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Hyperloop New Mode of Transportation

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***Abstract*— Today conventional mode of transportation is rail, road, water, and air. These modes of transport are relatively slow and expensive or a combination of relatively slow and expensive. Hyper loop is latest mode of transportation which is fast and inexpensive to change the pattern of transportation. Similar to Linux, hyper loop is also open and unique design concept. By bringing this concept to reality, it will help people to travel from one city to another city in a very small time and also at a low cost. The hyper loop capsule would accelerate with the help of linear electric motor and traverse through the tube at a high speed. By using passive magnetic levitation or air bearing, capsule will run above their track. Hyper loop consists of a low-pressure tube with capsules that are travelled at low and high speed throughout the length of the tube. The capsules are supported with the help of cushion of air. To accelerate the capsules the magnetic linear accelerator is fitted at various stations on the hyperloop tube. To enter and exit the passengers the passage may be left either at the end of the tube or branches along the tube length. Let's see how the hyperloop change mode of transportation.**

I. INTRODUCTION

Hyper loop concept is proposed by Elon Musk in 2013 who is the CEO of SpaceX and Tesla motors. Hyper loop consists of a low-pressure tube through which capsules may travel free of friction and air resistance at a high speed. The whole hyperloop system is powered by the solar panels mounted on the top of the low-pressure tube.

According to Elon Musk's concept, the capsule rides on air bearings which are driven by linear induction motor. The concept of hyper loop states that people will travel from one place to another place in a capsule which is propelled at a very high speed. We can say that hyper loop is magnetically levitated train which runs inside a long tube or pipe. Hyper loop is composed of low-pressure tube and the capsule which transport passengers from one place to another place at a very high speed. Linear induction motor and compressor is used to drive the hyper loop. It has the capacity of transporting 28 passengers at a time.

Magnetic accelerators are used for propelling the capsule. The tubes would keep at low air pressure environment, surrounding the pod with a cushion of air that allows the pod to move safely at such high speeds. Due to the tight quarters in the tube, pressure is created in front of the capsule. The tube needs a system to keep air from creating high pressure in front of the capsule. For that purpose, air compressors are recommended as the solution to the created problem. The air compressor sucks the air from front side of the capsule and transfers it to the rear end of the capsule through air bearings as well as bypass nozzle.

II. BASIC PRINCIPLE OF HYPERLOOP

Hyper loop is based on a principle of magnetic levitation. The principle of magnetic levitation states that the vehicle can be suspended and propelled on a guidance track made with magnets. The capsule on the top of the track is propelled by linear induction motors. Fig-1 shows the position of magnetic levitation along the track in the tube as well as the positions of batteries and the seating arrangement.

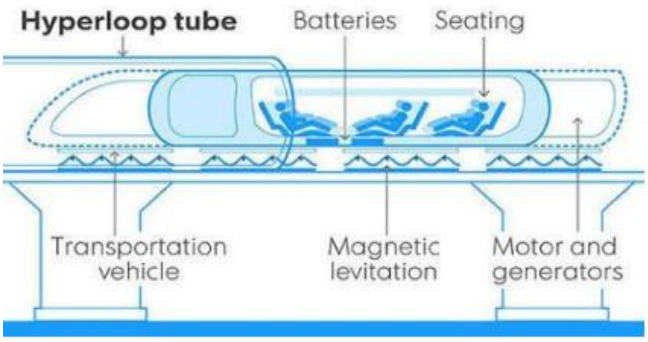


Fig -1: Arrangement of Magnetic Levitation

III. COMPONENTS OF HYPERLOOP

There are five components of hyper loop that are:

- Tube
- Capsule
- Compressor
- Suspension
- Propulsion

A. Tube

Tube is one of the main components of hyperloop system which is made of steel. Two tubes are welded together side by side or up and down to allow the capsules travel in both directions. These tubes will be supported with the help of pillars. Pillars are placed 30m(100ft) apart from each other. There are solar arrays are provided on the top of the tubes which provide power to the whole system. The geometrical dimensions of the tube are:

• Inner diameter of the tube is 2.23 m.
• The tube cross-sectional area is 3.91 m2
.
The expected air pressure inside the tube will be maintained around 100Pa.
The Fig-2 shows the view of tube.

Fig -2: Hyperloop Tube.

B. Capsule

The capsule has the capacity of carrying 28 passengers at a time and travel at a very high speed throughout the length of the tube. Magnetic linear accelerators are used to accelerate the capsules. These accelerators are fixed at various stations on the hyperloop tube. Each capsule contains rotors fixed at the bottom and the stators on the tube walls. The combination of stator and rotor give momentum to the capsule. The capsule are separated within the tube by an approximately 23 miles (37 Km) on average during operation.

