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DESIGN AND DEVELOPMENT OF WATER MAINS KEY

Dr. P. A. Makasare[1], Bhagat Yogesh Balasaheb[2], Bhade Sagar Balu[3], Bansode Shubham Anil[4],Bhawar Somnath Babasaheb[5]

[1]HOD, Dept.of Mechanical Engineering,GSMCOE, Balewadi, Pune,(India)
[2,3,4,5] Student, B.E Mechanical Engineering, GSMCOE, Balewadi, Pune, ,(India)

ABSTRACT

The main concept of the proposed system is closing and opening of sluice valve with less human effort. The core of project is the worm and worm gear arrangement. The main objective of model is opening and closing of water mains sluice valve. In the model the primary worm is in mesh with worm wheel .The worm wheel is centrally aligned with sluice valve key. The power is given to worm and further worm to worm wheel. Since sluice valve key is connected to worm shaft, it will rotate clockwise and anticlockwise according to operator requirement. The operator should lift the model and place at the appropriate place to open or close the sluice valve. This could prove to be a smart way of operation .Also Hi-tech on smart cities may use this technique for efficient working.

Keywords: Opening and Closing of Sluice Valve, Worm and Worm Gear Arrangement, Less Human Effort.

I INTRODUCTION

The main objective of the model is opening and closing of water mains sluice valve. In the model, the primary worm is in mesh with worm wheel. The worm is centrally aligned with sluice valve. The power is given to worm and further worm to worm wheel. The main concept of the proposed system is opening and closing valve sluice valve without human effort. The heart of the project is implementation is worm and worm gear. The components used for efficient function of individual blocks are motor, worm and worm gear, sluice valve. The main object of model is to open and close the sluice valve. The principal of model is the usage of stepper motor to transmit relative motion from worm to worm gear. In the model the worm and worm gear connected to motor shaft which has rotational motion due to motor if we push the corresponding switch for anticlockwise rotation which helps to opening the valve or else if we push the corresponding switch for clockwise rotation the given polarity will be charged oppositely and it helps closing the valve. The electric power can be given by the battery.

Worm and worm gear drives are used for transmitting power between two non-intersecting and perpendicular axes shaft. The worm gear drive is used as compact arrangement of high for high reduction ratio. The worm gear drive is used as compact arrangement. for high reduction ratio. The worm which is generally the driving member is a cylindrical form and resembles a trapezoidal or ACME threaded screw. the worm may be left hand or right hand and single start or multi start. The worm gear is similar to that of helical gear except that the face is concave to overlap the worm

A gate valve, also known as a sluice valve, is a valve which opens by lifting a round or rectangular gate/wedge out of the path of the fluid. The distinct feature of a gate valve is the sealing surfaces between the gate and seats are planar, so gate valves are often used when a straight-line flow of fluid and minimum restriction is desired. The gate faces can be parallel, but are most commonly wedge-shaped. Gate valves are primarily used to permit or prevent the flow of liquids, but typical gate valves shouldn't be used for regulating flow, unless they are specifically designed for that purpose. Because of their ability to cut through liquids, gate valves are often used in the petroleum industry. For extremely thick fluids, a specialty valve often known as a knife gate valve is used to cut through the liquid. On opening the gate valve, the flow path is enlarged in a highly nonlinear manner with respect to percent of opening. This means that flow rate does not change evenly with stem travel. Also, a partially open gate tends to vibrate from the fluid flow. Most of the flow change occurs near shutoff with a relatively high fluid velocity causing gate and seat wear and eventual leakage if used to regulate flow. Typical gate valves are designed to be fully opened or closed. When fully open, the typical gate valve has no obstruction in the flow path, resulting in very low friction loss.

A Stepper Motor or a step motor is a brushless, synchronous motor which divides a full rotation into a number of steps. Unlike a brushless DC motor which rotates continuously when a fixed DC voltage is applied to it, a step motor rotates in discrete step angles. The Stepper Motors therefore are manufactured with steps per revolution of 12, 24, 72, 144, 180, and 200, resulting in stepping angles of 30, 15, 5, 2.5, 2, and 1.8 degrees per step. The stepper motor can be controlled with or without feedback.

