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Hyperloop Transportation System

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Abstract – *The conventional modes of transportation of people consists of four unique types and that are rail, road, water, and air. These modes of transport tend to be either relatively slow, expensive or a combination of both. Hyperloop is a new mode of transport that seeks to change this pattern by being both fast and inexpensive for people and goods. Hyperloop is a proposed mode of passenger and freight transportation that propels a capsule-like vehicle through a near-vacuum tube at more than airline speed. The pods would accelerate to cruising speed gradually using a linear electric motor and glide above their track using passive magnetic levitation or air bearings. Hyperloop consists of a low pressure tube with capsules that are transported at both low and high speeds throughout the length of the tube. The capsules are supported on a cushion of air, featuring pressurized air and aerodynamic lift. Passengers may enter and exit Hyperloop at stations located either at the ends of the tube, or branches along the tube length. It quickly becomes apparent just how dramatically the Hyperloop could change transportation, road congestion and minimize the carbon footprint globally. With the Hyperloop, extremely fast, inexpensive intercity travel would be widely accessible. If both people and goods can move more quickly and comparatively cheaply, rapid growth is a logical outcome.*

Key Words: **Hyperloop, Propels, Vacuum Tube, Capsule, Passive Magnetic Levitation, Air Bearings**

1. PROBLEM DESCRIPTION

As we know that there are four modes of conventional transportation. First is rail which is relatively slow and expensive another is road and water which is relatively slow and next is air which is too expensive. Road travel is particularly problematic, given carbon emissions and the fluctuating price of oil. As the environmental dangers of energy consumption continue to worsen, mass transit will be crucial in the years to come. Developments in high-speed rail have historically been impeded by the difficulties in managing friction and air resistance, both of which become substantial when vehicles approach high speeds. Rail travel is relatively energy efficient and offers the most environmentally friendly option, but is too slow and expensive to be massively adopted. At distances less than 900 miles, supersonic travel is unfeasible, as most of the journey would be spent ascending and descending (the slowest parts of a flight.) Given these issues, the Hyperloop aims to make a cost-effective, high speed transportation system for use at moderate distances. The Hyperloop tubes would have solar panels installed on the roof, allowing for a clean and self-powering system.

2. INTRODUCTION

Hyperloop is a completely new mode of fastest transportation. Hyperloop is firstly proposed by Elon musk and a team of engineer from Tesla Motors and the Space Exploration Technologies Corporation in August 2013. The concept of hyperloop includes travelling people from one place to another place in a capsule which is propelling at a very high speed. We can also called hyperloop as a solar powered transportation system and it is an alternative of high speed train. Basically hyperloop is magnetically levitated train which runs inside a long tube or pipe. It consists of low pressure tube with capsule that is transported at both low and high speeds. It is driven by linear induction motor and compressor. It includes 28 passenger pods.

For propulsion, magnetic accelerators will be planted along the length of the tube, propelling the pods forward. The tubes would house a low pressure environment, surrounding the pod with a cushion of air that permits the pod to move safely at such high speeds, like a puck gliding over an air hockey table. Given the tight quarters in the tube, pressure buildup in front of the pod could be a problem. The tube needs a system to keep air from building up in this way. Musk's design recommends an air compressor on the front of the pod that will move air from the front to the tail, keeping it aloft and preventing pressure building up due to air displacement. A one way trip on the Hyperloop is projected to take about 35 minutes (for comparison, traveling the same distance by car takes roughly six hours.) Passengers may enter and exit Hyperloop at stations located either at the ends of the tube, or branches along the tube length.

3. LITERATURE SURVEY

Ahmed Hodaib, Samar F. Abdel Fattah (May 2016), discussed the design of a hyperloop capsule with linear induction

propulsion system which is used to accelerate and decelerate the capsule. They studied that like rotary synchronous motors; linear motors run on 3-phase power and can support very high speeds. However, there are end effects that reduce the motor's thrust force. Linear induction motors are thus less energy efficient than normal rotary motors for any required force output. They also discussed about the manufacturing of linear induction motor in this paper.[1]

Jeffrey C. Chin, Justin S. Gray, Scott M. Jones, Jeffrey J. Berton, They discussed about the Open-Source Conceptual Sizing Models for the Hyperloop Passenger Pod in this paper. They concluded that the refined analysis illuminates several interdisciplinary couplings that alter two major aspects of the initial concept. First, the pod travel speed and the tube cross sectional area are linked, forcing the tube size to be to be roughly twice the diameter of the original specification, in order for the pod to reach Mach 0.8. Second, the steady-state tube temperature is dominated by ambient thermal interactions unrelated to the heat generated by the pod compression system.[2]

