



Hotel Load in Indian Railways: Energy Conservation in EOG Scheme

Anula Khare and Saroj Rangnekar**

**Department of Energy, Maulana Azad National Institute of Technology Bhopal, (MP)*

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ABSTRACT : Fast life and increase in per capita income in India poses ever-growing demand for foremost and convenient train services. Increased numbers of coaches in complete air-conditioned coach trains having End-On-Generation rakes (EOG) need higher capacity Diesel Generator (DG) sets to meet hotel load. In order to improve system efficiency system losses need to be reduced. This paper discusses the comparative study and present status of power supply arrangement for hotel load in Indian railway. Subsequent to that role of power factor in EOG rakes has been discussed. EOG arrangement is becoming dominant as power supply system for hotel load and power factor is a major factor which affects efficiency, performance and energy conservation of the system.

Keyword : Hotel load, self generating unit, end on generation, power factor, energy conservation.

I. INTRODUCTION

Electrical energy in railways is needed for feeding hotel load, apart from the energy required for traction purpose. Coach lighting, fans, mobile and laptop charger, air conditioning equipment, pumping, hot plates, bottle coolers, water boiler, refrigerators, battery charger for emergency light, radiator motor and distribution transformer, these loads are collectively described as hotel load [2].

Train lighting by electricity was first introduced on Indian railways in 1897. In the olden days the passenger trains in India used to have 7 or 8 coaches hauled by steam locomotive and those coaches were divided into I class, I classic class and inter class. I class had number of light and fan points, II class had half of I class, inter class had much less than II class and III class had only 2 light points near the door. After independence, in the I parliament meeting in 1952, a resolution was passed that passengers travelling in III class should also have sufficient lighting, fan and water in toilet, accordingly this work was completed in 3 years. Train lighting system of that time consisted of axle driven generator working in conjunction with 24 volt battery and switch gear. This system was good but all wiring and switchgear parts were made of heavy copper content, to avoid theft it was replaced by aluminum and brass equipments were replaced by galvanized cast iron [9].

In today's era scenario has changed a lot. Improved luminaries are used not only for providing sufficient illumination but for indication purpose also. More emphasis is being given to air conditioned coaches. Trains are equipped with pantry car and other facilities. Power supply system is endorsed to perform with reliability.

II. CLASSIFICATION OF TRAIN SERVICES

Train services on the basis of power supply arrangement for hotel load can be classified as follows. Power requirement

varies for type of coach being used, and is maximum for air conditioned coach.

A. Self generation type

In this system two alternators are suspended from a bracket welded on bogie transform and driven by two axle mounted pulleys by means of a set of 'V' belt drive system. The alternators have double ended shafts with deep 'V' groove pulley at both ends which are driven by two axle mounted pulleys by means of a set of endless V-belts of 'C' section. The belts are rubber reinforced with polyester cord and are of low stretch type. The three phase output from the alternators are brought out from bogie area by means of conduits to the rectifier regulator, which are suspended from the under frame [7].

In all types of rectifier regulator (transformer controlled or magnetic amplifier) facility exists for controlling the dc output voltage. This is usually set at 128V (though m/c is designed to work at a voltage up to 130V dc, the setting has to be chosen to suit to a particular service by field trials). For supplying coach load when the train is stationary, 110 V dc battery sets are provided on all Self Generating Unit (SGU). On broad-gauge coaches each set of battery consists of 56 lead acid cells connected in series, housed in two battery boxes and mounted on under frame of these coaches [10].

The dc o/p is paralleled with the battery. A rotary switch in the power panel enables isolation of any one of the alternator in case of defect or fault.

In order to provide for battery charging at the terminal stations or during precooling, coaches are provided with one 200A capacity battery charger. This battery charger takes 415V shore supply through special battery charging sockets mounted diagonally one on each end wall. The battery charger consists of a transformer and a simple diode bridge

rectifier. The secondary of transformer is provided with tap changing arrangements which enable control of dc o/p voltage from 104 V to 140 V dc.

