# Specific absorption rate vs applied frequency in a single multi frequency experiment

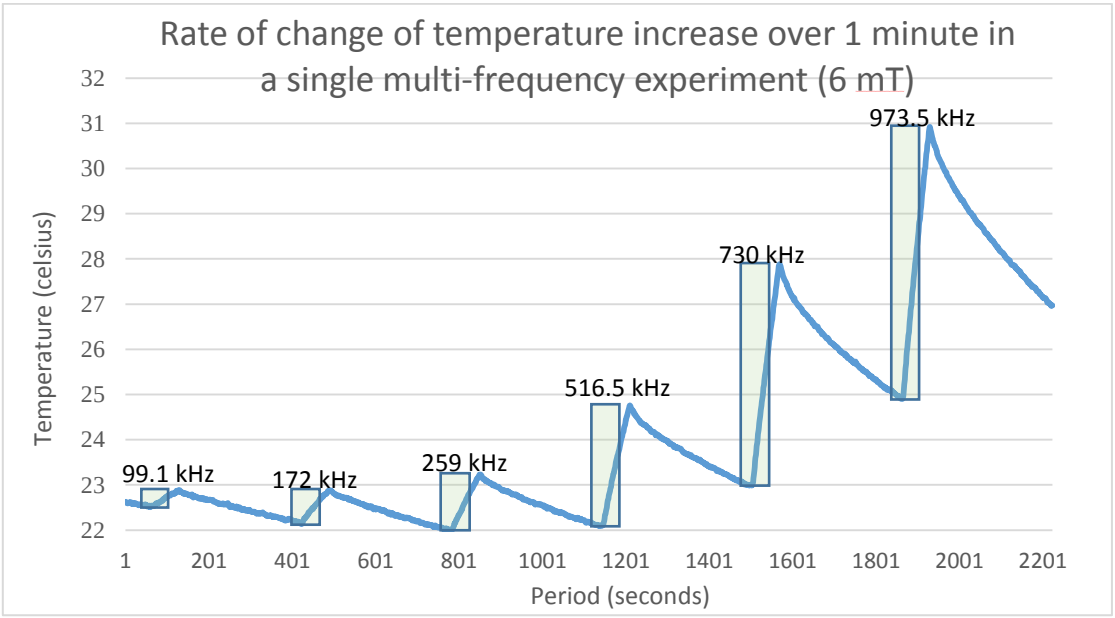
How to benefit from the magneTherm full range of frequencies and corresponding field intensities

It is important to test one parameter when related parameters are kept constant in order to elucidate the effect of that particular parameter in magnetic fluid hyperthermia related experiments. The versatility of settings within the magneTherm system, especially its extensive range of frequencies and variable field intensities allow such sequence experiments to be performed over a lengthy period with minimal user interference.

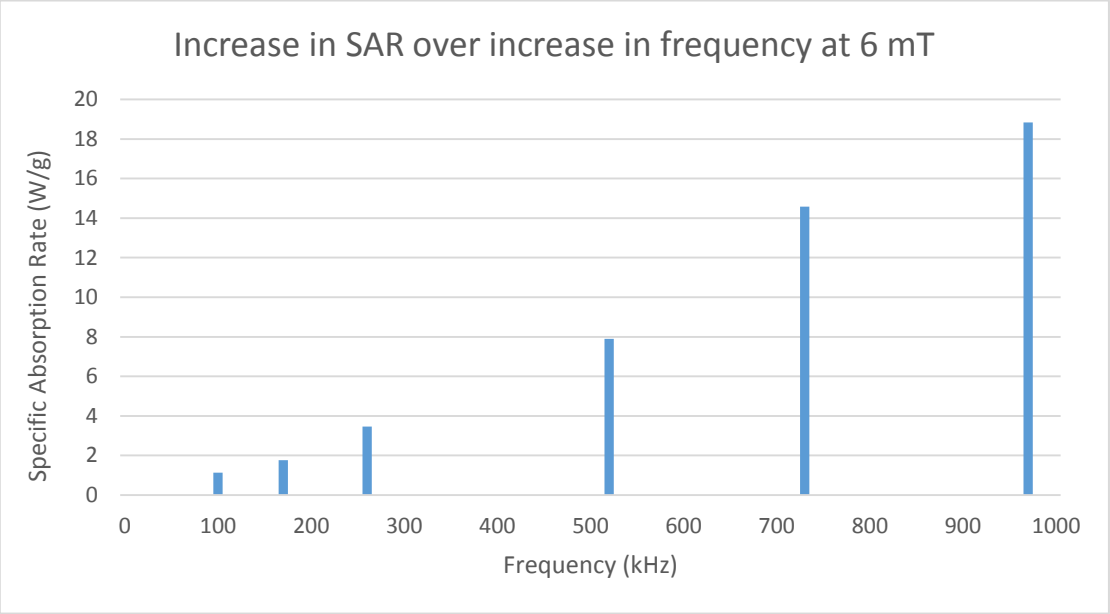
One Example of such experiments is as follows:

