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OVERVIEW OF IMPACT OF LIGHTNING ON THE ELECTRIFIED TRANSMISSION RAILWAY SYSTEM ADVANCING THE AREA AND SIZE OF SVC

M.VENKATSUBBA REDDY 1*, Mr. K.JOHN SAGAR 2*

1. *II.M.Tech , Dept of EEE, AM Reddy Memorial College of Engineering & Technology, Petlurivaripalem.*
2. *Assoc.Prof, Dept. of EEE, AM Reddy Memorial College of Engineering & Technology, Petlurivaripalem.*

Abstract:

With expanding spotlight on sparing and also earth well disposed means for mass transportation, railroads are picking up an extraordinary force in numerous nations. Footing burdens are a standout amongst the most troublesome sorts of burdens nourishing by an electrical utility and reasons complexities for the utility as well as for Railway Company. One of the viable answers for enhancing the force nature of the electric railroad is to introduce static VAr compensators (SVCs) in the footing substations. This paper talks about another procedure for controlling SVCs in railroad frameworks with the point of remunerating the voltage drop at the purpose of association of the trains to the railroad principle line. Likewise the area and size of the SVC is advanced by Particle swarm improvement (PSO) calculation. A complete model of the SVC with its control circuit is set up and mimicked by PSCAD program. The reproduction results show proper change in the voltage profile of train in the purpose of association with the railroad fundamental line. Likewise the outcomes demonstrate the capacity of proposed control framework to dispense with the voltage motions.

I.INTRODUCTION

In the year 1752 the considerable researcher named Benjamin Franklin [1] began to comprehend the way of Lightning by basically utilizing the kite and string. He was persuaded with a straightforward examination that the rainstorms have an ability to shape power and the lower side of cloud has negative charge [1] around then. Risky, solid and astounding; lightning is the most known actually happening wonder. The satellites record around 3 million flashes far and wide in one day[1]. The lightning wonder does not happen just on earth but rather it additionally happens on the neighboring planet around us.

The work talked about in this paper gives the fundamental thought of the some common wonder happening around us and its results on the electrical parts or gadgets that are being utilized. Lightning is the most well-known regular wonder; happening in the nature amid thunder storms. The immediate strike of lightning on any electrical component, sources, and so on., which are open under the mists may come about into the harm of gear. In this way, considering its significance in the electrical field it has been chosen for the study.

It was seen that a considerable measure of work is done on comprehension the impacts of lightning over voltages on the transmission lines. The fairly comparable work is finished by and alluded for this venture is finished by Gharehpetian. G and Shahnia. F, Paul. D (2002), Richter and Brizzi (2005), Mamis and Koksal (2001) and so on. For the said creators, the fundamental center was on Iranian framework just. In this paper the DC voltage that is accepted is for nation like UK and India.

In 2007 at IX International Symposium on Lightning Protection Bernhard Richter [2] displayed the utilization of surge arrester in the DC railroad framework. The paper distributed by him provider the thought regarding the establishment point and utilization of surge arresters in dc bolstered railroads.

The same thought regarding this venture was additionally distributed in 25th International System Conference, 2010 [3] by a portion of the analysts in Iran. The paper incorporates the same idea which is talked about above. With the help of ATP programming the analysts have demonstrated the utilization of lightning arrester in the Light Railway transportation framework [3]. The paper demonstrates the outcomes in two cases; including surge arresters situated at different focuses and without surge arresters. As talked about in the paper, lightning strike can influence the railroad framework severely and thus the significance of arresters.

Keeping in mind the end goal to check the impact of lightning over voltages on a DC overhead line power framework reproduction programming was utilized for comprehension the impacts of Lightning. With PSCAD programming the aforementioned targets was accomplished and concentrated on. The specified

programming is quick and in addition precise when it wants the planning of high voltage frameworks. While outlining the framework (DC and AC framework) for railroads a fundamental thought alongside the essential information will be utilized at a sure degree for accomplishing the outcomes.

In segment II, the idea of lightning wonder, the need of security from lightning and the perspectives of distinctive creators about the marvel is examined.

