

An Open Access Database of Magnetic Materials for Electrical Equipment Development

Yisong He, Siwei Cheng, Yapeng Jiang, Xiang Zhao, Jinrui Guo, Junquan Chen*

¹National Key Laboratory of Electromagnetic Energy, Naval University of Engineering, Wuhan, Hubei, China

The development of electrification has led to increasing demands on the performance of electrical equipment. And increasing attention has been paid to the performance of magnetic materials in electrical equipment. However, the current magnetic material property data has not been able to form a centralized management platform from the user's point of view, which is not conducive for practitioners to find, compare the property data and subsequently compute. This paper introduces an open access magnetic material database for electrical equipment from its composition, structure, operation mechanism and core functions. The material property data in the database covers a wide range of materials and a wide range of measurements, which can provide material property data support for the electrical industry.

Index Terms—Database, Magnetic materials, Open access, Electrical equipment, Motor, Transformer, Inductor

I. INTRODUCTION

In recent years, with the development of electrification, the research, development, and application of all-electric aircraft, motor vehicles and all-electric ships have put forward a strong demand for electrical equipment, such as power generation, daily electricity, propulsion power supply, and high-power supply. In design and manufacture, magnetic materials for electrical equipment like motor, transformer and inductor play an important role. Their property characterization not only affects the energy efficiency and stability of the equipment but is also closely related to the design optimization and technological innovation of electrical equipment [1]. Therefore, electricity-related practitioners are concerned about the property data of magnetic materials.

To facilitate people to find the magnetic material property data of electrical equipment, it is necessary to summarize and manage the property data of various magnetic materials. Magnetic material property data are often measured and provided by the production of the magnetic material of steel enterprises, but the means of steel enterprises to manage the material data are more backward, generally using EXCEL. As we all know, Excel is a common office software, and the property data of magnetic materials with professional specificity, and is not suitable for management with Excel. Especially in the case of a large amount of data, it is inconvenient to find, compare, draw, and export data, which is even more unfavorable for data analysis. Moreover, because these companies usually do not disclose magnetic material property data on their official websites and often measure only a few material properties under regular conditions, it is inconvenient to obtain the data, and it does not cover all usage requirements.

Therefore, based on the current situation in which the property data of magnetic materials for electrical equipment are not reasonably managed, the Laboratory has collected and tested global magnetic material property data and developed an open access database of magnetic materials for electrical equipment development relying on a self-developed test platform [2]. The database has been put up on the Internet,

which is convenient for electrical practitioners to query, download and to supplement the database data.

II. THE MAGNETIC MATERIALS DATABASE FOR ELECTRICAL EQUIPMENT

A. Characterization of magnetic material properties

The database is dominated by the property data of magnetic materials. Currently, six sub-databases are set up according to the soft magnetic property, permanent magnetic property, electrical conductivity, mechanical property, magnetostrictive property, and heat transfer property to store the data of each category. Each property has different characterization, which is shown in the Fig. 1. Considering expandability, there are also five reserved sub-databases.

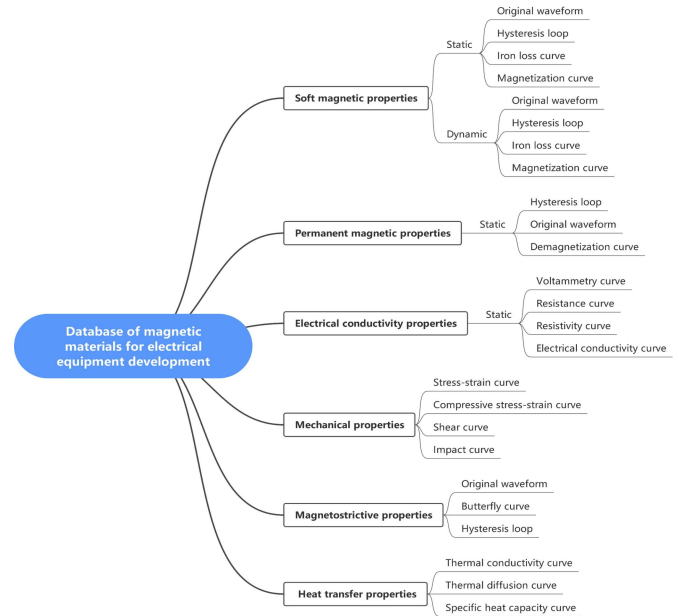


Fig. 1 Characterization of individual of magnetic material properties

B. Structure of the magnetic material database

Each material property data repository is divided into two parts: main and auxiliary databases. The composition of the database is shown in the Fig. 2. The main sub-database was organized into three data levels: basic sample data,

measurement conditions and measurement data. The auxiliary database contains information on the chemical composition of the material, material label, manufacturer, manufacturer's label, sample specification parameters, domestic and international grades, material test standards, and material implementation standards. Consequently, the identity information and property data of a material are stored in the main and auxiliary libraries, respectively, and users can search and query through all the fields in the main and auxiliary sub-database.

