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Advance Electric Traction System

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Abstract: The study analyses railway traction duty, providing an overview of the many types of railway traction machines and discussing the various ways for supplying and managing tractive effort for both loco-hauled and multiple unit trains. Railway transportation offers a large increase potential of transportation process energy efficiency at the realization of a variety of energy saving events. Electric traction is a type of locomotion that uses electric motors to provide driving power. It entails the use of electric power for traction systems, such as railways, trams, and trolleys. Around the world, there is a vast range of electric traction systems that have been designed based on the type of railway, its location, and the technology available at the time of the installation. Here we explore the need for electric railways, the entire process, how it works, the benefits and drawbacks, and the conclusion of electric traction. The paper concludes with a synopsis of the basic characteristics of railway traction power suppliers.

Keywords: Electric Traction, AC Locomotive, Railway, AC Traction, DC Traction, Composite System.

I. INTRODUCTION

The primary purpose of railway power supply systems is to efficiently and affordably provide electric energy to the electric locomotives linked to the system. Railway systems are an essential component of contemporary, high performing transportation systems due to their capacity to convey huge numbers of passengers in both urban and rural settings. When moving, electric traction uses electric motors to provide the driving force. The first electric railway was established in 1881 and was operated by German engineer Werner Van Siemens. The electric traction was initially introduced by Italian Railways. The first electric train between Bombay's Victoria Terminus and Kurla ran in 1925, marking the introduction of electric traction on Indian Railways. An energy-efficient, pollution-free, and environmentally beneficial alternative to fossil fuels is electric traction. The introduction of electric train services between Bombay VT and Kurla Harbour on 1500 Volt DC marked the beginning of electric traction in India in 1925. The main determinant of railroads competitiveness in the local and international markets for transportation services in modern times is energy efficiency [1]

Currently, 28% of Indian Railways' route kilometres are electrified. Later, IR added 3000 Volt DC, and once 25 kV AC traction emerged as a cost-effective method of electrification around the world, IR decided to adopt 25 kV AC traction as a standard in 1957, initially consulting with SNCF (French Railways). Railway firms are motivated by their corporate and social responsibility responsibilities, which frequently have goals for increased energy usage, in addition to dealing with the unpredictability in the energy market. The passengers' and customers' expectations of efficient functioning are complementary to this criterion. These elements have affected railway operators' research into emerging technology and adoption of novel energy-saving techniques. The importance of those that have no impact on performance or capacity is crucial.

II. LITERATURE SURVEY

In this analysis, the traction system was used to analyse the current trend in energy generation from renewable sources (such wind energy). showcase a little conventional source. By burning diesel fuel, environmental pollution will rise. Additionally, harnessing wind energy reduces pollutants and improves efficiency. In this procedure, the power grid synchronises frequency and connects the wind energy system to the network. Grid supply for the traction system's locomotive load. the 25 KV was used to supply the power. This system operated at extremely high voltage and power. Nearly 8% of India's traction system is powered by renewable energy sources. This essay examines a crucial strategy for interconnecting renewable energy sources. Using wind energy in conjunction with a traction system reduces environmental pollution while increasing productivity with the aid of a synchronised grid. And the information obtained on the output waveform Torque speed in this study is highly trustworthy. Compared to other source traction systems like (distal), it is more effective. This technique made use of a wind turbine, a DFIG, a converter, and other basic materials to

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create an electric traction system for the Indian railway. The DC motor is used by locomotives. Wind energy is converted to electricity using a doubly fed induction generator [2]

The study discusses the peculiarities of railway electric transport systems electric power supply, as well as the methodology for monitoring and evaluating electricity costs in order to develop effective methods for decreasing losses and, implicitly, the cost of energy. The analysis demonstrates that, due to the lack of PF compensation, the share of reactive energy price is significantly more than the share of active energy price. The proposed methodology and software module are valuable tools for calculating and visualising active and reactive power consumption per hour, week, month, and year, as well as the energy price, based on the recorded energy and reactive energy measurement values in the common coupling point [3]

An example of a traction motor control system for a metro power supply system is described in the article. The underground electrical power supply system's subsystem has been built as the model. Electric motor design considerations were made when the model was being created. The simulation was created after making a load calculation for electric motors. The electric motor starting and brake subsystem model enables the use of all of its power settings. Oscillograms of the motor starting and braking were obtained after the model was examined. The functions of the operator controller and the subway car rheostat controller are realised in the model to operate the subway vehicle subsystem. The underground car's power circuits are controlled by the driver's controller [4]