II PROBLEM STATEMENT

As the operator require more effort to open and close the sluice valve, hence to eliminate effort required by operator this system comes into picture .

Now a day’s automation is very important where time and effort is saved.

We were designing system for following parameters:

1. For 6 inch pipe line sluice valve
2. Valve stem size 2.5*2.5cm
3. Length of arm of T key (2 inch) 0.609m
4. Manual torque 105N-m
5. Required torque 105N-m for worm gear

The sluice valve presently manually operated is to be designed for worm gear drive

III SCOPE

At present the operator open and close the sluice valve manually, but we were developing this system automatic by using portable worm and worm gear box coupled with dc motor.

The future proposed system is that we were developing an app from we can operate no of valve from home. In this app there is option for no off valves , suppose if there are 50 valves of (2'' ,4'', 6'') in particular area we can establish a system which we are developing and operate this system via GSM network signal at home.

Other than this system in particular area we were establishing one operating station with strong network. There is one or more than one computers from this we were operating valves from operating station with appropriate timing

IV INNOVATIVENESS & USEFULNESS

Automated water mains key is the first of its kind developed on the line of manual operated water mains key.

Some features and benefit offered by the system:

1. Low maintenance cost.
2. Easy to operate and maintain.
3. No highly skilled labor required

V MODIFICATION IMPROVEMENT OVER THE EXISTING IMPLEMENTATION

1. Existing system is that the water mains operator operate sluice valve with the help of key.
2. For this purpose human require more effort which is painful for his body especially for old 12 inches valve.
3. Fully developed system over existing system is that we are giving effort by electric motor through worm and worm gear box arrangement.
4. This system is very reliable and compact.

VI TORQUE REFERENCE

Opening and closing valves in industrial facilities often requires operators to use bars and wrenches as levers in order to overcome initial actuation forces. In order to determine more appropriate operational specifications, the maximum torque production capability was measured when 12 male participants used 4 different valve hand wheels at3 different heights and 2 different angles (in relationship to the coronal plane). The results indicate that the participants produced significantly greater torque when the largest of the4 wheels (40.6 cm diameter) was used than when the medium (22.9 cm), small (20.3 cm), and handled (17.8 cm) hand wheels were used. Although the main effect of heights was found to be statistically significant, post-hoc analyses between the heights found them to be, essentially, equal.

In addition, the vertical and horizontal wheel orientations were not found to be different. The results are applicable to all industries where hand wheels are used and applicable to valve manufacturers for designing operational torque specifications below the values found in this study.

In industry many workers are required to perform a variety of hand wheel turning tasks such as opening and closing valves in chemical process and waste water treatment facilities. In many cases, the torque required to begin movement of the wheel (breaking") is greater than can be applied by an individual. These methods introduce safety hazards, and can cause physical injury, equipment damage, or both. If these valve systems are designed properly, workers will be able to perform wheel turning tasks safely and efficiently.

Based on the conditions simulated in this study, larger rather than smaller valve hand wheel are the best choice for an application where maximum torque is the primary consideration, such as "breaking" valves in the process industry. Therefore, operators would be able to use their whole body weight to rotate the larger hand wheel. In addition, following the laws of physics, torque produced by a force is increased with a greater moment arm. Therefore, when designing any valve that will require a significant amount of torque to operate, data from this study indicates that larger wheels should be used.

