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Influence of Cross-wind on Pantograph-Catenary Arc

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The pantograph–catenary system plays a key role in the electric energy acquisition for high-speed train. Current constantly flows from the overhead catenary to the pantograph strip installed on the top of locomotive body[1]. With the service speed of high-speed train continuously increasing, pantograph-catenary arc phenomenon occurred frequently. On the one hand, the pantograph-catenary arc could guarantee current to flow from the overhead catenary to the pantograph strip effectively during the pantograph-catenary off-line process. On the other hand, the pantograph-catenary arc is a kind of high temperature plasma. The high temperature arc formed during the ignition process would cause contact surface material to be ablated, produce pantograph catenary electrical wear, have effect on current flow quality, even lead to catenary contact wire disconnection. Pantograph–catenary arc has become an obstacle for the further development of high-speed railway. Therefore, analyzing the arc characteristics of pantograph-catenary arc and exploring the temperature distribution during arc ignition is of great significance. Although some researches concerning gap distances, input current, electrode materials influencing on the pantograph-catenary arc behaviors have studied, the investigations on the influence of cross-wind on pantograph-catenary arc are lacked. Due to the limitation of the experimental conditions, it is difficult to measure the temperature distribution of the arc plasma directly. This paper aims to conduct a numerical study on influence of cross-wind on the PC arc behavior. An improved PC arc model was developed based on the classical MHD theory, with the temporal evolution of PC arc dynamics considered. By using Multiphysics analysis soft COMSOL, electromagnetic equation, hydrodynamic equation and state equation were solved. The temperature distribution of arc plasma, catenary wire, and pantograph strip has been obtained[2]. The detailed pantograph-catenary arc behaviors influenced by cross-wind are represented by the temperature distribution.

We found that the arc root's offset as well as the arc column length increase gradually as the increase of cross-wind velocity. The greater cross-wind velocity is, the larger the pantograph-catenary arc root's offset is in unit time. Due to the influence of cross-wind, temperature distribution range and numerical value of electrodes have obvious differences compared with no cross-wind. We found that the greater cross-wind velocity is, the larger the pantograph-catenary arc voltage is. There are two possible reasons for the increase of pantograph-catenary arc voltage. The first reason is the cross-wind makes the arc column length increase, hence the arc voltage increases. Another possible reason is that the wind blowing makes arc energy loss, arc temperature decrease and the conductivity of arc plasma drop, so the pantograph-catenary arc voltage increases[3]. The simulation temperature distribution appearance is compared with the former related torch plasma arc experimental arc appearance.

References

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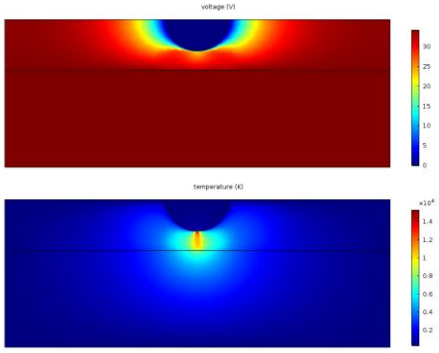

Fig.1. The arc temperature and voltage distribution when cross-wind velocity at 0m/s.

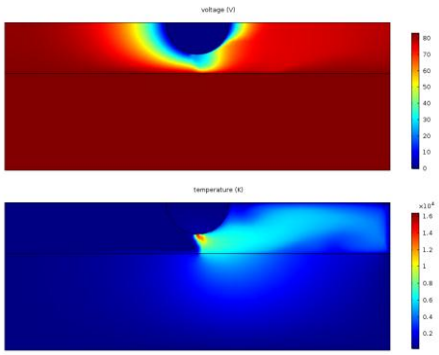

Fig.2. The arc temperature and voltage distribution when cross-wind velocity at 6m/s