

# Review on Design of Slider Crank and Rack and Pinion Mechanism for Half Orbital Motion for Gas Agitation System

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**Abstract**— There are various types of motions achieved with the help of different mechanisms. As we know slider crank mechanism gives the reciprocating motion from circular motion. Slider crank mechanism widely used in industrial application while rack & pinion generally used in steering mechanism to obtain linear movement of vehicle wheels by the expense of circular motion of steering. Nowadays lots of industries require half orbital motion for mixing food, chemicals, gases, etc. Specially for mixing two gases (Novac-1230 and HFC-227) in proper proportion they require half orbital motion. In some of the industries gases combined by agitation process. Mixing of two or more gases by stirrer in cylinder causes chance of leakage or accidents because of harmful gases, to avoid this acting external movement is safer way to mixing of gases.

**Keywords:** Slider crank mechanism, rack and pinion, Agitation, Half orbital motion, Industrial applications

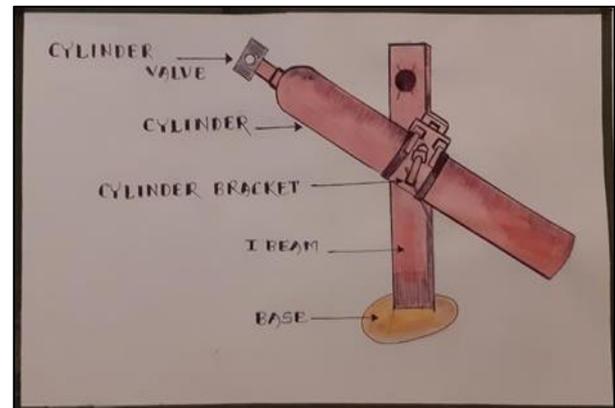


Fig. 1: Typical agitation system

A typical agitation system mention above only require a half orbital motion, for proper mixing of two gas inside in the cylinder. By taking in to the consideration of half orbital motion, slider crank mechanism is suitable for the operating condition, but the weight of that fire extinguisher cylinder is minimum 80 kg and maximum 300 kg. And only slider crank mechanism does not gives the uniform motion for such a heavy load, hence we decide to add one more mechanism inside the system I.e. rack and pinion mechanism which also have same principle. Both this mechanism gives the rotational motion to linear or reciprocating mechanism and vice versa.

It is more convenient to use of both mechanism for obtaining a half orbital motion. As described in below.

## I. INTRODUCTION

Oscillating cylinder with the help of both slider crank mechanism and rack and pinion mechanism is generally useful in gas industry. Which make the fire extinguisher cylinder, for mixing two different gases such as H<sub>2</sub>O (l) and CO<sub>2</sub> (g) form.

Shaking mechanism does not gives a half orbital motion it only oscillate the component, which is not capable to mix two gases properly.

The use of mechanism in industry always reduce the human effort. Also increase the productivity in which minimum number of defects.

Generally in gas industries, such as company which make fire extinguisher cylinder they have one section called agitation section. In that section they mix two different gases giving manually movement to that cylinder. But some time it is dangerous, if accidently cylinder fall down then this is hazardous to the worker. Md. Shimul Hossain et al [1] mention in his case study as automatic LPG Cylinder filling system is more secure and effective. To overcome this type accident it is necessary to make agitation system automatic. By keeping the mind function of slider crank mechanism and rack and pinion mechanism, we decide to use this two mechanism.

## II. TYPICAL AGITATION SYSTEM

In some industry a manually operated agitation system is used to make a fire extinguisher cylinder.

In manual operating system consist lot of parts like cylinder holder bracket, bearing, cylinder holder "I beam" and also many more parts. By using such valuable parts this system is not automatic, it require a human efforts for gas agitation which is not convenient, and also time consuming.

## III. LITERATURE REVIEW

- 1) Mechanism:-stiff bodies connected by cumulative manner to obtained desired motion.
- 2) Link: - link is a connecting structure which connect the other linkages.

Mechanism is a combination of link, kinematic pair, and kinematic chain.

- 3) Kinematic pair: - two links come contact and form a kinematic pair.
- 4) Kinematic chain: - two kinematic pair come contact and form a kinematic chain [2].

### A. Slider Crank Mechanism:

It is four bar link mechanism, which consist of three revolving joint and one reciprocating joint. Internal combustion engine is one of the best example of this mechanism in which linear motion is converted into rotational motion or vice versa [3].

