processes is 36823.3KJ. In the whole driving cycle, the brake energy takes up 32.6% of the total energy consumption. In the most of the brake process, the electrical brake can be applied.

The brake recycle energy takes up nearly 70% of the total brake energy, while the effective brake recycle energy takes up 26.3% of the total brake energy. Base on this analysis results, the electrical brake system is applied in most of the brake process. In the whole driving cycle, the recycle brake energy used to charge the battery takes up nearly one third of the total brake energy. While the other two thirds recycle brake energy is transferred to the electric consuming brake system which can be used to warm-up the engine, heat the cab and seat of the series-parallel hybrid electric vehicle in order to realize the maximum utilization of the vehicle energy.

This function of electric consuming brake which turns the electricity into heat is very useful for some kinds of vehicle working condition under low ambient temperature, especially for the usage in the high altitude condition. In high altitude areas, the temperature is very low. The air pressure is also very low. Under this circumstance, heating needs to be used widely in the engine cold start, transmission cold start, battery warm-up and cab environment heating. Later on, the more specific and detailed control strategies of the whole vehicle integrated system management aiming at both greater energy saving and better man-machine comfort performance need to be developed.

Simulation results show that the complex integrated brake system and control strategy are effective for the series-parallel hybrid electric vehicle. It not only can ensure the security of the vehicle driving and battery energy storage, but also can enhance the energy utilization and prolong the working lifetime of mechanical brake device in the brake process.

5. Conclusion

The complex integrated brake system with electric consuming brake subsystem and advanced strategy proposed in this paper can fulfill the various brake requirement of the series-parallel hybrid electric vehicle under different driving conditions. In view of the complexity and dynamic characteristics of the different brake conditions, an integrated simulation analysis method based on a coupled vehicle model which combined the driveline model and the thermal management system model is proposed to study the energy flow and utilization of the electrical brake. According to the simulation results under the UDDS driving cycle, the analysis method based on the coupled simulation model can be applied on the dynamic brake traits and energy distribution research for series-parallel hybrid electric vehicle feasibly and effectively.

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7. References

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