When a variety of energy-saving events are implemented, the railway transportation has a considerable potential to boost the energy efficiency of the transportation process. This is because utilising potential energy storage systems could boost the efficiency of regenerative braking used on electric train stock. With the aid of the suggested calculation's order, the authors of this article present simulation modelling findings of the interaction of the electric rolling stock and the electric traction system. The created model was tested using operational data related to the operation of the electric rolling stock in the MATLAB matrix system.[5]

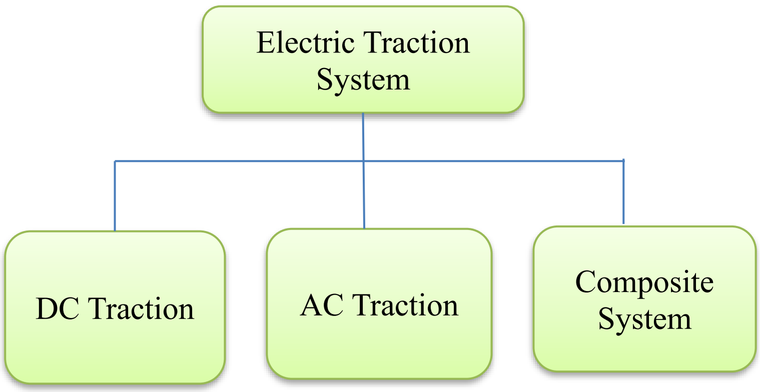
This paper's major goal is to develop suggestions for increasing the energy economy of rail vehicles with multimotored electrical traction when they are operating at partial load. The dependence of the coefficient of performance (COP) to the traction power for electric locomotives (supplied from AC and DC networks) was discovered by processing the data from an on-board recorder. This dependency's interpolation was derived analytically. Then, a formula was developed to control the number of traction motors, ensuring that the COP of the electric locomotive remains stable over the full range of loads. A train model made of a locomotive and numerous carriages in numerical form was constructed to test this algorithm.[6]

III. THEORY

3.1 Electric Traction System: -

Traction is the process of pulling something across a surface, particularly a road or track. Electric traction is the process of pulling vehicles with electric power from overhead wires, third rail, storage batteries, or diesel generators mounted on the trucks. Electric traction, to put it simply, is the term for a traction system that runs on electricity. Electric trains, tramcars, tram buses and other types of hybrid vehicles all frequently employ the electric traction technology.

3.2 Types of electric Traction:



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3.3 DC Traction System: -

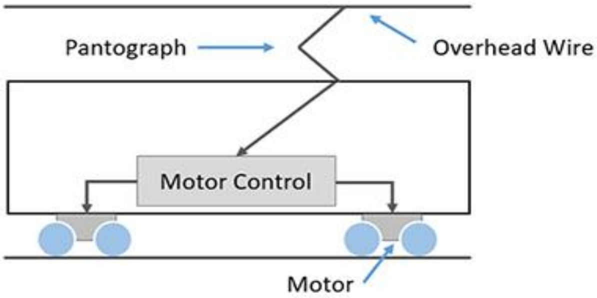

Fig1.DC Traction System

The term "DC traction system" refers to a traction system that uses DC series motors to power electric trains. For main line service, substations are positioned at a distance of 15 to 30 km, while urban and suburban heavy traffic requires a substation distance of 3 to 5 km.
Many benefits come with choosing a DC electrification system, including considerations for weight and space, quick acceleration and braking of DC electric motors, lower cost than AC systems, reduced energy use, and more. The rectifiers and power-electronic converters in this type of system de-escalate the three-phase power that is received from the power grids to low voltage and convert it into DC.

The vehicle receives this type of DC power in one of two ways:

- The third and fourth rails in the system run at modest voltages (600–1200V).
- High voltages are used in overhead rail systems (1500-3000V).

The supply systems of DC electrification include;

- 300-500V supply for the special systems like battery systems.
- 600-1200V for urban railways like tramways and light metro trains.
- 1500-3000V for suburban and mainline services like light metros and heavy metro trains.

The DC series motors are widely used in the DC traction systems due to their high starting torque and gentle speed control. At low speeds, they deliver tremendous torque, and at high speeds, low torque.

