# Modified Jiles–Atherton model and parameters identification using false position method

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**Abstract:** A modified Jiles-Atherton model is suggested in this study. By substituting the irreversible magnetization Mirr with the magnetization M in the relationship between the effective magnetic field He and the magnetic field H, this model utilises a physical meaning. To get the Jiles-Atherton parameters for both the classic and modified Jiles-Atherton models, the false position method is paired with the iterative procedure. By solving three nonlinear equations derived from three conditions, these parameters are assessed. By contrasting the produced hysteresis loops with the experimental ones, the validity of the modified model is determined.

**Keywords:** • Hysteresis curve • False Position Method • Magnetization • Jiles–Atherton model

## 1. Introduction

The hysteresis phenomena is modelled by a number of different ways. Some of them are physical in nature, while others don't take physical properties of materials into account. The most prominent and frequently employed physical model is **Jiles-Atherton**. Jiles and Atherton estimate the effective magnetic field by replacing the total magnetization with the irreversible magnetization, leading to a more straightforward expression for the total differential susceptibility. In this paper, we present a **modified Jiles-Atherton (MJA) model** to evaluate the equivalent magnetic field. The full magnetization is taken into account by this model. The expression of the total differential susceptibility provided by Jiles and Atherton differs significantly from that resulting from this modification (JA).

The correct parameters must be known in order to incorporate this model into a calculating code. Both the JA and MJA characteristics need for an identifying method. The parameters of the JA model are identified using a variety of ways. For both models in this work, we employed a strategy that combines an iterative algorithm and a **False Position Method, or FPM**. Three nonlinear equations include the parameters that we want to extract

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from the MJA, and the FPM solves these equations. Measurement information such as the initial, coercive, and remanence susceptibilities are required for this technique. Additionally, the coercivity field intensity, remanence magnetization, and the saturation point coordinates must be introduced.In order to compare the experimental results of the hysteresis loops to the JA model, the MJA model is validated.

## 2. Results

Hysteresis loops from the JA and MJA models, each using the specified parameters from Table 1, are compared to experimental ones. The hysteresis loops of both models are depicted in Figs. 1 and 2. Both MJA and JA models show good agreement between measured and simulated hysteresis loops.

**Table 1**
Parameters extracted from experiment.

| Parameters | Measured |
|---|---|
| $\chi_{in}$ | 184.12 |
| $\chi_m$ | 0.0443 |
| $\chi_r$ | $1.9725 \times 10^3$ |
| $\chi_c$ | $9.974 \times 10^5$ |
| $H_m$ (A/m) | $1.039 \times 10^3$ |
| $H_c$ (A/m) | 69.37 |
| $M_m$ (A/m) | $1.134 \times 10^6$ |
| $M_r$ (A/m) | $8.905 \times 10^5$ |

**Table 2**
Identified J–A model parameters.

| Identified parameters | JA model | MJA model |
|---|---|---|
| $Ms$ (A/m) | $1.18 \times 10^6$ | $1.18 \times 10^6$ |
| $a$ (A/m) | 46.858 | 46.9605 |
| $k$ (A/m) | 81.10 | 79.001 |
| $\alpha$ | $1.4843 \times 10^{-4}$ | $1.507 \times 10^{-4}$ |
| $c$ | 0.0219 | 0.0214 |

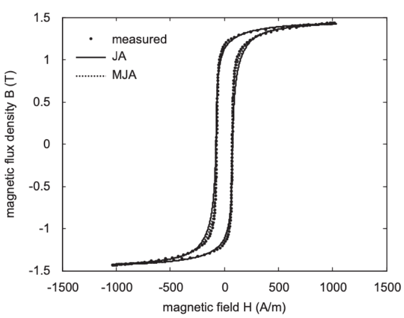


**Fig. 1.** Measured and simulated magnetic flux density.

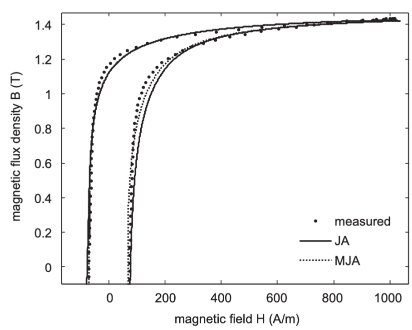


**Fig. 2.** Measured and simulated magnetic flux density (zoom up).

This demonstrates the efficiency of the method used to determine the model parameters, but it also indicates that the hysteresis loop of the MJA model fits the experimental one better.

## 3. Conclusion

The Jiles-Atherton model's hysteresis evaluation is enhanced by employing the correct expression of the effective magnetic field relation, which uses total magnetization rather than irreversible magnetization. To determine the parameters of the MJA and JA models and determine the hysteresis loops, an approach based on an iterative algorithm and the false position method is developed. The experimental data is contrasted with these parameters. In comparison to the JA model, the MJA model's hysteresis loop more closely matches the experimental loop. By accounting for the dynamic behaviour of both soft and hard magnetic materials, this model can be enhanced.