Mark Sakowski (2016) discussed the current maglev technology along with the theoretical evacuated tube technology and they concluded that the hyperloop is feasible and if properly designed, has the potential to be much more efficient in terms of energy usage of pods traversing down the tube.[3]

N. Kayela, (2014) investigated that the hyperloop is a fifth mode of transportation alongside trains, planes, automobiles and boats. He discussed about the railway track for the hyperloop, stations for the hyperloop. Also, discussed about the two version of capsule that is one is passenger only version and another is passenger plus vehicle version.[4]

Mohammed Imran (2016) He focused his study element on the hyperloop technology (the passenger transport system). He discussed about the two version of hyperloop in that one is passenger only version and another is passenger plus vehicle version. Hyperloop System.[5]

4. BASIC PRINCIPLE OF HYPERLOOP

Hyperloop is based on a principle of magnetic levitation. The principle of magnetic levitation is that a vehicle can be suspended and propelled on a guidance track made with magnets. The vehicle on top of the track may be propelled with the help of a linear induction motor.

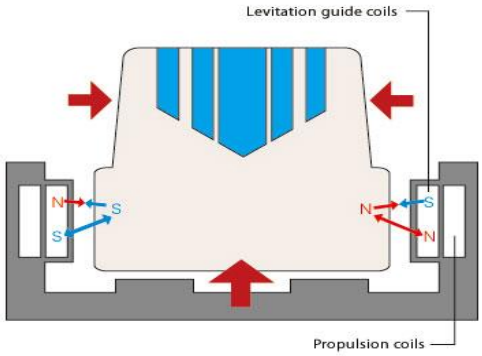

Fig-1: Operating principle of hyperloop[8]

5. CONSTRUCTION

5.1 Tube:

The tube is made of steel. There are two tubes which are welded together side by side configuration to allow the capsules travel in both directions. The tube will be supported by pillars. There is a solar arrays are provided on a top of the tubes for the purpose of power to the system.

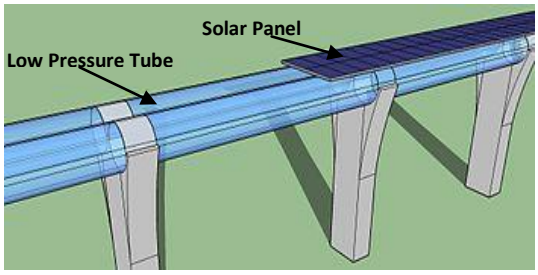

Fig-2: Construction of tube [9]

5.2 Capsule:

The capsule can carry 28 passengers at a time and it send at a very high speed and it is levitated by a high pressure air cushion. The design of capsule is start with the aerodynamic shape. There are two version of capsule are being considered: a passenger only version and a passenger plus vehicle version.

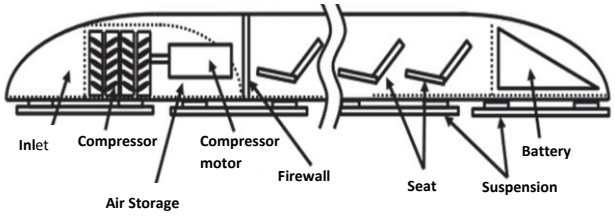

Fig-3: Arrangement in capsule[6]

5.3 Compressor:

The compressor is fitted at the front side of the capsule. It supplies the air to the air bearings which supports the weight of the capsule. The compressor allows the capsule to traverse to the low pressure tube without choking the air flow that travels between tube walls and capsule.

Fig-4: Compressor [7]

5.4 Suspension:

Air bearing suspension offers stability and extremely low drag at a feasible cost. A stiff air bearing suspension is superb for reliability and safety. When there is a gap between ski and tube walls is high then it shows the nonlinear reaction and which results in large restoring pressure.

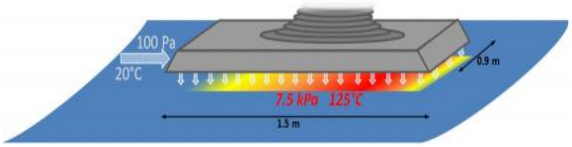

Fig-5: Schematic of air bearing skis that support the capsule [6]

5.5 Propulsions:

To accelerate and decelerate the capsule the linear induction motor is used in hyperloop system. It provides some advantages over a permanent magnet motor. To accelerate the capsules there is linear accelerators are constructed on a length of the tube. Stators are placed on the capsules to transfer momentum to the capsules via the linear accelerators.

