

A RESEARCH REVIEW ON MAGNETIC LEVITATION TRAINS

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Abstract- This paper involves the design hardware, technology, application and future uses of “Magnetic levitation trains.” The maglev transportation system is more stable, faster, economic, efficient. Maglev systems are currently in use for applications such as bearings, high- speed trains, and manufacturing. Maglev is a method of propulsion that uses magnetic levitation to propel vehicles with magnets rather than with wheels, axles and bearings. With maglev, a vehicle is levitated a short distance away from a guide way using magnets to create both lift and thrust (levitation would not exceed above 10 centimeters). In future these High-speed maglev trains would give a huge competition to the aviation industry.

Keywords: Electrodynamic suspension, Electromagnetic suspension, Induct rack, Evacuated tubes, stability, propulsion, Guidance, magnetic induction.

1. INTRODUCTION

Maglev trains move more smoothly and somewhat more quietly than other conventional trains. And, they do not rely on traction or friction, their acceleration and deceleration are faster than conventional trains, they are unaffected of weather. The power needed for levitation is not at all the large amount of the overall energy consumption; most of the power in these trains are used to overcome air resistance (drag), as with every high speed form of transport .These trains can move continuously high speeds than the conventional trains ,they hold Shwetha singh (1) explains about the Magnetic levitation has a very advanced and efficient technology. We can use of it in industrial purpose as well as in office and homelike as the fan in buildings, transportation, weapon (gun, rocketry), nuclear reactor, use of elevator in civil engineering, toys, pen. So it has many applications which are using in the whole world. It gives the clean energy and it’s all application gives the lack of contact and thus no friction. Magnetic levitation improves efficiency and life of the system. It reduces the maintenance costs of the system. With the help of in this paper we tried to explain the advantage of it and the need of it in future engineering and the world. So we can say it is the future of flying trains and cars. The fastest means of rail transportation.

2. MAGLEV TECHNOLOGY

This technology uses monorail track with linear motors, these trains move on special tracks rather than the mainstream conventional train tracks. They use very powerful electromagnets to reach at higher velocities (Fig. 2.1). They float about 1- 10 cms above the guideway on a magnetic field. These trains are propelled by the guideways. once the train is pulled into the next section the magnetism switches so that the train is pulled on again. The electro magnets run the length of the guideway.



Fig. 2.1 Maglev Trains in Japan

2.1 Types of Maglev Technology

- Electromagnetic Suspension
- Electrodynamic Suspension
- Inductrack System

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2.2 Electromagnetic Suspension

In this system Electromagnets are attached to the train and also attached to the guide way track. They have ferromagnetic stators on the track and they help them to levitate the train. They have guidance magnets on the sides of the track they are laid complete along the track. A computer is used to control the height of levitation of train they make us levitate about (1 – 15 cms). The Max speed these trains could reach is about 438km/hr they are fast and give good competition to aviation industry . They have on-board battery power supply which gives surplus amount of energy required to run a cabin.

H. Yaghoubi and H. Ziari (Magnetic fields inside and outside the vehicle are less than the electronic dynamic suspension; is proven, commercially that available technology can attain very high speeds ; no wheels, secondary propulsion system are required .due to the system's instability and the required constant corrections by outside systems, vibration issues may occur.