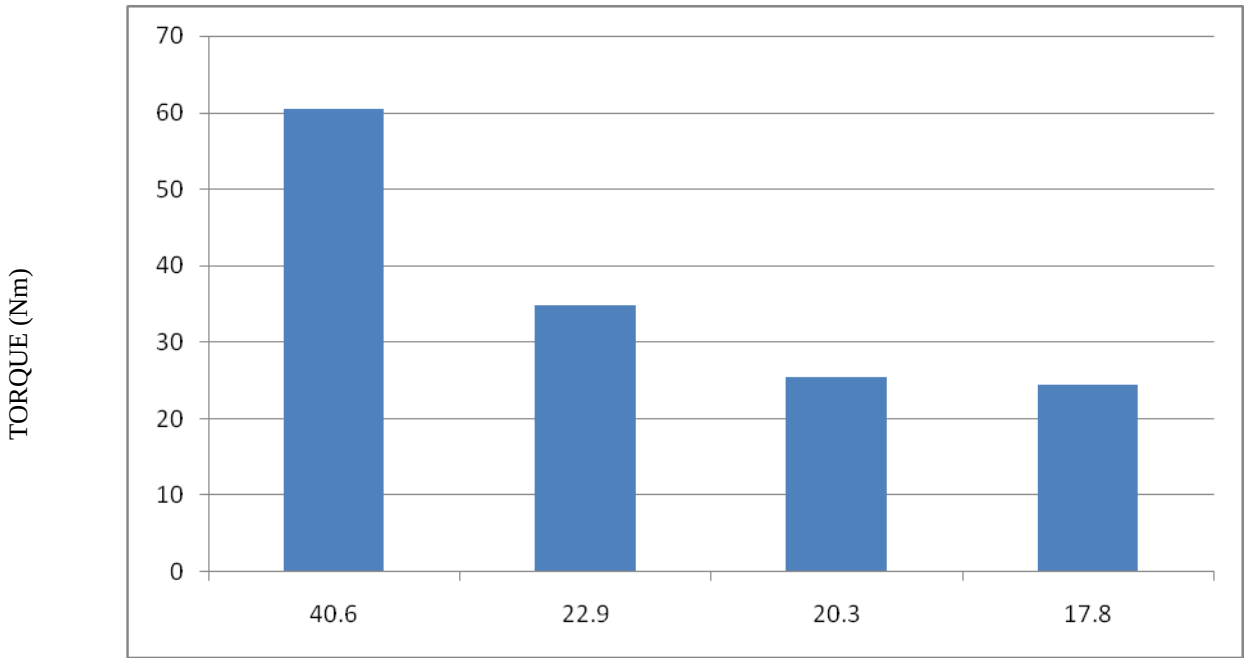

Fig. 1. Main Effect of hand wheel size on torque

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VII CONSTRUCTION AND WORKING

7.1 Sluice Valve

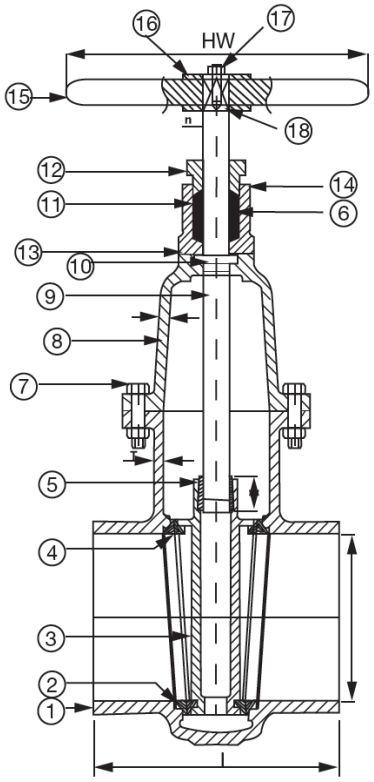

Figure. 2. Sluice Valve Constructions

S.No.	Name of Parts	Material	Specification
1.	Body	Cast Iron/S.G. Iron	IS:210 Gr.FG 200
2.	Body Seat Ring	Leaded Tin Bronze	IS:318 LTB2
3.	Wedge	Cast Iron/S.G. Iron	IS:210 Gr.FG 200
4.	Wedge Ring	Leaded Tin Bronze	IS:318 LTB2
5.	Wedge Nut	Leaded Tin Bronze	IS:318 LTB2
6.	Gasket	Rubber	IS:638 Type-B
7.	Bolts & Nuts	Carbon Steel	IS:1363
8.	Bonnet	Cast Iron	IS:210 Gr.FG 200
9.	Stem	Stainless Steel	IS:6603 12Cr12
10.	Bolts & Nuts	Carbon Steel	IS:1363
11.	Gasket	Rubber	IS:638 Type-B
12.	Stuffing Box	Cast Iron/S.G. Iron	IS:210 Gr.FG 200
13.	Packing	Asbestos	IS:4687
14.	Gland	Cast Iron/S.G. Iron	IS:210 Gr.FG 200
15.	Hand Wheel	Cast Iron/S.G. Iron	IS:210 Gr.FG 200
16.	Washer	Mild Steel	
17.	Bolts	Carbon Steel	IS:1363
18.	Bolts & Nuts	Carbon Steel	IS:1363