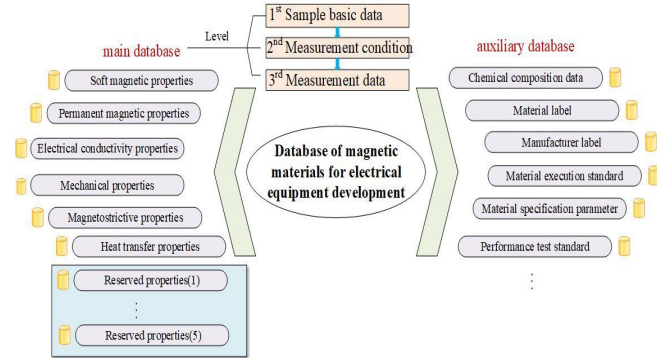


Fig. 2 Composition and structure of the magnetic materials database

C. Operation mechanism of the magnetic database

- **Open access:** database is always free for data and information sharing and co-construction.

- **Phenomenological model:** The materials are dispersive and the properties of materials from different manufacturers and models varies. Even materials of the same model will have their properties changed in the course of use and by external influences. At present, the material properties are very complex, and the quantitative characterization of the properties under the action of multi-physical fields has not yet been solved from the physical mechanism, so the characterization of the material properties in this database mainly relies on the measurement of the macroscopic properties of the actual samples, and then uses mathematical tools to carry out image-only modeling of them. In other words, the material property data in the database are responsible for the measured sample materials.

- **A materials information hub for the electrical equipment industry:** The creation of a magnetic materials database must rely on the use and maintenance of the various practitioners in the industry, and, as the role illustrated in Fig. 3 shows, the properties of the database should be continually improved by interacting with information from researchers, materials producers, designers, and metrology departments.

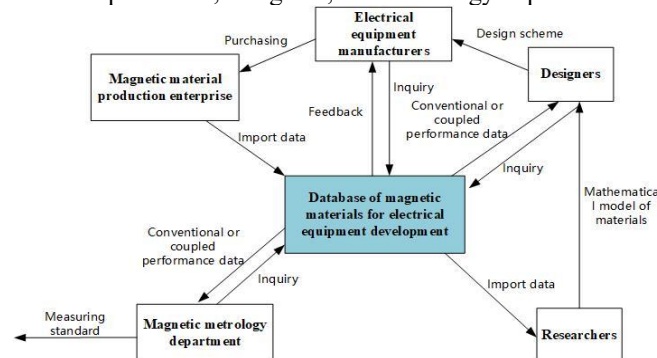


Fig. 3 The role of the magnetic material database for electrical equipment as a link in the electrical industry

III. CORE FUNCTIONS OF MAGNETIC MATERIAL DATABASE

A. Material properties query function

The database now contains mounts of material property data. The database not only supports the query and download of various material property data and curves but also allows us to view the corresponding charts and download test reports. The database supports the export of TXT files and finite-element software data, which is convenient for users to download and use.

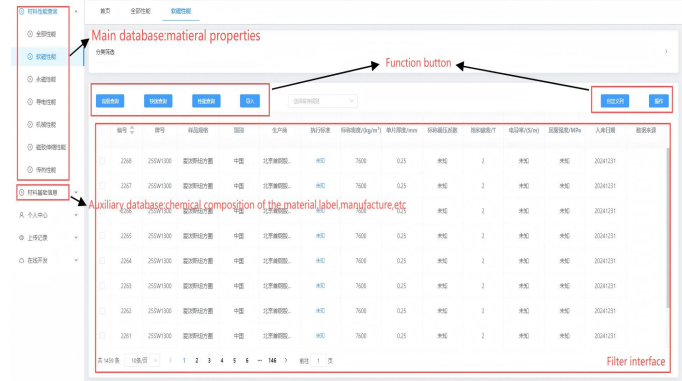


Fig. 4 The interface of the magnetic database for electrical equipment

B. Personalized service function

The database is open and free to the public, easy to operate, with fast query, advanced search, customized information display and other functions.

C. Communication and interactive service functions

By using web technology, the database has a “social” attributes, the user can be in the database platform for any material related data to like, comment, attention. The background will be based on the user's use of the situation, to actively push the user concerned about the material update information. In addition, the database also supports users to upload their own material property data information to correct and enrich the data of the database.

IV. CONCLUSION

In this paper, an open access database of magnetic materials for electrical equipment is presented, which now includes property data for 722 material samples and will be enriched in the future. This database addresses the need for electrical practitioners to have a one-stop shop for material properties and also facilitates the connection between them, which is conducive to compute and to the efficient development of electrical equipment.

REFERENCES

- [1] P. Nieves, S. Arapan and J. Maudes-Raedo, "Database of novel magnetic materials for high-performance permanent magnet development," Computational Materials Science, vol. 168, pp. 188-202, Jun, 2019.
- [2] "Material properties database." National Key Laboratory of Electromagnetic Energy, Naval University of Engineering, <http://59.172.104.174:32152>, 2024.