Analysis on technical aspect of a Hyperloop system

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Abstract— **The features of the new transportation technology-Hyperloop is analyzed in this paper. Hyperloop technology is quickly gaining traction in the group of researchers and public as it is faster than trains and aircrafts and safer than road and water transportation. Hyperloop is an ultra-fast vaccum train, which moves on air or magnetic cushion within the tubes with small internal pressure thus reducing resistance to movement. General features as well as technologies, assurance and risk factors are anatomized in the present study. It also inspects the hyperloop routes under construction in India by the Virgin Hyperloop One and Hyperloop Transportation Technology.**

***Index Terms*—Hyperloop, Magnetic Levitation, Resistance, Transportation**

I. Introduction

A pod carrying a bunch of people whizzing through low-pressure tubes at a speed of 1200 kilometers per hour, nearly the speed of sound(1234.8kmph) is the key concept of Hyperloop. Scientist at Tesla Motor & Space X, Elon Musk introduced the Hyperloop, a tube-based transportation mechanism. It relies on the principle of an evacuated tube bearing a capsule that exceeds the speed of the usual mode of transportation. This theory first appeared in the former transportation concept of ETT and Swissmetro [1]. What makes Hyperloop different from other similar transportation systems is the working of air within the tube. The primary resource of information is "Alpha Paper" and the continuing approaches are based on this paper [2]. Many a big name in the Industry had taken up the idea first routed as the brainchild of Elon Musk [4].

II. Features of Hyperloop

Hyperloop is a single framework that combines the vehicle impetus framework, vitality the executives, timing and core. The twin-tube road is used to transport passengers. Among the two tubes, the driving of the capsules happens forward in one while the other tube pulls in the opposite direction [15].

As per the estimate of Virgin Hyperloop One, flight alone produced 859 million metric tonnes of carbon dioxide in 2017 worldwide [3]. According to Virgin Hyperloop One, fossil fuel emission could go down by 58% if each air travel of 310-930 miles speed goes in hyperloop route [5].

Using linear electric motors, vehicle movement is obtained. While the tube incorporates the stationary motor element to power the vehicles, the moving motor is located stationary on the capsule.

The Hyperloop system of transport between cities will be made to stand above a couple of feet from the land on pylons to evade snooping with power lines or public road overpasses. Pylons are fixed on both tubes at a height of 5m in open areas at a distance of 30m between them [2]. Capsules move through this pylon supported tube and can achieve a maximum speed only on a straight path of the road. Deviations potentially result in speed losses.

Though noise is budding distress when introduced, tests of premature phase Hyperloop companies put forward the idea that the hyperloop system would compose a lesser amount of noise compared to what is happening in highways today. The pod's "woosh" reverberation was dampened by the adjoining tube [3].

III. Technologies used for Hyperloop

The two most promising technologies for levitation are EDS(Electrodynamic Suspension) and EMS(Electromagnetic Suspension), currently used in Magnetic Levitation(Maglev) Trains. Yet, these new technologies need to be tested and proven for meeting the operational requirements of a Hyperloop [6].

The LSM(Linear Synchronous Motor) and LIM(Linear Induction Motor) stand out from the rest of the technologies in the field of propulsion. In terms of cost and reliability, LIM performs better even though it falls short of the speed attained by LSM. From the energy consumption point of view, LSM tops the rest [5].

There are so many problems in the existing modes of transportation, for example, capacity shortage, environmental problems, disruptive situations, etc. [5,17].

Artificial Intelligence can be used in many ways in operating the Hyperloop. It can help in areas of design, building, operations, and maintenance. For example, incident detection, safety prediction of system failure, security checking, scheduling, and smooth working of the hyperloop system.

Weight sensors situated along the cylinder would consequently speak with core crisis to convey about slowing mechanisms in case of a huge scale spill [8].

IV. Hyperloop routes in India

Virgin Hyperloop came to India in 2017. There are 5 Hyperloop routes under construction in India. Recent discussions held with both the central and state governments and expecting approval and certification by 2025. For Pune-Mumbai Hyperloop(117.5km), MoU signed in December 2019 with the Punjab Transport Department. It will be the largest private infrastructure investment in Maharashtra by creating around 1.8 million direct and indirect jobs [7]. The other hyperloop routes selected by Virgin Hyperloop One are Amritsar-Chandigarh(226km), Delhi-Chandigarh(240km) and Bengaluru-Kempegowda(40km) and the route selected by Hyperloop Transportation Technology is Anantapur-Vishakhapatnam(700km). In addition, there are planning and discussions carrying on regarding the hyperloop routes from Bengaluru-Chennai(334km), Bengaluru-Trivandrum(736km), Delhi-Mumbai via Jaipur and Indore(1,317km) and Mumbai-Chennai via Bengaluru (1,102km) [18,20].