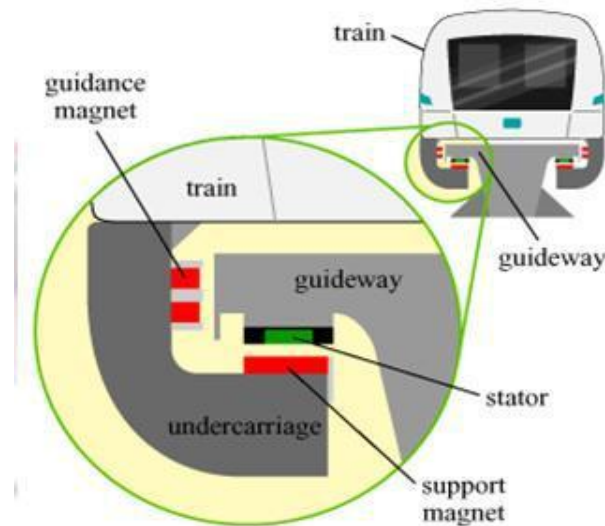


Fig.2.2 Electromagnetic Suspension

2.3 Electrodynamic Suspension

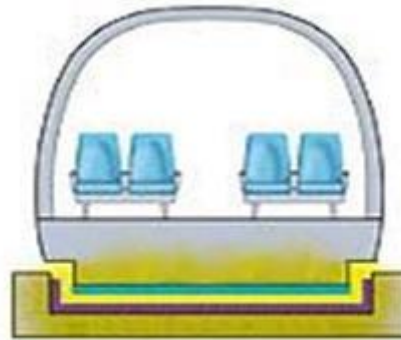
H. Behbahani, H. Yaghoubi, and M. A. Rezvani, (2) as per this system Supercooled, superconducting magnets are placed under the train. By this system the train could Levitate about 10 cm. The magnetic field which helps the train to levitate is due to use of superconducting magnets. If these permanent magnets are placed array they would also be used as Inductrack system. The force in the track is created by induced magnetic field in wires or conducting strips in the track. In electrodynamic suspension (EDS), both the guideway and the train exert a magnetic field, and the train is levitated by the repulsive and attractive force between these magnetic fields.

EDS systems have a major downside as well. At slow speeds, the current induced in these coils and the resultant magnetic flux is not large enough to support the weight of the train. For this reason, the train must have wheels or some other form of landing gear to support the train until it reaches a speed that can sustain levitation. Since a train may stop at any location, due to equipment problems for instance, the entire track must be able to support both low-speed and high-speed operation. Another downside is that the EDS system naturally creates a field in the track in front and to the rear of the lift magnets, which acts against the magnets and creates a form of drag.

H. Behbahani, H. Yaghoubi, and M. A. Rezvani, (7) explained the name maglev is derived from MA Gnetic LE Vitation. Magnetic levitation is a highly advanced technology. It has various uses, including clean energy (small and huge wind turbines: at home, office, industry, etc.), building facilities (fan), transportation systems (magnetically levitated train, Personal Rapid Transit (PRT), etc.), weapon (gun, rocketry), nuclear engineering (the centrifuge of nuclear reactor), civil engineering (elevator), advertising (levitating everything considered inside or above various frames can be selected), toys (train, levitating spacemen over the space ship, etc.), and stationery (pen). The common point in all these applications is the lack of contact and thus no wear and friction. This increases efficiency, reduces maintenance costs, and increases the useful life of the system. The magnetic levitation technology can be used as an efficient technology in the various industries. There are already many countries that are attracted to maglev systems. Many systems have been proposed in different parts of the worlds. This paper tried to study the most important uses of magnetic levitation technology. The results clearly showed that the maglev can be conveniently considered as a solution for the future engineering needs of the world.

Onboard magnets have large margin between rail and train they enable highest recorded train speeds (581 km/h (361 mph)) and heavy load capacity; has demonstrated successful operations using high-temperature superconductors in its onboard magnets, cooled with inexpensive liquid nitrogen. Strong magnetic fields on board the train would make the train inaccessible to passengers with pacemakers or magnetic data storage media such as hard drives and credit cards, necessitating the use of magnetic shielding; limitations on guideway inductivity limit the maximum speed of the vehicle; vehicle must be wheeled for travel at low speeds. As per fig. 2.3.

ELECTRODYNAMIC



Electromagnets on the guideway levitate the car.