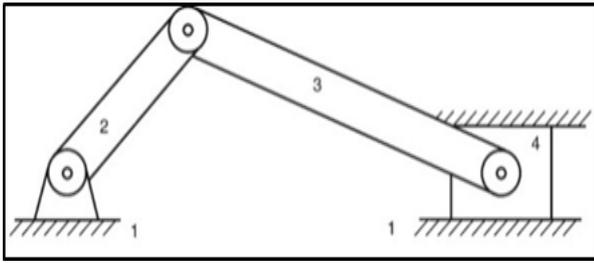


Fig. 2: Slider Crank Mechanism

Generally driving torque will drive all the links, which is connected to rigid link. There is a revolving joint between flexible link and rigid link, which help to reciprocate the system. The working speed is directly proportional to the driving torque. The maximum driving torque is obtained by providing high power motor. Crank is a main arm of slider crank mechanism, with the help of crank we convert the circular motion of driving torque into reciprocating motion of system.

By fixing each link of mechanism we obtained a different motion called inversion of mechanism. Connecting rod of piston cylinder, with worth quick return mechanism, shaper machine mechanism are some inversion of slider crank mechanism. This mechanism is also responsible to operate stable and unstable form of component. Force analysis of slider crank mechanism gives the idea about," as compared to belt film transport slider crank mechanism gives continuous motion. The force which is obtained from connecting rod is very high. And also in slider crank mechanism there is definite relation between velocity and acceleration curve.

Dynamic behavior of slider crank mechanism is play important role while developing any kind of application. The velocity, acceleration of mechanism is responsible for any application. The study of modification of slider crank mechanism gives the end point of connecting rod will exhibit high velocity.

#### B. Mechanical advantages:

The main advantages of slider crank mechanism while used in any machinery are the ratio of output force to the input force or torque at any instant.

Power input = Power output [4].

##### 1) Advantages:

- 1) It is always helpful to convert rotary motion into linear straight line motion.
- 2) Easy construction and operation.
- 3) Can perform various application such as cutting, slotting, shaking etc
- 4) Process can be automated.

#### C. Rack and Pinion Mechanism:

Rack and pinion is a type of mechanism which performs circular motion of pinion gear into linear motion of rack. Geometry of pinion gear is circular containing teeth on its periphery while rack is straight strip containing teeth. Teeth of pinion gear are engaged with teeth of rack as pinion rotate about center rack move linearly.

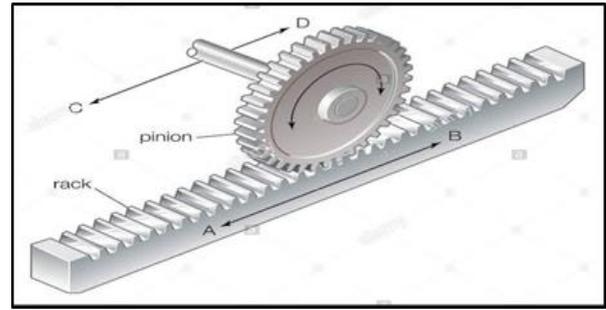


Fig. 3: Rack and pinion mechanism

#### D. Industrial application:

##### 1) Steering mechanism:

Rack and pinion is commonly found in the steering mechanism of cars and their steered vehicle.

##### a) Canal gate lock control:

For snag and release the water in canola there are gate locks which contain steering connected to barrier with shaft by means of rack and pinion mechanism.

##### b) Stairlifts:

Rack and pinion nowadays used to operate stair lifts.

It is possible to obtained circular motion and reciprocating motion. But it is difficult to obtained a half orbital motion, by using both slider crank and rack and pinion mechanism, it is possible to obtained half orbital motion.

## IV. METHODOLOGY

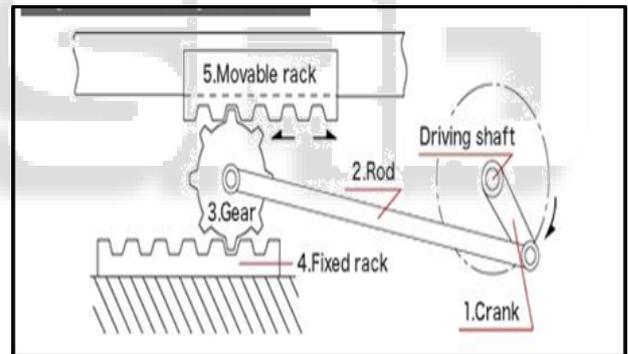


Fig. 4: Half Orbital Motion Mechanism

Motor gives the driving torque to the crank which is connected to the connecting link, as per principle of slider crank mechanism it convert the circular motion into reciprocating motion [4] This reciprocating motion push the rack and the gear which attached on the rack drive the pinion as per gear teeth provided on them, by adjusting the numbers of teeth on pinion we obtained desired motion. Saad Mukras et al [5] presents study on modeling a slider crank mechanism with joint wear. This wear occurs at one of the joint due to operating conditions but in this case this occurrences of wear is very low due to combination of working mechanism of slider crank with rack and pinion. A 180 watt induction motor of 1500 rpm is used. This motor is connected to gear box having 12.5 speed ratio for achieving optimal speed. Slider crank mechanism is operated with this motor and one end of slider crank is input to the rack and pinion mechanism by movable joint. Pinion has provision as it is connected to cylinder bracket hence half orbital motion is achieved.

