Numerical routine for magnetic heat pump cascading

Heat pumps use low-temperature heat absorbed from the energy source to create temperature gradient (TG) across the energy sink. Magnetic heat pumps (MHP) can perform this function through operating active magnetic regeneration (AMR) cycle. For building heating, TGs of up to a few K might be necessary, which is hardly achievable with a single MHP and such techniques as cascading are required. Series and parallel cascading increase the AMR span and heating power, respectively, but do not change TG. Therefore, the intermediate type of cascading was proposed with individual MHPs separately connected at their cold and hot sides [1]. In these works, a single MHP is separated into smaller cascaded MHPs with the same total mass. This kind of mass redistribution is hard to implement experimentally since several prototypes with different AMR number and sizes should be constructed. In this theoretical study, instead of changing individual AMR sizes, we rearranged parallel-connected AMRs in separate blocks (HP1, HP2 and HP3 in Fig. 1(a)) and connected the cold (hot) outlet of one block to the cold (hot) inlet of the next block giving a cascading configuration. Thus, not only the total mass but also the total number of AMRs remain constant, making this configuration easier to implement. A MATLAB routine for cascading simulation from a single AMR data was implemented. Calculated heating power for configuration in Fig. 1(a) is plotted in Fig. 1(b) and the cold- and hot-side TGs are around 2 K and 3 K. Changing the number of MHPs, we optimized input parameters to achieve maximum heating powers. We have found that both maximum heating power and COP decrease together with number of heat pumps, but the TGs and the temperature span can be largely increased. References [1] M. Tahavori et al., “A Cascading Model Of An Active Magnetic Regenerator System”, In Proceedings of the 7th International Conference on Magnetic Refrigeration at Room Temperature (2016) 248-251