Fig. 2.3 Electrodynamic Suspension

2.3 Inductrack System (Permanent Magnet Passive Suspension)

It is a fail suspension system, no power is required to activate magnets; Magnetic field is located below the car; they can generate enough force at low speeds (around 5 km/h (3.1 mph)) to levitate maglev train; In case of power failure cars slow down on their own safely; permanent magnets are arranged in an array which helps in propulsion of the trains. They require either wheels or track segments that move for when the vehicle is stopped. Neither Inductrack nor the Superconducting EDS are able to levitate vehicles at a standstill, although Inductrack provides levitation down to a much lower speed; wheels are required for these systems. EMS systems are wheel-less.

3. DEVELOPMENT OF MAGLEV TRAINS

There are different factors which are used in the development of maglev trains, these help in movement, stability, guidance etc of a train.

3.1 Propulsion

H. Behbahani and H. Yaghoubi (6), Some EMS systems such as HSST/Linimo can provide both levitation and propulsion using an onboard linear motor. But some EDS systems and some EMS systems are like they can levitate the train using the magnets on board but cannot propel it forward. As such, vehicles need some other technology for propulsion. A linear motor (propulsion coils) mounted in the track is one solution. As per fig. 3.1.

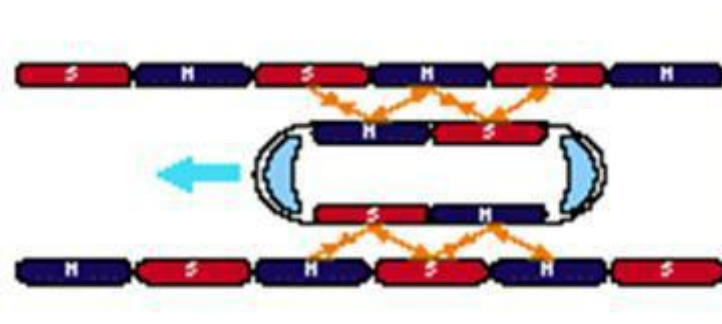


Fig. 3.1 Propulsion

3.2 Stability

As per Earnshaw's theorem, any combination of static magnets cannot be in a stable equilibrium. Therefore, a dynamic magnetic field is required to achieve stabilization. EMS systems rely on active electronic stabilization which constantly measure the bearing distance and adjust the electromagnet current accordingly. All EDS systems rely on changing magnetic fields creating electrical currents, and these can give passive stability. Because maglev vehicles essentially fly, stabilisation of pitch, roll and yaw is required by magnetic technology. In addition to rotation, move forward and backward, sway (sideways motion) or heave (up and down motions) can be problematic with some technologies.

3.3 Guidance

Some systems use Null Current systems (also sometimes called Null Flux systems); they use a coil which is wound so that it enters two opposing, alternating fields, so that the average flux in the loop is zero. When the vehicle is in the straight ahead position, no current flows, but if it moves off-line this creates a changing flux that generates a field that naturally pushes and pulls it back into line. This is the guidance system of maglev trains. As per fig. 3.2.

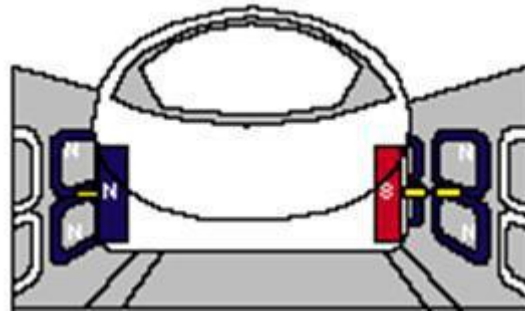


Fig. 3.2 Guidance

3.4 Evacuated Tubes

Some systems (notably the Swissmetro system) propose the use of (vactrain) maglev train technology used in evacuated (airless) tubes, which is used to remove air drag. This has the potential to increase speed and efficiency greatly, as most of the energy for conventional maglev trains is lost due to aerodynamic drag. One potential risk for passengers of trains operating in evacuated tubes is that they could be exposed to the risk of cabin depressurization unless tunnel safety monitoring systems can repressurize the tube in the event of a train malfunction or accident.