Advantages of DC traction system: -

- In case of heavy trains that require frequent and rapid accelerations, DC traction motors are better choice as compared AC motors.
- DC train consumes less energy compared to AC unit for operating same service conditions.
- The equipment in DC traction system is less costly, lighter and more efficient than AC traction system.
- It causes no electrical interference with nearby communication lines

3.4 AC Traction System: -

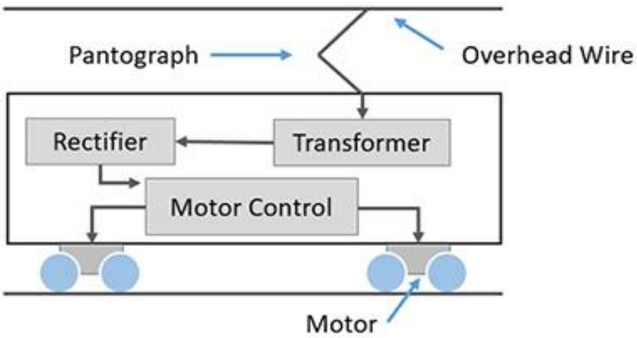

Fig2.AC Traction System

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An AC traction system is very popular nowadays, and it is more commonly used in most traction systems due to several advantages, such as quick availability and generation of AC that can be easily stepped up or down, easy controlling of AC motors, fewer substations required, and the presence of light overhead catenaries that transfer low currents at high voltages, among others. AC electricity supply systems include single-phase, three-phase, and composite systems.

The single-phase systems have an 11 to 15 KV supply running at 16.7 Hz and 25 Hz to allow AC commutation motors to run at varied speeds. In order to convert from the high voltages and fixed industrial frequency, it makes use of step-down transformers and frequency converters. The most widely utilised arrangement for AC electricity is single phase 25KV 50Hz. Since it doesn't require frequency conversion, it is utilised for heavy haul networks and main line services. One of the most popular forms of composite systems, it converts the supply to DC in order to power DC traction motors.

The locomotive is powered by a three-phase induction motor with a 3.3-KV, 16.7Hz rating in a three-phase system. Transformers and frequency converters adapt the high-voltage distribution system at 50 Hz supply to this electric motor rating. This system uses two overhead wires, with the track rail constituting a separate phase. However, this creates numerous issues at intersections and crossings.

Advantages of AC traction system: -

- Fewer substations are required.
- Lighter overhead current supply wire can be used.
- Reduced weight of support structure.
- Reduced capital cost of electrification.

3.5 Composite System: -

Composite System (or multi-system) trains are utilised to offer continuous service along electrified routes that employ more than one system. Changing locomotives at switching stations is one way to accomplish this. Overhead wires at these stations can be switched from one voltage to another. Another option is to utilise multi-system locomotives that can operate at a variety of voltage and current levels. Four-system locomotives are common in Europe. (15 kV 1623 Hz AC, 25 kV 50 Hz AC, 1.5 kV DC, 3 kV DC).

Examples of Electric Traction System: -

- Railway electrical locomotives
- Battery driven road vehicles
- Petrol, diesel trucks and buses
- Tramways and tramcars
- In small ships

IV. FUTURE SCOPE

According to 10% of the world market, the Indian railway market will be the third largest in five years, and metro rail will account for 70% of that market. Due to population growth and economic growth, India's demand and supply for power are in balance. We must create eco-friendly cities with more public transport in order to address the issue. The extension of the metro rail network results from this demand.

V. CONCLUSION

In comparison to steam and diesel locomotives, electric locomotives are more effective. Utilising electric power for traction systems, such as trolleys, trams, and railroads, is known as electric traction. comprehending the fundamental laws of motion is the first step in comprehending the needs and operating principles of an electric traction system. The overall tractive effort vs. speed characteristics are still largely the same as in the early days of electric railways, and train services are subject to the same restrictions, such as adhesion and power limits, despite recent significant advancements in the capabilities of power electronic converters and microprocessor controllers. The authors of this text have made an effort to introduce these fundamental elements. In comparison to steam and diesel locomotives, electric locomotives are more effective. Utilising electric power for traction systems, such as trolleys, trams, and railroads, is known as electric traction. comprehending the fundamental laws of motion is the first step in comprehending the needs and operating principles of an electric traction system. The overall tractive effort vs. speed characteristics are still largely the same as in the early days of electric railways, and train services are subject to the same restrictions, such as adhesion and power limits, despite recent significant advancements in the capabilities of power electronic converters and microprocessor controllers. The authors of this text have made an effort to introduce these fundamental elements.

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