Comparative Study of Dc Fast Charging Standards for Electric Vehicles

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***Abstract*:** Electric Vehicles are clean alternatives to traditional vehicles. The presence of quick charging stations for electric vehicles is the elementary aspect in the rise of Electric Vehicles for clean environment. There are various DC quick chargers available in the market such as CCS, CHAdeMO, GB/T, Tesla Superchargers. This paper discusses about the DC quick charger CHAdeMO.

IndexTerms: **Automobile Industry, CHAdeMO, Electric Vehicles, DC Quick charger (DCQC).**

I. INTRODUCTION

Today the world is looking for better, sustainable and environment friendly transportation solutions. One of the front-runners in this area are electric vehicles. The need to switch to electricity as a fuel is strong, but the process of making that switch is slow. The transition from traditional gasoline engine (ICE) vehicles to electric vehicles (EV) has been a gradual process. Electric vehicles can be driven long distance's if sufficient charging infrastructure is available. The difference between an electric and gasoline powered car is that the refuelling infrastructure and also electricity as a fuel is comparatively cheaper than gasoline.

1.1 Necessity of fast DC chargers:

Today's technology supports 2 charging methods: AC onboard charger and DC off-board charger. For charging operations, DC quick chargers usually need more initial investment than AC chargers, but the desired time per charging station is significantly lower as compared to AC chargers.

1.2 Types of DC quick chargers:

Currently, the DC Fast Charging methods being used by electric car manufacturers are CCS, GB/T, Tesla Supercharger and CHAdeMO.

1.3 CHAdeMO:

CHAdeMO is a DC quick charging method for battery electric vehicles. It delivers up to 62.5 kW of high-voltage direct current. CHAdeMO Association defined CHAdeMO as Global Industry Standard.

II. RESEARCH METHODOLOGY

P. Jampeethong et al [1] projected a paper on electric vehicle (EV) fast charger supported by CHAdeMO. Here, the changed PN device has been applied to perform the charging pulses with each positive and negative pulse to realize time needed for an EV that ought to be but half-hour. CHAdeMO protocol has been explained for providing grid-support function. The proposed CHAdeMO modification can allow the EV to perform grid- support function. The experimental validation has also been validated comparing to CC/CV charging mode. The planned pulse technique will modify the check batteries from two-hundredth of state of charge (SOC) to eightieth of SOC faster than standard CC/CV methodology concerning seven min. Moreover, the temperature rise of planned charging technique is a smaller amount than a CC/CV methodology concerning one- degree Celsius. Furthermore, both charging techniques are consumed almost a same level of energy. The experimental results illustrate that the proposed pulse technique and modified PN converter are a promising technique to apply for a quick charger for EVs.

P. Dost et al [2] An analysis of electric vehicles (EVs) dc-quick chargers (DCQC) are mentioned in this paper. This analysis contains a plan for application of a work for (DCQC). This paper conjointly shows security aspects of the DCQC. These are evaluated and exemplary measurements concerning safe usage of a DCQC are bestowed, as well as aspects of varied sides, like safety, insulation and tangency behaviour. Details of the DCQCs charging method, concerning the ability quality in each dc-link and ac gird affiliation are mentioned. Assessments of the potency of completely different power states likewise as assessments of harmonics (up to) high-frequency behaviour in each voltage and current are enclosed.

Kushal Dhawad [3] Charging connectors for Electric Vehicles at charging stations is discussed. Standards of both connectors CHAdeMO and SAE (J1772) are considered. In both the type of connection there is scope for improvement as both are having problem of reduction of harmonics due to switching which will affect the grid efficiency.

Satish Rajagopalan et al [4] proposed a paper on Fast Charging which discusses the findings in depth such as demand charges and installation costs and also provides an update on the standing of DC quick charging connected standards. With the need to handle these shortcomings, EPRI has developed a right away medium-voltage fed all solid-state quick charging system, the Utility Direct Medium Voltage quick Charger (UDFC). Such a system would permit the charging system to be connected on to the medium voltage system, supply multiple ports in order that total charging capability will be showing intelligence shared between multiple vehicles directly, modify installation and increase overall system potency.

Zhipeng Liu et al [5] a mathematical model for the best filler of work unit charging stations are developed with the reduction of total value related to work unit charging stations. A changed primal-dual interior purpose rule (MPDIPA) is employed. During this paper, the target performed is outlined because of the reduction of the whole prices related to work unit charging stations to be planned, together with the investment prices, operation prices, maintenance prices, and network loss prices within the designing amount.

M. M. Rahman et al [6] this paper is planned on Voltage Sensitivity issue (VSF) that is employed to search out the best place for the hybrid electric vehicles (PHEV) charging station. Here a voltage sensitivity analysis-based technique is planned to work out the simplest location for a PHEV charging station in the industrial distribution system. The speed of increase of grid losses and also the most allowable capability also are found satisfactory for the chosen bus.

III. RESULTS AND DISCUSSION

In [1] Fig 1 illustrates the results of standard CC/CV charging mode. Initially, the CC will perform and then the CV mode will operate to avoid temperature rise.

