Numerical routine for magnetic heat pump cascading

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**Motivation**

The possibility of magnetic heat pumps (HPs) industrialization depends on their ability to provide sufficient heating power with competitive COP. Conventional HPs provide from few to tens of kW. To make it achievable with magnetic HPs, we proposed cascading [1], which also may reduce losses, Fig. 1. Here the more practical cascading design is studied: we develop a general numerical routine to model cascading and apply it to a three-heat pump cascade, Fig. 2.

![Pump: Wp~(dV/dt)^3 Wp~(Q/dT)^3](image)

**Numerical routine**

1. MATLAB code calculates thermodynamic properties from a single AMR data precalculated using 1D transient model
2. Different types of connections can be accounted for
3. Modular: components can be integrated into energy models, substituted and scaled

**Example:** heating power of three-HP cascade and comparison to single HP

![Figure 5. Routine results for 3-HP cascade total powers (points), single HP (solid, right) and individual HPs inside 3-HP (solid, left)](image)

**Three-HP cascading system performance**

1. Temperature difference at the HP hot outlet increases approx. 3 times compared to the case with no cascading
2. COP is slightly less than without cascading
3. Heating and cooling powers slightly degrade

![Figure 6. Performance of the three-HP cascading system](image)

**Conclusion**

Calculated increase in temperature difference (3-4 K) is an argument in favor of a magnetic heat pump cascades as possible residential heating systems. Developed numerical routine can be useful in modelling magnetic HPs operation inside target buildings.

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**References**