Rare-Earth Permanent Magnet Studies with a Lake Shore 7400 Series VSM System Equipped with a Model 74035 Single Stage Variable Temperature Option

In response to an increasing concern for energy conservation, rare-earth permanent magnets are now widely used in applications that require the best ratio of weight to magnetic field strength. These magnets are found in devices such as electrical motors, hybrid vehicles, eolian generators, hand tools and portable communication devices. The widespread use of rare earth magnets produces a need for more precise characterization of their magnetic properties, with more rigorous experimentation that exposes them to the environmental conditions that more closely represent their end-use environments.

Typically, you would measure demagnetization curves at room temperature, as illustrated in Figure 1.

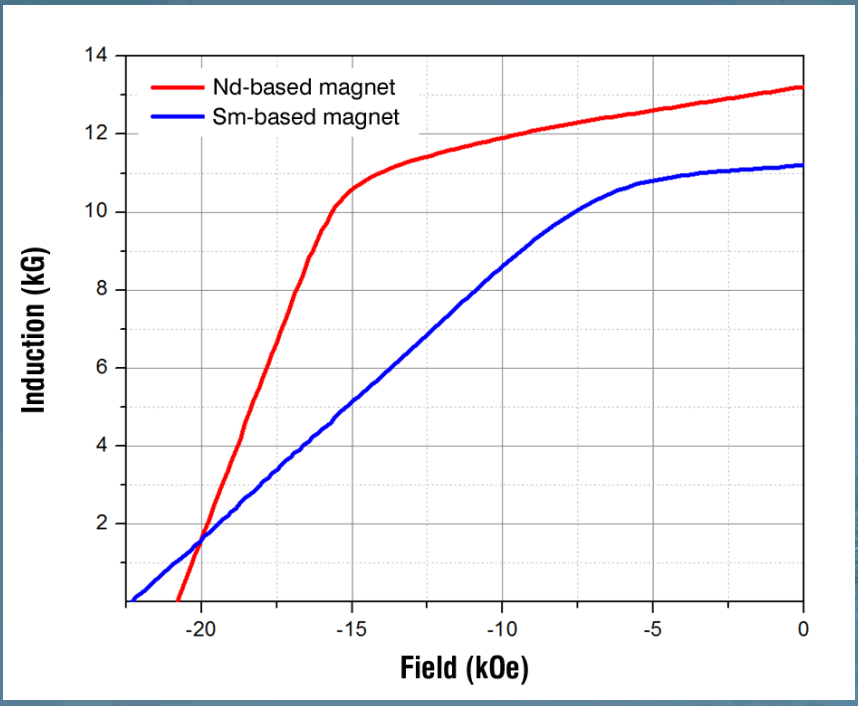


Figure 1: 2nd quadrant room temperature demagnitization curves for Nd and Sm-based magnets*

From this measurement, you would conclude that the Nd-based magnet maintains its properties better when exposed to a higher demagnetizing field. However, this measurement was performed at room temperature. Quite often in real-life applications, the magnets will be exposed to sub-freezing temperatures or to high heat, such as a windmill operating in a northern climate or a starter installed on a vehicle, close to the engine.

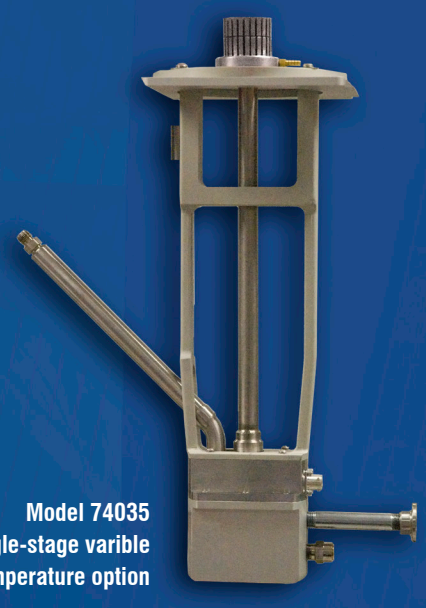
** This application note is not meant to advertise the use of Sm-based magnets over Nd-based, since both technologies have their advantages and a discussion about them is beyond our purpose.*

The problem with performing experiments that imitate the temperature environments of the end-use product is that it is extremely time consuming. In addition, removing and re-saddling a sample to another piece of hardware can be frustrating, and it can reduce the accuracy of your measurements.

The Lake Shore Model 74035 single-stage variable temperature option addresses these problems and provides a solution for experiments that need a full range of temperature environments. Installed on the Model 7400 VSM, it provides an experimental approach to better emulate reality and let you predict how a specific permanent magnet will behave in a given application.

In the measurement illustrated below, you can observe that even below or at room temperature the Nd and Sm magnets have similar properties. However, once the temperature rises, the Sm-based magnet proves to retain its magnetic properties better than the Nd-based magnet.

One of the key features of the Lake Shore Cryotronics solution is that you can fully characterize the magnetic properties as a function of external field and temperature, in a continuous sweep without sample removal.



Model 74035 single-stage varible temperature option

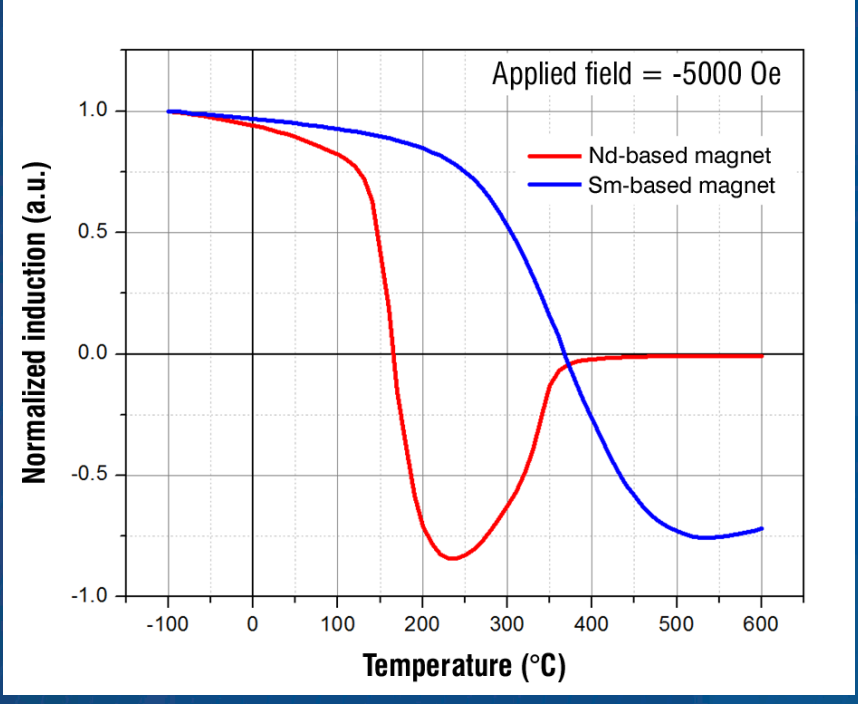


Figure 2: Fixed applied demagnetizing field temperature dependence curves

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