3.5 Power and Energy Usage

Energy for the maglev trains is used to accelerate the train, and the power could be regained when the train slows down ("regenerative braking"). It is also used to make the train levitate and to stabilise the movement of the train. The main part of the energy is needed to force the train through the air ("air drag"). Also some energy is used for air conditioning, heating, lighting and other miscellaneous systems.

At low speeds the percentage of power (energy per time) used for levitation can be significant consuming up to 15% more power than a subway or light rail service. Also for very short distances the energy used for acceleration might be considerable. But the power used to overcome air drag increases with the cube of the velocity, and hence dominates at high speed.

4. COMPARISION WITH CONVECTIONAL TRAINS

Conventional railway is probably more efficient at lower speeds. But due to the lack of physical contact between the track and the vehicle, maglev trains experience no rolling resistance, leaving only air resistance and electromagnetic drag, potentially improving power efficiency. Some systems however such as the Central Japan Railway Company SCMaglev use rubber tires at low speeds. The weight of the electromagnets in many EMS and EDS designs seems like a major design issue. A strong magnetic field is required to levitate a maglev vehicle. For the Transrapid (German maglev), this is between 1 and 2 kilowatts per ton. Another path for levitation is the use of superconductor magnets to reduce the energy consumption of the electromagnets, and the cost of maintaining the field. Most energy use for the TRS is for propulsion and overcoming the friction of air resistance at speeds over 100 mph. Convectional trains would weigh less than maglev. Because the major source of noise of a maglev train comes from displaced air, maglev trains produce less noise than a conventional train at equivalent speeds. However, a study concluded that maglev noise should be rated like road traffic while conventional trains have a 5–10 dB "bonus" as they are found less annoying at the same loudness level. Maglev design eliminates the use of braking and overhead wire unlike the convectional one „s, they get their electrical supply from ground, their design is so aerodynamical that they reach about 300 mph very fast than the convectional high speed trains.

4.1 Control Systems

There are no signalling systems for high or low speed maglev systems. There is no need since all these systems are computer controlled. Besides, at the extremely high speeds of these systems, no human operator could react fast enough to slow down or stop in time. This is also why these systems require dedicated rights of way and are usually proposed to be elevated several metres above ground level.

Two maglev system microwave towers are in contact with an EMS vehicle at all times for two-way communication between the vehicle and the central command centre's main operations computer. There are no need for train whistles or horns, either.

4.2 Flexibility and Reliability

Aircraft are theoretically flexible but commercial air routes are not. High-speed maglevs are designed to compete on journey times with flights of 800 kilometres (500 miles) or less. Additionally, while maglevs can serve several cities in between such routes and be on time in all weather conditions, airlines cannot come close to such reliability or performance. Because maglev vehicles are powered by electricity and do not carry fuel, maglev fares are less susceptible to the heavy price swings created by oil markets. Travelling via maglev also offers a significant safety margin over air travel since maglevs are designed not to crash into other maglevs or leave their guideways. Aircraft fuel is a significant danger during takeoff and landing as there are chances for accidents. In real-world situations the speed of maglev are less than aircraft, but maglev still save time due to less number of hurdles it takes to travel in them as compared to air travel. With air travel, people need to spend time at airports

for check-in, security, boarding, etc. In air travel, time is also consumed (primarily in busy airports) by the aircraft for taxiing, waiting in queue for take-off and landing, which are negligible in case of maglev.

5. RESULTS AND DISCUSSIONS

Magnetic levitation trains have a lot of applications and advantages like they are fast exceeding the speed of 300 mph. it has no fuel consumption, cost is cheaper than flights, faster, effective, less maintenance. used in transport both passenger and goods, no fossil fuel used, less noise, takes less space than conventional trains.

CONCLUSION

These trains consume very less energy compared to conventional trains. They require no large engine kind of stuff as they run using linear motors. They Move a lot faster than normal trains because they are not affected by ground friction; they would only have air resistance or drag resistance. They are incompatible with existing rail lines because they need a separate track to levitate, unlike the traditional high-speed trains. Initially the cost is very high but it may decrease in near future.

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