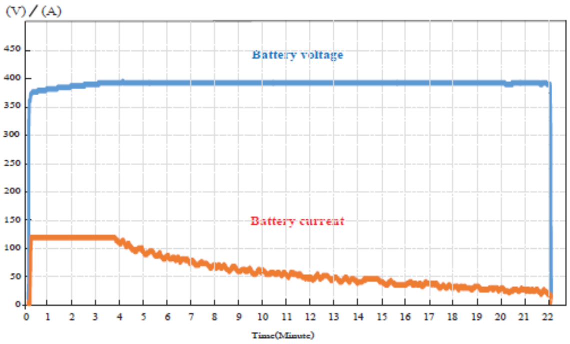


Fig 1. Voltage and Charging current operating in CC/CV charging mode.

Fig 2 illustrates the pulse charging mode, the pulse charging takes place throughout the constant voltage region that isn't over the current limitation.

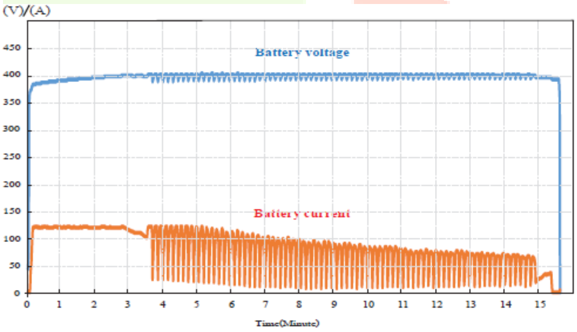
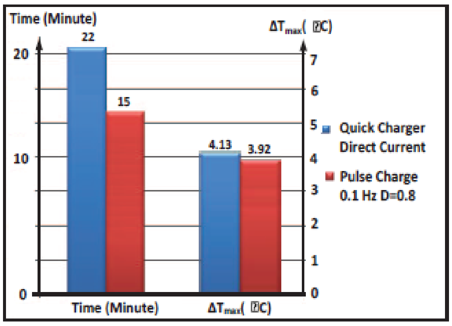


Fig 2. Voltage and Charging current operating in pulse charging mode.

Fig 3 illustrates the time required for CC/CV charging mode is about 22 min and the time required for pulse charging mode is about 15 min. Additionally, the temperature rise of pulse charging technique was about 3.92 °C; whereas, the temperature rise for CC/CV method was 4.13 °C.Fig 3. Comparison of experimental results between CC/CV method and pulse charging method.



In [2] Fig 4 illustrates the schematic diagram of the test bed.

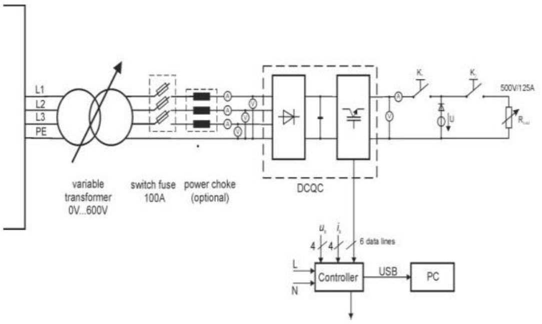


Fig 4. Wiring of DCQC with a test bed.

For safety assessment the insulation test and charging process, a short circuit is initiated within the DC link. The results are shown in Fig 5.

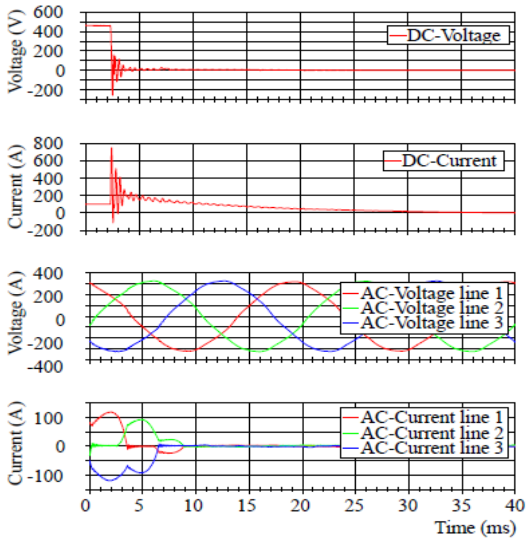


Fig 5. Reaction of DCQC to a short circuit during charging process.

As indicated by CHAdeMO determinations the DCQC has a proficiency of over 90%. At the ostensible point, the surveyed DCQC achieves an effectiveness of up to 94%. However, at the energy of 35.5kW or underneath, the effectiveness declines to beneath 90%.