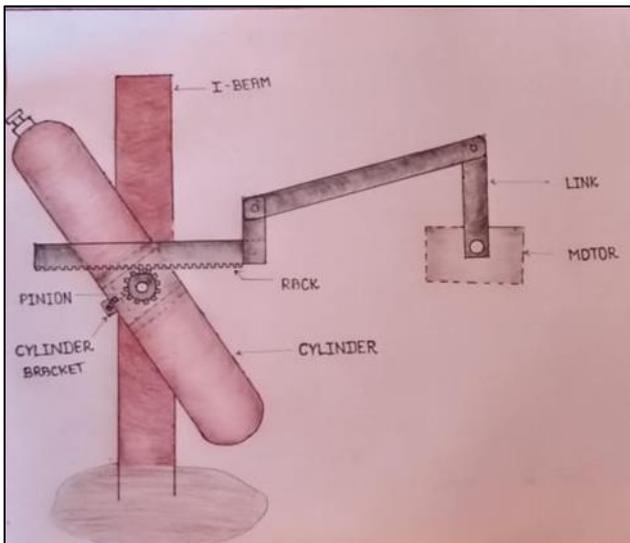


Fig. 5: Modified Agitation System

Our aim is to obtain half orbital motion which can be achieved by providing suitable number of teeth at the end of both rack and pinion. S.R.Patel, D.S.Patel & B.D.Patel reviewed that Dynamic study is very important for design and optimization of mechanism [6]. In this review 120 rpm is required for mixing of this gases which can be achieved easily with this operating mechanism with induction motor. One more thing is motion obtained from pinion is not circular it is half orbital circular which help to achieved half orbital motion. These two mechanisms are cheaper, simple in construction and also provide a better result. Only slider crank mechanism does not gives  $180^\circ$  half orbital motion, that's why with the help of rack and pinion arrangement it gives exactly half orbital rotation without any difficulty.

#### V. CONCLUSION

It is necessary to obtain a half orbital motion which is required for agitation system of two gases. Traditional way of mixing of the gases is difficult for human intervention as per safety concern, so automatic mixing of gases with the help of mechanisms are quite easier and operating under safety consideration achieved. Half orbital motion can be easily achieved with the help of this both mechanism. Gear teeth gives better control over the operating mechanism. Work in process (WIP) time is reduced with this application system which is better for any organization. No need of skill operator as automatic working of mechanism in agitation process, this also reduced numbers of workers required for operation.

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#### REFERENCES

- [1] Mohammad Shimul Hossain\*, M. G. "Liquefied Petroleum Gas (LPG) Bottling Process and Required Safety During Bottling: A Case Study," Petroleum Science and Engineering Science Publishing Group, pp. 5-9, 2019.
- [2] Killoy, E. B. (2013). "Slider - Crank Mechanism for Demonstration and Experimentation MQP," Available at: [https://web.wpi.edu/Pubs/E-project/Available/E-project-042513-103948/unrestricted/Slider-Crank\\_MQP\\_Final\\_Draft.pdf](https://web.wpi.edu/Pubs/E-project/Available/E-project-042513-103948/unrestricted/Slider-Crank_MQP_Final_Draft.pdf). Cited on 21 February 2020.
- [3] Theory of machines by R.S.Khurmi and K. Gupta available at: <https://www.engineeringbookspdf.com/theory-of-machines-by-r-s-khurmi-and-j-k-gupta/> Cited on: 22 February 2020.
- [4] Ashok, K. R., "Design and force analysis of slider crank mechanism for film transport used in VFFS machine," International Research Journal of Engineering and Technology, 04(12), pp. 41-47, 2017.
- [5] S. Mukras, Nathan A. Mauntler, Nam H. Kim, Tony L. Schmitz and W. Gregory Sawyer, "Modeling a slider-crank mechanism with joint wear," SAE International, 2009.
- [6] S.Patel, D.Patel, B.Patel, "A Review on kinematics dynamics analysis of mechanism," International journal of Engineering science and Innovative Technology, vol. 2, pp.338-341, March 2013.