II. LITERATURE REVIEW

Vitality has now turned into the fundamental need of the individual and now the financial advancement relies on upon it. With the disappointment in the supply vitality, numerous present day apparatuses utilized for every day purposes or work may stop. Increment in the populace in late year has additionally expanded the interest of force. So as to give that much measure of force the misfortunes must be minimized. Today transmitting the force with abnormal state of voltages has turned out to be more basic as it prompts least misfortunes with incredible proficiency. In any case, at these high voltages because of some common and manual operations the rate of ascend in undesirable voltage level has been expanded. This ascent in voltage can be brought as over voltages which are for the most part because of the normally happening lightning wonder and because of the exchanging operation when done into the framework like opening or shutting of circuit breakers, flaw and so forth, and some more.

Over voltages created because of the lightning strikes in the DC jolted railroad framework influences [4] the types of gear included into the framework or substation. The over voltages are constrained up to lightning or exchanging as well as there are some different reasons by which transient over voltages can ascend into the framework and may get moved into the running trains [4]. Alternate reasons because of which the over voltage can jump out at the DC zapped railroad is as per the following: -

1. Dc electrical switch operation which makes over voltage more than 2 times of ostensible voltage [4].

2. Curve development because of un-even association of pantograph likewise brings about the arrangement of over voltages [4].

3. Operation of vacuum electrical switch [4].

4. Free contacts in the electrical types of gear [4].

5. Current constraining breakers makes bend which may bring about the over voltage [4]. So as to minimize the impact brought on by lightning, Surge arrester is utilized as a part of practice. The surge arrester ordinarily has taking after trademark which are depicted beneath [4]: - 1) Should not work at the ostensible voltage of the framework and must have least spillage current. 2) Should begin letting so as to work at the once again voltages promptly little increment in its own particular terminal voltage.

3) Energy put away in DC frameworks ought to have the capacity to handle and control.

4) Should bear any barometrical conditions.

5) Should not come up short for the over voltages of the framework.

As talked about in this paper, the transient over voltages can without much of a stretch enter the electrical gear of the footing station. So keeping in mind the end goal to secure the framework all the more viably different establishment focuses are essential to be considered. The establishments focuses are [4]

1) In the traction substation at primary terminal of transformer and rectifier

2) Ac side of the rectifier unit

3) DC side of the rectifier

4) In between the rectifier output and the input to the overhead line of railway

5) Input point coming from overhead lines to the train

III. THE THEORY OF PARTICLE SWARM OPTIMIZATION (PSO)

As of late, various computational procedures roused by natural frameworks are proposed. Illustrations are manufactured neural system (ANN) [24] propelled from the human cerebrum, hereditary calculation (GA) which is roused from the human advancement and Particle swarm streamlining (PSO) that is motivated from the social conduct of winged animal rushing or fish educating. The PSO calculation is a populace based stochastic streamlining system in which the potential arrangements (called particles) fly through the hunt space by

taking after the present ideal particles. This procedure is as indicated by the basic scientific formulae in light of the molecule's position and speed [25]. In each emphasis, the position of every molecule is redesigned by taking after two "best" values. The first is the best experience of every arrangement called pbest. The other "best" esteem is the worldwide best molecule called gbest. Subsequent to discovering these two best values, the molecule upgrades its speed and positions as takes after [25]:

$$V_j^{k+1} = W \times V_j^k + C_1 \times r \times (pbest_j - X_j^k) + C_2 \times r \times (gbest - X_j^k)$$

$$X_j^{k+1} = X_j^k + V_j^{k+1} \quad , j = 1, 2, \ldots, N_{sw}$$

where k Vj is the speed of j th molecule in k th emphasis, k X j is the position of j th molecule in k th cycle, r is an arbitrary worth in the extent [0,1], , are learning components which generally equivalent to 2 and Nsw is the quantity of swarms in the populace.

One huge component of PSO is that it's redundant that the streamlining issue be differentiable in light of the fact that PSO doesn't utilize the inclination of the issue [26]. A percentage of the benefits of PSO in correlation with GA are that PSO is simple execution and less setting parameters. For the most part, PSO can be connected to any sporadic and time variable streamlining issue.