Fig. 3. Part list of sluice valve

7.1.1 Bodies and Bonnets

Bodies and bonnets shall be so designed as to withstand the test pressure specified. The bodies of the valves shall be fitted with seat rings securely fixed in machined recesses. The manufacturer shall provide a reasonable clearance behind the rear face of the flange on body and bonnet to provide free access to use spanners for assembling and dismantling. The portions of bonnet (gland and stuffing box) which come in contact with spindle shall be provided whenever required by the customer with bushings of minimum 3 mm thickness.

7.1.2 Flanges

The Flanges and their dimensions of drilling shall been accordance with the requirements given in IS 1538unless otherwise specified by the purchaser in the contract.

7.1.3 Wedges

Valves shall be fitted with double faced cast iron wedge made in one piece and having two machined facing rings securely fixed into machined recesses in the wedge. When shut, the wedge-facing ring shall ride high on the body seat ring to allow for wear. The minimum wear travel shall be 25 percent of the face width (B) of the seat ring. The wedge faces shall be smooth finished and shall have an equal inclination of not less than 4° up to 600 mm size and not less than 2° in sizes 700 mm and above on each side of the face of the wedge.

7.1.4 Guides and Lugs

The guides and the lugs shall be provided to guide the wedge through its full travel. It shall beoptional for the manufacturer to provide guides on the wedge and lugs on the body or *vice-versa.* Where sluice valves are intended to be used in a horizontal position and where so desired by the purchaser the lugs and guides shall be provided with channel and shoe arrangements per material specification.

7.1.5 Stems and Wedge Nuts

Stems shall have machine-cut single start square or trapezoidal threads of such lengths that the wedges can be raised to a position so as to ensure full flow passage through the valve. The clearance between the wedge net housing lugs on the wedge and the inside surface of the valve body shall be adequate to insert the wedge net into the wedge lug recess either in the direction of water flow or in perpendicular direction when the wedge is in closed position. The stem of all valves shall be so screwed as to close the valve when the cap, hand wheel or crank handle is rotated in clockwise direction (However, counter clockwise rotation of stem for valve closure is permitted subject to agreement between the purchaser and the manufacturer). Stems required for hand wheel mounting shall be tapped on top to suit setscrew.

7.1.6 Hand Wheel

Hand wheel material shall be as per Table 1 and shall have on the upper side of the rim the words open and shut with direction arrows. The hand wheel shall be secured by a setscrew. A steel washer to cover the square hole in the boss shall be fixed between the head of the setscrew and the boss of the hand wheel. The rim of the hand wheel may be smooth or serrated and the spokes may be curved or straight. The size of hand wheel for each size of valve shall be as specified in Tables 2 and 3.The total hand wheel effort shall not exceed 80 N at the periphery of the hand wheel on opening/closing of valve.

7.1.7 Valve Caps

The stem of sluice valve operated by a removable key shall be provided with caps

7.2. Working

Sluice control valve is basically is a device which will resist the flow of the fluid either liquid or gases through a pipe, right. This is the basic purpose and directly it is controlling the flow indirectly it is controlling the pressure and any other process parameters. Control valve as you know it is a final control element in a process, and it is most important part of any industrial instrumentation. As we know sluice valve is control element in the circuit which can control the flow directly. When we rotate the hand wheel wedge of valve go upward and downwards by opening and closing the valve against the static pressure head

7.3 Worm and Worm Gear

Fig. 4. Worm

Fig. 5. Worm gear

A worm is a gear with one or more cylindrical, screw-like threads (also referred to as “starts”) and a face width that is usually greater than its diameter. A worm has a center hole (bore) for mounting the worm on a shaft. Worm gears, like worms, also are cylindrical and bored for mounting on a shaft. However, unlike a worm, a worm gear’s diameter is usually much larger than the width of its face. Note: Worm gears differ from spur gears in that their teeth are somewhat different in shape and are always formed on an angle to the hole (axis) in order to mate with worms. See (Fig.4).