B. Mid on generation (MOG) type

In this system supply is obtained at 110V through one power car in the center having 230 KVA DG sets. This system is used for trains having frequent stops and is most suitable for slow moving passenger trains on branch line. It has centralized control in all coaches. Reduced maintenance is required because of absence of bulky batteries. But the drawbacks are noise and smoke pollution, requirement of electrical staff to operate and maintain the car and reduction in commercial space equivalent to one power car.

C. End on generation type

In case of end-on-generation type power supply coaches are fed by tapping from one of the two feeders of 415 V, 3 \emptyset , 50 Hz, ac emanating from the power car. Two power cars are used at both ends. For providing supply to lights and fans each coach is provided with a step down transformer of capacity 2.5/5 KVA. This transformer steps down the voltage from 415 V, 3 \emptyset , to 110V, 3 \emptyset . 110V ac supply is provided for lamps and fans by connecting them between line and neutral on the secondary side of this transformer.

415 V, 3 \emptyset supply is directly used for compressor motors, the condenser fan motors and heaters installed in the evaporator. The evaporator blower motor is fed at 110V, 3 \emptyset , ac.

A 24 volt emergency battery of 90 Ah capacity has been provided on the under frame along with a battery charger. The battery supplies the emergency lights provided in the coach in the event of power failure.

This system is independent of mode of traction, and has advantage of elimination of bulky batteries and alternators hence reduced dead weight and maintenance. Also system has high reliability due to cent percent standby system. Now days high capacity power cars are being developed, each giving 2500kVA. Shortcomings of this type of system are higher fuel cost, noise and smoke pollution, voltage drop, reduction in commercial space equivalent to two power cars and requirement of more staff to operate and maintain.

D. Head on generation (HOG) type

Under head on generation scheme power can be taken either directly from Over Head Electric (OHE) supply through a separated pantograph mounted on power car or through hotel load winding already provided in some of three phase electric locomotive. In Europe HOG system is already in use for supplying hotel load.[4]

In India Saptagiri Express (12 coaches-9 second class sitting, 1 air conditioned (AC) chair car and 2 sleeper)

operating 2 pairs of daily services between electrified Chennai and Tirupati since 1981 is a train set where power supply for lighting load of 35 KW to the rack is derived from HOG [6].

This system has centralized power distribution for hotel load. It gives pollution free and cheaper power has high reliability and reduced dead weight and maintenance. Unlike EOG and MOG commercial space is not wasted, it gives improved haulage capacity of long trains. It is best suited for modern advanced coaches. But the drawbacks of this system are power interruption of short durations. It requires rake integrity like EOG. Fitness of OHE for multiple raised pantographs is a condition for working. Also safe inter distance between pantographs needs to be specified.

III. MODERN TRENDS OF LIGHTING AND AIR CONDITIONING

Among the classification discussed above SGU and EOG systems are commonly used, SGU for composite coach trains and EOG for complete AC coach trains like Rajdhani, Shatabdi and Garibrath express trains.

Initially incandescent lamps were provided for illumination, which due to their less illumination per watt and higher heat dissipation got replaced by fluorescent tube light. Energy efficient CFL (compact fluorescent light) of further generation replaced FTL, however in recent years there has been a major shift in technology from CFL to LED's which are getting popularity for use. LED based lights is being used for night light fittings, tail light fittings, passenger alarm, berth indication and accident emergency light fitting and it is proposed for their adoption on regular basis after trial [1].

With introduction of more and more fast trains in India, the need of air conditioning has increased not only for improving comfort but also from operating point of view, because due to higher train speeds, the need to avoid opening of windows due to wind resistance considerations also assume importance. Also, in India the temperature varies from 46 degree during summer to 2.7 degree during winter.