IV. OPTIMIZING THE LOCATION AND CAPACITY OF TCR BY USING PSO

As said beforehand, the principle reason for this paper is to repay the voltage drop of the railroad fundamental feeder utilizing a TCR/FC gadget. In this segment, PSO is utilized to advance the area and size of SVC. For this reason, MATLAB writing computer programs is utilized to decide the best area furthermore the most ideal size of SVC so that the voltages of the trains' association focuses to the railroad principle line don't be under 25.2 kV. In this examination, the development of trains has been considered by assuming that the track areas are isolated into four equivalent segments and the separation between two trains is consistent (equivalent to 18.75 km). The separation of the first train from nourishing substation is changing in the extent 0-18.75 km. With running this project, in every stride, the separation of the first train from bolstering substation is expanded as 1 km and hence toward the end of running the system we have

eighteen distinct areas. In this manner, for every keep running of the project, we will get 72 distinct areas for the trains. Truth be told, the yield of the system is eighteen distinct voltages where each of these voltages is the base voltage between those of four trains at every stride. Minimal voltage of these eighteen trains has been picked and afterward by utilizing PSO, the span of SVC has been figured so that this base voltage doesn't be under 25.2kV. The steps of this algorithm are described at below:

step1: Input information, for example, ‹ and starting molecule's position (introductory area and limit of SVC), and so on; step2: Pick irregular area and limit for every molecule;

step3: Run the heap stream program and register all the level of voltages for all areas; step4: Choose the best area as gbest and the best experience of particles pbest;

step5: Check all parameters to be in the constrained extents;

step6: Run the heap stream program and figure all the level of voltages for all areas; step7: Update gbest and pbest; step8: Check the end criteria of the calculation; If the end rule is met, print the outcomes generally back to step7.

Here, the control variables are the area of trains which is haphazardly fluctuating between 0-75 km and the span of SVC that can take any consistent worth in the scope of 0-20 MVAr. The end standard for the enhancement procedure is to achieve the base voltage of trains at the purpose of association with the railroad principle line such that it doesn't be under 25.2 kV. The dynamic and receptive forces for every train are thought to be separately equivalent to 2.25 MW and 1 MVAr, individually. Table 1 demonstrates the consequence of 10 times running of PSO calculation to acquire the ideal size and area of the SVC. Because of the measurable way of PSO strategy, we have an alternate quality in every running. In Table 1, the parameter is the SVC separation from the primary station (km), is TCR limit (MVAr) and v is the train voltage at the association point to the railroad fundamental line (kV)

V. SYSTEM DESCRIPTIONS

5.1. Single track section

To concentrate on the voltage drop at the purpose of trains association with the

railroad primary feeder, demonstrating a footing framework including a few trains and the compensator (TCR/FC) is vital. In this paper, studies are completed on the 25 kV zap frameworks for principle line railroads (Fig.3).

The single track segment is encouraged trough a solitary stage venture down transformer from the high voltage supply which is displayed by an inductor. As it can be seen from Fig. 3, the entire length of 75 km feeder is just as separated into four sections of 18.75 km such that toward the end of every part would be an association point as a stacking point. Each of these parts is demonstrated by a π-equal circuit (Fig.4) with a longitudinal impedance of (3.17+j0.0258) Ω/km at 50 Hz and a shunt capacitance of 0.375μF/km.

As appeared in Fig.4, the development of train along the railroad line has been displayed by considering the time variable line impedance for the first area. Here, d is the separation of the first train from the feeder area that adjustments in the extent 0-18.75 km. Alternate trains have a consistent separation from one another equivalent to 18.75km. Different train positions conveyed along the feeder framework can be chosen for stu

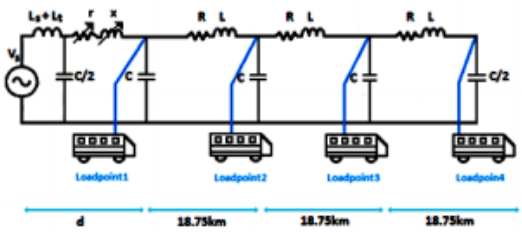

Fig.4. Equivalent circuit of a 75 km track section

5.2. Locomotive Models

Contingent upon the point of studies (voltage drops or music), two distinct models are utilized for train:

• A consistent present, steady power element model, including a solitary diode span which is suitable for voltage regulation recreations;

• A full representation for consonant and element concentrates on. This model is including ordinary thyristor converters which are utilized with postponed terminating to control the current in lower velocity ranges. On the other hand, more often than not these converters work immediately and rate expanding is accomplished by field debilitating [6].

