

1. The front end is fixed with the camera to record all the things along its motion through the pipeline. It's fixed with the BO (Buffer Overload) motor to give it a swivelling action, so as to facilitate the movement of the head through 360°.
2. LED is used, so as to capture and record the video through the pipeline with enhanced clarity, since it is very dark through the pipelines.
3. The calculated torque required for actuating the spring is 5Kg of torque. However, 4 actuators of 1.5Kg torque are used. Using excessive torque won't harm the system. However, less torque would result in malfunctioning of the system.
4. For these actuators 12V battery supply is used. 3V dc motor is used for supplying voltage to the BO motor.
5. 4 dc motors of 12V are used for 4 wheels of the system of diameter 120mm.
6. Along the wheels vacuumed rubbers are fixed, so as to provide a better grip while travelling on a vertical pipeline.
7. Also, two arms are provided on point B which is controlled by remote by an external operator, to clean the clogging in the pipe by means of the sharp ends provided on the tip of the arms.

IV. CONSTRUCTION

Initially the central element is taken and links of h2 are fixed at point b as shown in the figure. At point e, links e1, d1 and e2, d2 are mounted. Two links of h3 are used to connect wheels of 1, 2, 3 and 4. The spring is mounted on the front of the robot from where two links of h1 are connected to two links of h2 respectively. Translational elements are fixed along d1, d2, e, a1, a2 and b. Just below the spring, a compartment is located wherein 12v batteries and 3v batteries are stored. The camera is located along with the BO motor to capture 360° rotation of the video along the pipeline. Vacuumed rubbers are connected to 4 wheels which are activated by lever mechanism, in turn connected by the remote handled by the external operator. Also, the two arms are mounted on b for cleaning waste along the pipeline**.**

Working

Initially the robot is inserted within the pipeline. Led is activated and the video is captured. The BO motor helps in providing 360° rotation of the video. While moving through a vertical pipeline, vacuumed rubbers are present activated by a lever in turn by a remote which is externally handled. The mechanical arms mounted are for cleaning the waste along the pipeline. The external remote consists of a forward, reverse, left and right button for the robot movement. It also consists of a switch which helps in reduction or increase in the height of the robot which enables it to travel within a pipeline of diameter 340mm to 425mm. Also, there is a switch for the mechanical arms for the robot to cleanse the waste along its way. Once it comes out of the pipeline, the video captured is processed and suitable actions are taken to counter the defects in the pipeline.

Advantages

- In most cases, it is difficult for the inspectors to examine the pipeline for effects; however with this robot it is easier to detect the pipe defects in horizontal as well as vertical pipelines.
- Relative cost of manufacturing the robot is less and image capturing and processing is easier.
- The robot is very less in weight as it uses acrylic materials as its supporting linkages.
- Also, it produces a 360° view of the pipeline, thus improving the accuracy of the robot's defect detetion.
- It produces a better grip and traction along the vertical pipeline.
- Also, it has long mechanical arms for cleaning the waste along its process.

Limitations

- This robot works only in an empty pipeline, it does not function when the pipeline is filled with fluid.
- Suddenly arising branches or obstructions such as valves, plugs, etc may be difficult to handle even though it is electronically controlled.

REFERENCES

[1] "robotics". *Oxford Dictionaries*. Retrieved 4 February 2011.

[2] Timoshenko, S. P., and Gere, J. M., Theory of Elastic Stability, 2 ed., McGraw-Hill, 1961

ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 1, Issue 5, September 2016

[3] *Leach, Andrew R. (2001). Molecular modelling: principles and applications. Englewood Cliffs, N.J: Prentice Hal*

[4] Koch, Hans-Eberhard: 100 Jahre Metallschlauch Pforzheim

[5] ASM Handbook, Volume 13, "Corrosion".

[6] AWWA M45 Fiberglass Pipe Design 1.1

[7] Mesarovic, Sinisa (1995)"Dynamic Strain Aging and Plastic Instabilities." J. Mech. Phys. Solids 43:671-701 No. 5