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V. Assurance and Risk factors

A. Assurance

Hyperloop leads to huge economic growth as it enables more people to work in one city and live in another or visit far of places for social gatherings.

Implement the system at a low cost in design and traveling. Both passenger-only versions, as well as passenger plus cargo version, operates at a very high speed, nearly 1200kmph.

Independent of changing weather conditions like floods, earthquakes and safe from animal attacks and traffic jams.

It has very low power consumption as a solar panel is the major source of energy.

B. Risk factors

Without compromising on safety to minimize the cost of emergency exits, it is better to further study the potential of safe-havens.

It may be an uncomfortable riding experience for passengers due to G-forces and jostling. Moreover, a windowless pod may not produce a joy ride. Individual travelers cannot move openly as it lacks adequate space.

The limited capacity of the pod design requires more number of departures every hour.

The project will be an environmental disaster as huge number of trees need to be cut to bring the project into operation.

Hyperloop Technology Tests and demonstrations carried out so far did not meet the maximum speed and the long run [5-8, 16-19].

VI. Series of events

The series of events taking place during the Hyperloop travel by passengers are shown in Figure1 [7-8,12-15].

Series of events

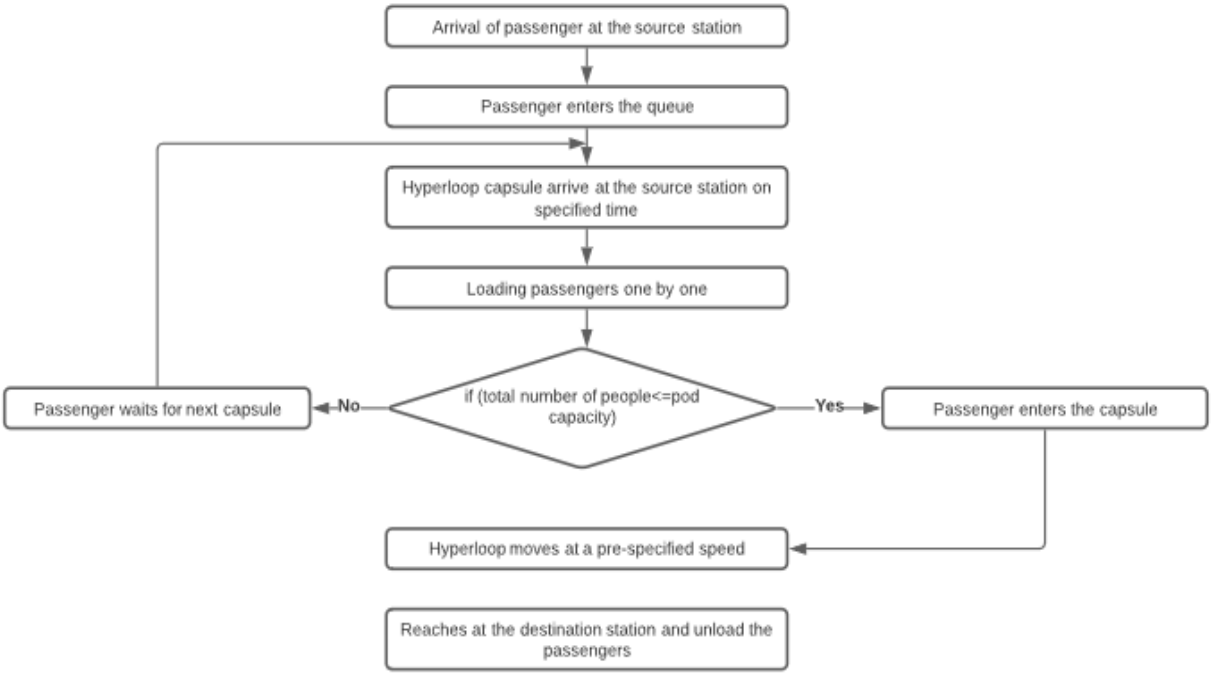

Figure1

1. Passengers who wish to travel through the Hyperloop in the specified route arrive at the source station, purchase tickets and then enter into the queue.
2. Hyperloop capsule arrives at the source station platform at the specified time and the passengers are loaded one by one.
3. Passengers can enter into the capsule until the pod limit is reached. The remaining passengers have to wait for the next capsule.
4. Hyperloop travels through the route at a pre-specified speed with no stops in between the source and the destination.
5. Hyperloop reaches the destination station and parks at the designated platform.

VII. Conclusion

Technology has put forward many advantages for speeding up the life of people. It travels nearly with the speed of sound.

But there are risks also which need to be addressed and the researches are being conducted. Traveling long distances through Hyperloop causes claustrophobic reactions for some passengers and handling the emergency situation has to be ensured by monitoring at regular distances. This paper gives some insight for the new researchers about Hyperloop workings and Technology.

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