Fig. 5 demonstrates a streamlined model of train that is utilized as a part of this paper. In this model, it is accepted that the transformer voltage proportion is 1:1. The parameters of the railroad framework utilizing as a part of this paper are appeared in Tabl

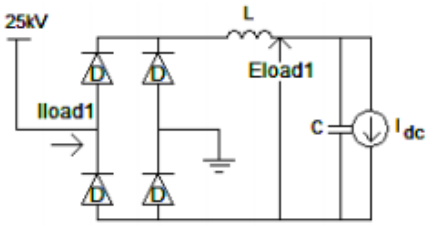

Fig.5. Simplified model of locomotive for voltage drop studies

Table 2. System parameters

Element	Value
Vs	*25.2kV*
Rs + Rt	*1 Ω*
Ls + Lt	*0.0271H*
R (Line Sec.)	*3.17 Ω*
L (Line Sec.)	*0.0285H*
C (Line Sec.)	*0.0375μF*
L (each Loco.)	*0.05H*
I (each Loco.)	*0.068A*

VI. IMPLEMENTATION OF DC SYSTEM IN PSCAD SOFTWARE

For planning this framework into the product, the fundamental thought with a specific end goal to accomplish the DC as the yield is considered which can be found in the square outline drawn beneath.

With the same idea talked about over, another framework was intended to see the impact of lightning on the DC overhead line. For this situation a DC line is to be considered as associated between two substations. Every substation has diverse source however same voltage levels, 3 twisting transformers at every substation with same appraisals and one twelve heartbeat rectifier at every substation.

As per reasonable perspective, the 12 beat rectifier which is to be actualized has certain points of interest and impediments. It has favorable circumstances, for example, it is attainable to diminish the odd request music into the framework yet again the impediment is that monetarily it is costly when contrasted with a solitary 6 beat rectifier. It likewise Increases the extent of the framework. The enhanced circuit which is composed in PSCAD programming is as appeared in the figure beneath,

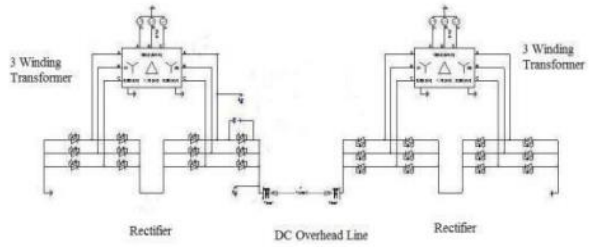

Fig 2: - PSCAD model of DC Electrified system

VII.CONCLUSION

For this paper, the result of lightning over voltage on the railroad overhead lines (DC) which are utilized to supply the trains was examined and talked about. A run of the mill framework plan was planned under the PSCAD programming for this paper. The most extreme issue that influences the supply arrangement of railroad was concentrated on. So as to lessen the misfortunes and any basic conditions which may influence the human life specifically or in a roundabout way, a suitable security system was executed. It can be inferred that when the lightning hits any of the stages on the AC side of footing station the transient overvoltage streams towards the rectifier alongside the impelled voltages in alternate stages which at long last influences the DC overhead line. Likewise the lightning wonder when strikes cause mutilation into the supply voltage which makes further music in the rectifier. It can be likewise said that the line which is hit by lightning builds the flux around it which may make a most extreme power between two lines that can be risky. With the utilization of surge arresters in such framework demonstrates the effectiveness and need in lessening the high voltage surges brought about because of lightning. Additionally the area where the surge arresters ought to be set is of high significance.

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