In order to transmit motion and power at various speeds and speed ratios, worms and worm gears work in sets, rotating on shafts at right angles to one another. The worm usually drives the worm gear. Accordingly, the worm gear is usually the driven member. See (Fig .5)

7.4 Important:

In worms and worm gear sets, both the worm and worm gear are of the same hand. Right-hand sets are considered standard. As a result, right-hand sets will always be furnished unless otherwise specified.

7.5 When to use worms and worm gears

Worms and worm gears provide solutions to wide range of drive problems, particularly when the following factors need to be considered:

1. High ratio speed reduction
2. Space limitations
3. Right angle shafts
4.Non-intersecting shafts

Now that you have been introduced to worms and worm gears, let's take a closer look at each, starting with the worm.

7.6 Worms–physical dimensions

When ordering special (made-to-order) worms, the pitch, pitch diameter, pressure angle, number of threads and hand should always be specified, as should the physical dimensions illustrated in Fig. 6.

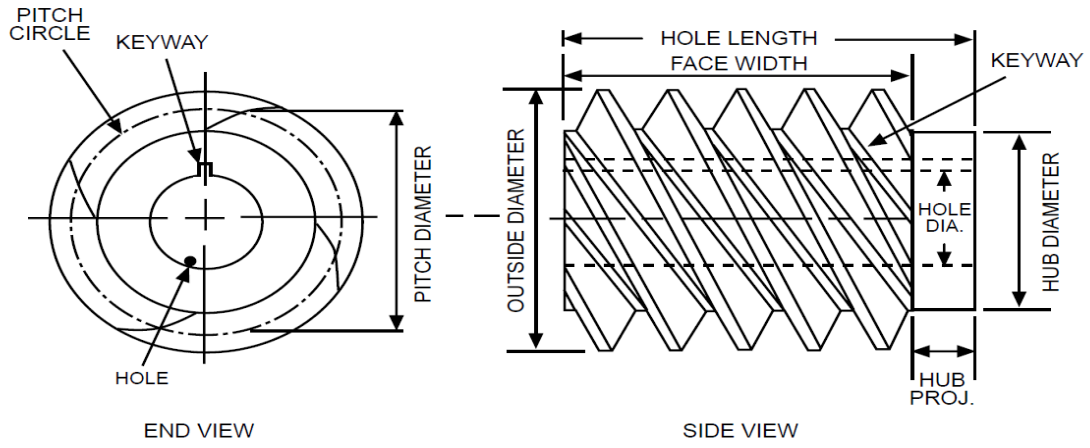

Fig. 6.

7.7 Worms gears–basic dimensions

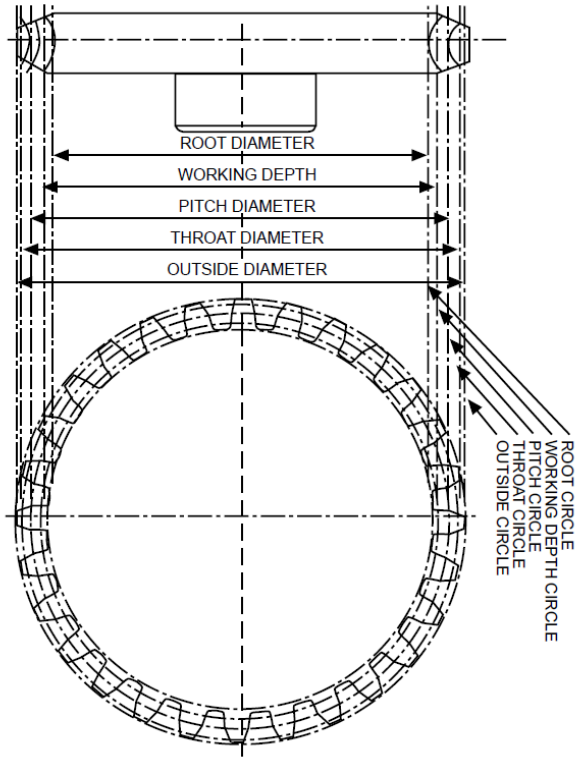

Fig. 7.

As noted in our discussion of spur gears, gear dimensions are important because they provide valuable information when determining how best to meet a customer's needs. Here are definitions you need to know in order to determine the basic dimensions of worm gears. (Fig. 7)

1. Pitch Diameter – the diameter of the pitch circle (which, you will remember, is the "imaginary" circle on which the worm and worm gear mesh.