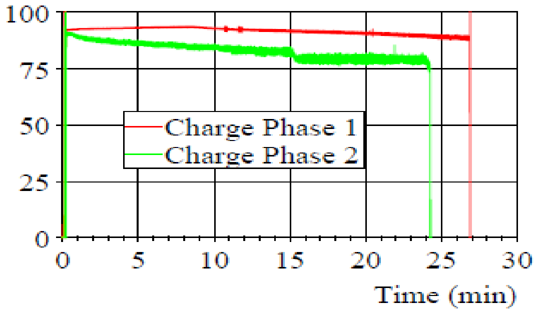


Fig 6. Proficiency of DCQC charging in charging phase1 (S.O.C. 0% to 82%) and phase2 (S.O.C. 82% to 96%).

In [4] Three cases are considered that are, No limit to fast charging, replace the vehicle after fast charging and multicar housing. Results from the three cases foresee that generally unobtrusive quantities of DC quick chargers (from 1 to 5 for each 1000 BEV 100s) are expected to meet common driving conduct needs. Fig 7 demonstrates the outline due to the examination for 50 kW.

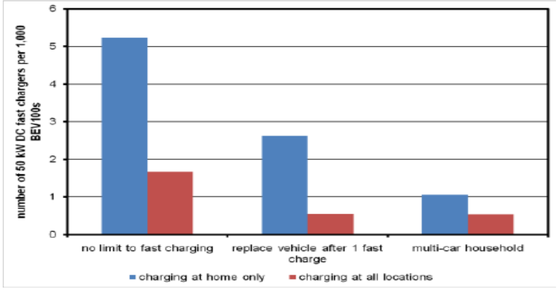


Fig 7. Number of 50kW quick chargers for every 1,000 EV100s for each of the three cases.

In [5] After the EV charging stations' optimal places are determined using the two-step screening technique, the MPDIPA is used to work out the comprehensive model for EV charging stations' optimal capacities. The optimal places and capacities of EV charging stations that have been gathered are shown in Table I. The precise configuration of every EV charging station is shown in Table II.

Table I. Optimal places and capacities of EV charging stations.

Optimal Sites	Optimal Capacities/(kVA)	Type	Total Cost/($)
1	500.00	1	1,313,917.16
31	80.00	3	
39	80.00	3	
87	50.00	3	
107	200.00	2	

Table II. Precise configurations of EV charging stations.

DETAILED CONFIGURATIONS OF EV CHARGING STATIONS

Site	Number of large chargers	Number of medium chargers	Number of small chargers	Number of AC charging points
1	1	2	2	4
31	0	0	2	3
39	0	0	2	2
87	0	0	1	3
107	0	1	2	4

The optimal planning strategy for the EV charging stations listed in Table II

In [6] One of the vital indices to examine system stability or system strength is VSF. The system voltage is reviewed w.r.t. the change in loading as:

$$VSF = \left\| \frac{dV}{dP} \right\|$$

VSF measures the strength of a bus. From Fig 12 it is perceived that the rate of increment in real power and reactive power loss is significantly higher for case 1 and 2. For, case 3 the rate is least. For case 4 the rate is slightly greater than case 3.

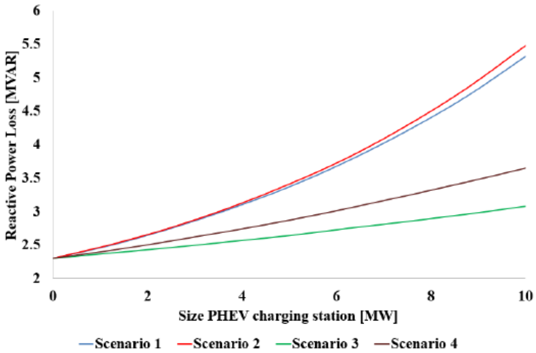
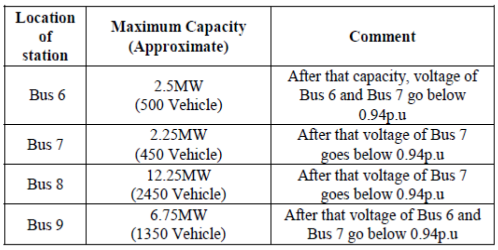


Fig 8. The rate of increment for reactive power loss with increment in size of PHEV charging station.

On the off chance that any parts of the distribution network are not changed or if any new compensator isn't utilized, the proximate maximum capacity of the selected buses is given in Table III.

Table III. Maximum allowable capacity



Location of station	Maximum Capacity (Approximate)	Comment
Bus 6	2.5MW (500 Vehicle)	After that capacity, voltage of Bus 6 and Bus 7 go below 0.94p.u
Bus 7	2.25MW (450 Vehicle)	After that voltage of Bus 7 goes below 0.94p.u
Bus 8	12.25MW (2450 Vehicle)	After that voltage of Bus 7 goes below 0.94p.u
Bus 9	6.75MW (1350 Vehicle)	After that voltage of Bus 6 and Bus 7 go below 0.94p.u

IV. CONCLUSION

The purpose of this paper was to get an idea of the research done in dc fast charging technology (CHAdeMO). From the literature survey, it is observed that CHAdeMO type of fast charger has further scope of improvement. We propose our work on CHAdeMO, for the development of communication between the charger and the vehicle and vice versa.

V. ACKNOWLEDGEMENT

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