Air-conditioning of railway coaches started in 1960's, since then performance of air conditioned coaches on Indian railway has improved tremendously. The air conditioned coach failure per 100 coaches holding has come down gradually from 14 % during 95-96 to 4.8% during April-Sept. 1997. Holding stock of air conditioning coaches has increased steeply over the 3years. It increased from 1367 air conditioned coaches during 1994-95 to 1893 coaches during 1996-97.

IV. ANALYSIS OF EOGRACKS WITH REGARDS TO POWER FACTOR

Rajdhani, Shatabdi, Garibrath are fully air conditioned trains and require more power. Electrical load per coach for EOG system is in the range of 40 KVA for passenger

coaches, 60 KVA for pantry car and 70-80 KVA for generator car. Average AC coach load in summer is 42KW. The load is predominantly reactive in nature. Actual field measurement data in summer and winter condition with full load on indicate that power factor varies between 0.48 (power car with lights) to 0.61 (only power car), being 0.52 for power car and 7 coaches connected. For light load alone power factor is around 0.44 and for light with AC and pantry it is in the range between 0.5 to 0.75. Voltage and current Total Harmonic Distortion (THD) exceed the IEEE limit by 5 to 10% [2] .

Power factor shows improvement with nearly full load on, this condition generally occurs in summer season. Power factor varies with time during 24 hours in a day because of variation of load requirement with time.

A lower power factor demands for larger current for a fixed power, requires large KVA rating of equipments making them larger in size and expensive. Poor power factor gives poor voltage regulation. It prevents full utilization of installed capacity due to reactive power component. Poor power factor increases losses thereby reducing efficiency and adversely affects the life and economy of the system [3].

Time variant load condition of hotel load is responsible for poor power factor, performance of induction motors (which are major parts of air conditioning system as blower, compressor, and condenser) vary widely as regard the value of power factor. Also with only light load 50 KVA transformer operates at lower capacity than rated. Use of fractional horse power motors in pantry equipment also contributes to poor power factor.

Improvement in power factor can be obtained by installing power factor correction device at any location either at each equipment or with every coach or centrally at power car. Power factor correction device has to balance the lagging current. The device could be static capacitors, synchronous condensers or phase advancers. Power factor improvement is also achieved by use of smart converters such as pulse width modulated voltage source converters with high frequency power electronic switches. It is preferred to use electronically switched capacitors in place manual switching during high or fast changing loads [8].

An 800volt, 100KVAR, manually switched power factor correction panel of five stage capacitors installed at one DG set of power car improves the system performance raising the power factor from 0.52 to 0.74 for one power car with 7 to 9 coaches [2].

With more advanced power factor improvement techniques, further improvement can be expected in power factor as well as capacity enhancement and reduction in THD as much as to bring it within IEEE limits. Power factor improvement also affects fuel consumption, because with addition of each rake fuel requirement increases [5].

Maximum possible power factor improvement leads to power saving by 20% and a considerable reduction in cost.

V. CONCLUSION

With advent of recent technologies and increasing number of AC coaches it is expected to give prior importance to energy conservation measures.

Apart from replacement of incandescent lamps by fluorescent tube lights/CFL and HPMV lamps by HPSV/metal halide lamps, natural light and ventilation should be used up to maximum extent. Power factor correction measure is important to achieve economic and efficient operation. Also provision of electronic ballast and fan regulators should be provided. Automation of pumps to reduce pumping hours, provision of frictionless foot valves with pumps, checking and control leakage of compressed air and liquid, allowing minimum number of joints bands in air/water pipe lines should be taken care of. Regular maintenance of equipments ensures high efficiency. Energy efficient air-conditioning system should be used. In case of EOG rakes use of high capacity generator cars helps for reduction in fuel consumption. Generator cars should be switched off at terminal stations. Use of non conventional sources of energy should be encouraged. Training the users for energy conservation and training and awarding staff for energy conservation measures and also conduction of energy audit through expert agencies will be a forward step for energy conservation.

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