There are two versions of capsule that are:

• passenger only.
• passenger plus vehicle version.
• The geometrical dimensions of the capsule are:
• The maximum width is 1.35m.
• Maximum height is 1.10m.
• Frontal area with rounded corners is 1.4 m2
(except propulsion and suspension components).

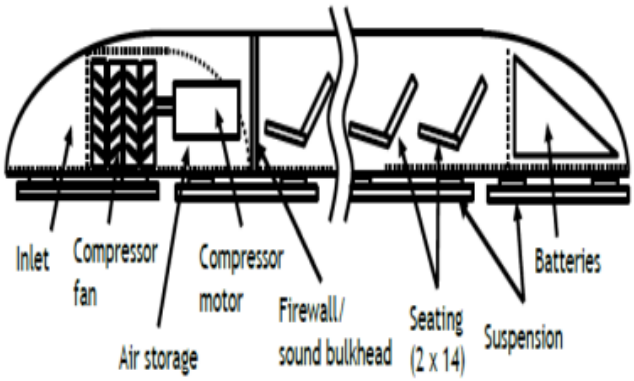
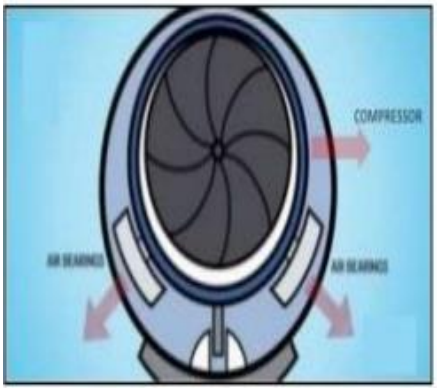


Fig -3: Hyperloop Passenger Capsule Subsystem Notional Locations.

C. Compressor

The compressor is fitted at the front side of the capsule. It sucks the air and transfer to the air bearings which supports the weight of the capsule. The compressor allows the capsule to traverse through low pressure tube without choking the air flow that travels between tube walls and capsule. Tube air is compressed with a compression ratio of 20:1 via an axial compressor. Up to 60% of this air is bypassed:

• The air travels via narrow tube near bottom of the capsule to the tail.
• A nozzle at the tail expands the flow generating thrust to mitigate some of the small amount of aerodynamic and bearing drag.



Compressor

FIG -4: Compressor

D. Suspension

For the purpose reliability and safety, the air bearing suspension are used which offers stability and extremely low drag at a feasible cost. Due to exceptionally high stiffness, air bearing suspension is required to maintain stability at very high speed. Aerodynamic and pressurized air bearing suspensions are superb for the hyper loop system. The skis are pushed away due to the increased pressure which creates considerable discomfort for passengers. Hyper loop capsules will float above the tube's surface on an array of 28 air bearing skis that are geometrically conformed to the tube walls. The skis support the weight of the capsule by pressurized cushion of air.

The geometrical dimensions of skis are:

- Length is 1.5 m
- Width is 0.9 m.
- Pressure between tube walls and the ski is 9.4 x 103 Pa.

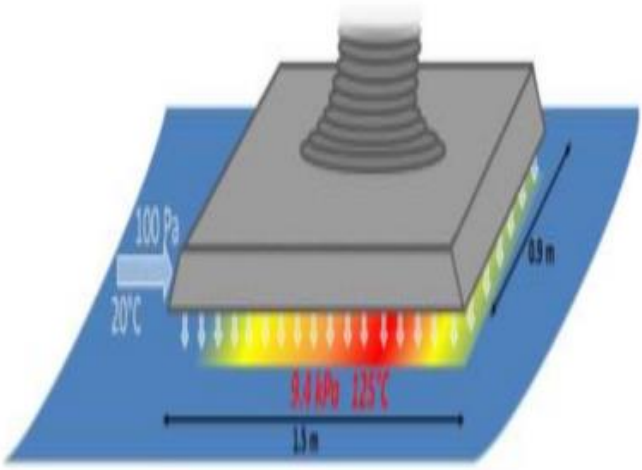


Fig -5: Ski

E. Propulsion

Propulsion system is important component of hyperloop system to accelerate as well as to decelerate the capsule from 0 to 300mph. Propulsion helps the capsule to maintain required speed in urban areas as well as in the hilly areas. To accelerate and decelerate the capsule linear induction motor is used which provides advantaged over permanent magnet motor. Linear induction motor lowers the material cost, reduces the weight of the capsule and also lowers the dimensions of capsule. Fig-6 shows the arrangement of the stator and rotor while the stator is mounted to tube and the rotor is mounted to the bottom of capsule.

