150 °C in nominal operation point. Compared to the state of the art (2L-IGBT), this corresponds to an improvement of 2.1 % at 25 °C and 2.7 % at 150 °C. In addition, the efficiency remains almost constant over a large load range between 25 and 125 %.

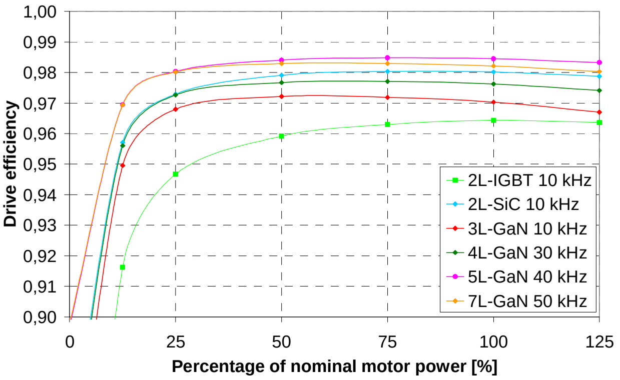

Fig. 18. Efficiency of the power electronic system with inverter and motor filter as function of motor power at 25 °C junction temperature

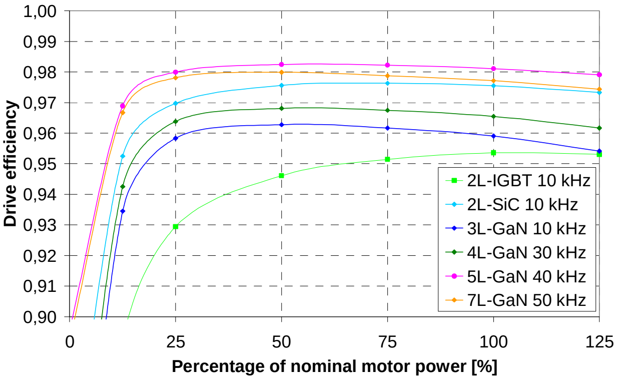

Fig. 19. Efficiency of the power electronic system with inverter and motor filter as function of motor power at 150 °C junction temperature

4. Conclusion

Low-voltage wide-bandgap power semiconductors (SiC MOSFETs, GaN FETs) are now available for multilevel inverters with 560 to 750 V DC link voltages. They have hardly any switching losses, so that very high switching frequencies (several 100 kHz) are possible. With a higher number of inverter levels, the size of the motor filter can be reduced. For the investigated 11 kW induction motor, the five-level inverter with 40 kHz switching frequency is an optimum topology. Volume and weight of the motor filter can be reduced by 86 % and 78 % respectively. The overall efficiency of the power electronic system achieves 98.5 % at 25 °C and 98.1 % at 150 °C junction temperature. Compared to the state of the art (two-level with IGBTs with 5 kHz switching frequency), this is an improvement of 2.1 % at 25 °C and 2.7 % at 150 °C. Moreover, lower inverter power losses would lead to a reduction of cooling effort and to smaller inverter size. The application of multilevel inverters can make a contribution to efficiency improvement in electrical drives for new applications as e-mobility or renewable energy conversion.

References

[1] Floricau, D.; Gateau, G.; Leredde, A.; Teodorescu, R: The efficiency of three-level active NPC converter for different PWM strategies. European Conference on Power Electronics and Applications, Barcelona 2009, Proceedings on CD-ROM..

[2] Lidow, A.; De Rooij, M.; Strydom, J.; Reusch, D.; Glaser, J.: GaN Transistors for Efficient Power Conversion. Third Edition, John Wiley & Sons Ltd. 2020.

[3] Ravyts, S.; Dalla Vecchia, M.; Zwysen, J.; Van den Broeck, G.; Driesen, J.: Comparison between an interleaved boost converter using Si MOSFETs versus GaN HEMTs. International Conference on Power Electronics, Intelligent Motion and Power Quality, Nürnberg 2018, pp. 647–654.

[4] Xu, J.; Chen, D.: A performance comparison of GaN E-HEMTs versus SiC MOSFETs in power switching applications. Bodo`s Power Systems, June 2017, pp. 36–39.

[5] Lei, Y.; Barth, C.; Qin, S.; Liu, W.; Stichwell, A.: A 2-kW single-phase seven-level flying capacitor multilevel inverter with an active energy buffer. IEEE Transactions on Power Electronics, Vol. 32, No. 11, November 2017, pp. 8570–8580.