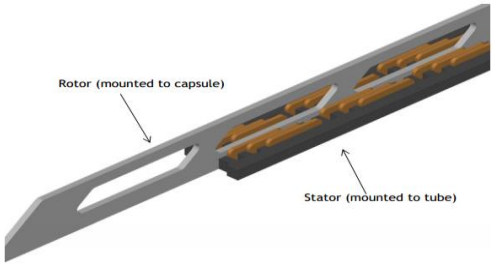

Fig-6: Propulsion [6]

6. WORKING OF HYPERLOOP SYSTEM

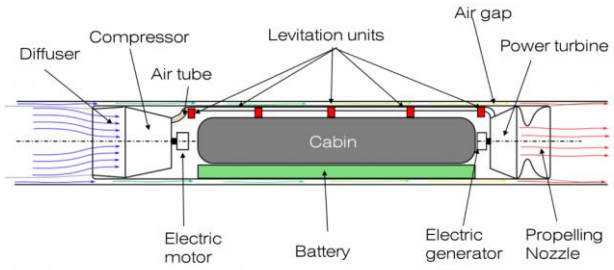

Fig-7: Working of hyperloop system

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

In hyperloop system an air compressor fan is fitted on front side of pod which sucks the air. It transfer high pressure air front side to the rear side of capsule (pod) and it propel the pod. It creates the air cushion around the pod, so that the pod is suspended in air within the tube.

On the basis of magnetic levitation principle the pod will be propelled by the linear induction motor. By the linear induction motor the capsule send from one place to another place to a subsonic velocity that is slower than the speed of sound.

The pod will be self-powered. There is solar panel fitted on top of the tube. By this solar panel there is enough energy is stored in battery packs to operate at night and in cloudy weather for some periods. The energy is also is stored in the form of compressed air.

The air between the capsule acts as a cushions to prevent two capsules from colliding within the tube.

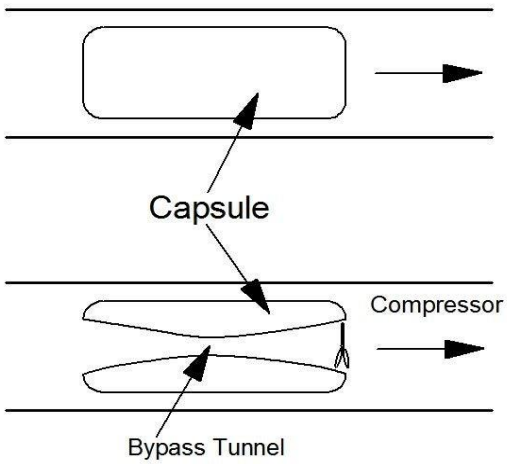

Fig-8: Air through bypass tunnel

In above figure it shown that the air through the compressor is send to a bypass nozzle at the rear end of the capsule. If capsule cover too much area of the tube then, the air is not flow around the capsule and ultimately the entire column of air in the tube is being pushed ahead of the capsule and because of this there is friction between the air and tube walls is increases tremendously. Therefore to avoid this problem the compressor is fitted at the front of the capsule through which the air is flow which will not flow around the capsule and send it to bypass nozzle.

7. MERITS AND DEMERITS OF HYPERLOOP TRANSPORTATION SYSTEM

7.1 Merits:

1. It saves the travelling time.
2. There is no problem of traffic.
3. It is powered by the solar panel.
4. It can travel in any kind of weather.
5. Cost of hyperloop is low.
6. Not disruptive to those along the route.
7. More convenient.
8. Resistance to earthquake.

7.2 Demerits:

1. Turning will be critical.
2. Less movable space for passenger.
3. High speed might cause dizziness in some passenger.
4. Punctured tunnel could cause shockwaves.

8. CONCLUSION

1. A high speed transportation system known as Hyperloop has been developed in this report.
2. Hyperloop transportation system can be used over the conventional modes of transportation that are rail, road, water and air.
3. At very high speed it provides better comfort and cost is also low.
4. By reducing the pressure of the air in the tube which reduces simple air drag and enables the capsule to move faster than through a tube at atmospheric pressure.

9. FUTURE WORK

1. Improve the passenger capacity.
2. Detailed station designs with loading and unloading of passenger
3. Safety features improvement.
4. It can be used in material handling deices.

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