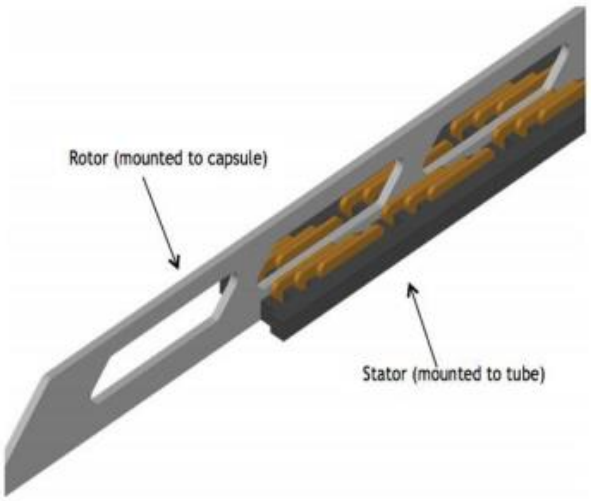


Fig -6: Arrangement of Stator and Rotor

IV. WORKING OF HYPERLOOP SYSTEM

Working of hyperloop system is based on magnetic levitation principle. As we know that the passenger pod travel through low pressure tube which is pylon-supported tube.

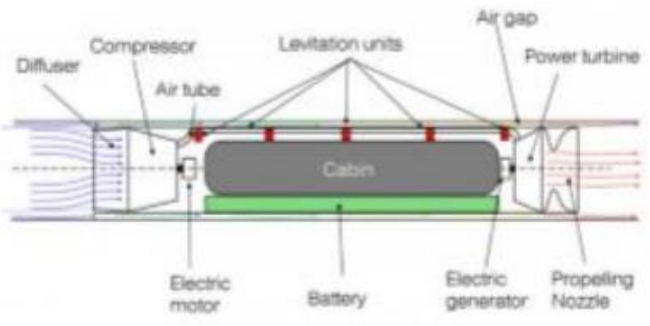


Fig -7: Working of Hyperloop

The principle of hyper loop system is also same as working principle of Air Hockey. The capsules are accelerating at a high speed due to linear electric motor and move above their track with the help of passive magnetic levitation or air bearings. Powerful electromagnets levitate and propel the capsules forward. This reduces the frictional losses, as train glide over the desired track. As there are no frictional losses, the capsules travel at a very high speed. The low-pressure air in the tube also increases the efficiency by dismissing the losses due to air drag and this makes the capsule travel at very high speed. The high speed of capsules decreases the time required for the journey ortransporting passengers as well as the vehicle from one place to another place.

The cushion of air created by air bearings supports the weight of the capsule. The capsules are accelerated by linear induction motor. The solar panel fixed on the top of the tubes powered the whole hyper loop system as well charge the battery packs which are used in night or in cloudy weather. The energy stored in the form of compressed air is also used whenever required. If the capsule covers too much area of the tube, then air in the tube is not passes around the capsule. Due to that the air pressure increases and this pressurized air pushes the capsule backward. To avoid this problem air compressor is fitted on front side of capsule which transfer this air from front side to the rear side via bypass nozzle as well through the air bearings as shown in Fig-8.

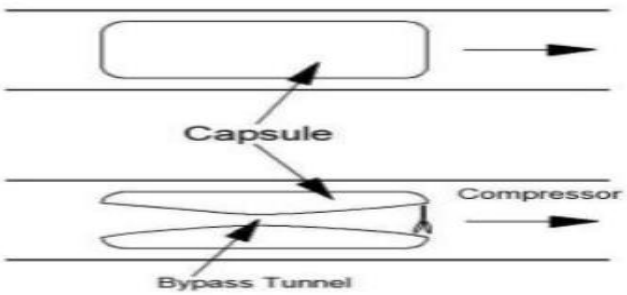


Fig -8: Air Flows through Bypass Tunnel

V. MERITS AND DEMERITS

MERITS

- It saves the travelling time.
- There is no problem of traffic.
- It is powered by the solar panel.
- Immune to weather.
- Cost of hyperloop is low.
- More convenient.
- Resistance to earthquake.
- Safer.

DEMERITS

- May occur critical situation at turnings.
- Less movable space.
- May occur dizziness in passengers.

VI. FUTURE WORK

- Expansions of control mechanisms.
- Designs of various stations.
- Capacity of carrying passengers at a time.
- Improvement of safety features.

VII. CONCLUSION

- Hyperloop system is the superb alternative for transportation instead of today's expensive and slow transportation systems.
- This system provides more comfort to passengers.
- By reducing the pressure of the air in the tube capsule travels at very high speed.

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