This experiment is a proof of principle experiment to show that magneTherm allows the user to study the relationship between specific absorption rate and applied frequencies in magnetic nanoparticle calorimetric experiments. A 2 ml sample of 15 nm sized DMSA stabilized magnetite nanoparticle suspension was exposed to increasing frequencies 99.1 kHz, 172 kHz, 259 kHz, 516.5 kHz, 730 kHz and 973.5 kHz at a 6 mT constant field intensity.

This varying frequency experiment over a constant field intensity takes into account the unique feature of magneTherm i.e. a full range of up to 21 frequencies starting from 50 kHz to 1000 kHz. The field intensity was set to 6 mT and the nanoparticle suspension was exposed to frequencies ranging from 100 kHz to 1 MHz in one single multi-frequency experiment. The experiment started with a 1 minute cooling period and followed a similar pattern to the previous experiment i.e. one frequency exposure for a minute followed by a 5 minute cooling period at zero field intensity then vice versa continuously without break for all the other frequencies.




Rate of change of temperature of the magnetic nanoparticle at varying frequency with a constant field intensity




Rate of change of SAR of the magnetic nanoparticle at varying frequency with a constant field intensity

This six frequency experiment took 61 minutes to complete using a single coil.

It is worth noting that the single coil multiple frequency capability is essential to quality and comparable measurements for this application – if the coil is changed to achieve different frequencies then the field strength, flux density and homogeneity will all be different for each frequency invalidating the idea of varying one parameter only when others are kept constant.

These kinds of experiments are made possible by the flexible features of the magneTherm system as it has been designed specifically for the application of heating nanoparticles in an AC magnetic field.

As mentioned earlier the mARCS (magneTherm Absorption Rate Calculation Sheet) will automatically plot and display the graphic representation of rate of change of temperature and the corresponding calculated SAR values.

The above examples proves the basic principles and show that reliable, accurate and reproducible continuous experiments can be performed using the magneTherm system to provide a complete heating profile of a magnetic nanoparticle sample. The measured field intensity map allows the user to perform experiments with optimum field strength which is far more accurate than calculated values.

## Conclusion

Perform single, fast experiments for complete characterization of your samples.

Either SAR *vs* H or SAR *vs f* curves can be obtained with excellent precision and reliability.

A complete tool for the study of thermoresponsive materials and exploring the experimental accuracy of your SAR (H , f) is now within affordable reach.

A totally unique and affordable device for testing the heating capacity of magnetic nanoparticles:

- Low and high frequency from 50KHz - 1000KHz: provides user flexibility within one system.
- Wide sample aperture: Enables calorimetric, in-vivo, in-vitro and materials experiments within one sample enclosure.
- Vertical and horizontal sample enclosure positioning/access: enables use with nanoparticle samples and animal models.
- Convenient bench-top size: provides portability, reduces footprint.
- Only requires a tap or a recirculating water bath for cooling: maintains room temperature.
- Used by our customers for in vivo mouse studies: provides user flexibility.