2. Working Depth – the maximum distance the worm thread extends into the tooth space of the gear.

3. Throat Diameter – the diameter of the throat circle at the center line of the worm gear face (the lowest point on the tooth face).

4. Outside Diameter – the largest diameter of the worm gear teeth. It is equal to the diameter of the outside circle.• Root Diameter – the smallest diameter of the worm gear. It is equal to the diameter of the root circle.

7.8 Working of System

Simple working of system is that when we give input power through motor to worm, worm rotate clockwise or anticlockwise and transmit power to worm gear, on worm gear which is perpendicular to worm there is key coupled to shaft to open and close the sluice valve , the simple proposed system is given in (fig.8)

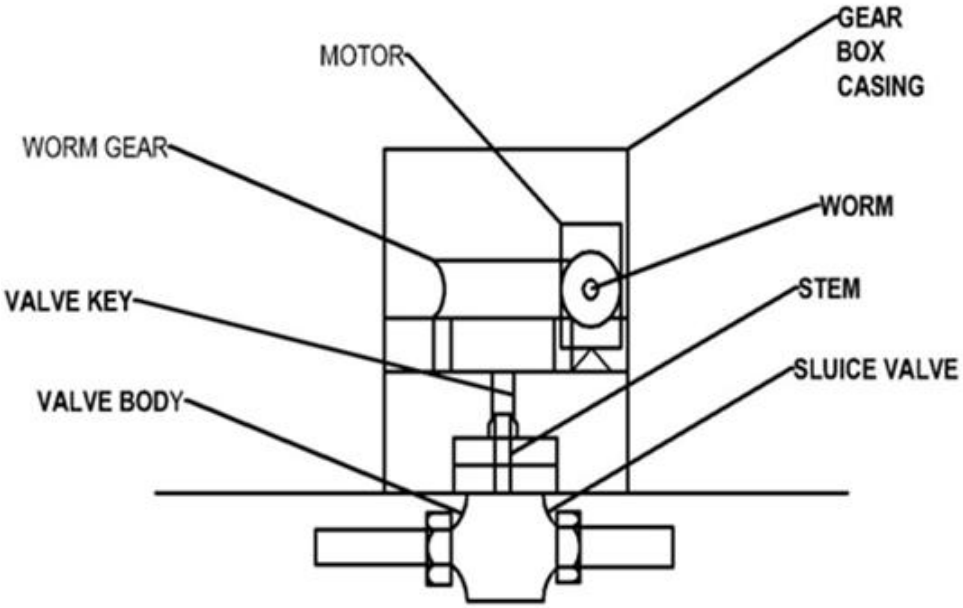

Fig. 8. Working of system

VIII DESIGN CALCULATIONS FOR WORM AND WORM GEAR

8.1 The component of force acting on worm

(Fg)t =(Fw)a =643797.62 N

(Fg)a =(Fw)t =112244.89 N

(Fg)r =(Fw)r = 50743.66 N

TABLE 1. Dimension of gear

Sr.no	Parameter	Symbol	Dimensions
a)	worm gear		
1	Module	m	2.5
2	No.of Teeth	Zg	150
3	Pitch circle diameter	dg	3750mm
4	Face width	b	18.25mm
5	Addendum	ha	Ha=1*2.5=2.5 mm

6	Deddendum	hf	hf=1.25*2.5=3.125mm
b)	worm		
1	Module	m	2.5mm
2	No.of start	Zw	1
3	Pitch circle diameter	Dw	$2.5*10^{-2}$ m =25mm
4	Length of worm	Lw	60mm
5	Addendum	ha	ha=$2.5*10^{-3}$ m =2.5mm
6	Deddendum	hf	$3.125*10^{-3}$ m =3.125mm

IX CONCLUSION

This concept leads the efficient use of worm and worm gear arrangement as human require much effort to shut and open the valve, Automated water mains key is the first of its kind developed on the line of manual operated water mains key, as some benefits offered by system are low maintenance cost ,easy to operate, no highly skilled person required . Fully developed system over existing system is that we are giving effort by electric motor through worm and worm gear box arrangement.

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