Non-Intrusive Measurement of the Active Power in Induction Heating Systems through the Proximate Magnetic Field

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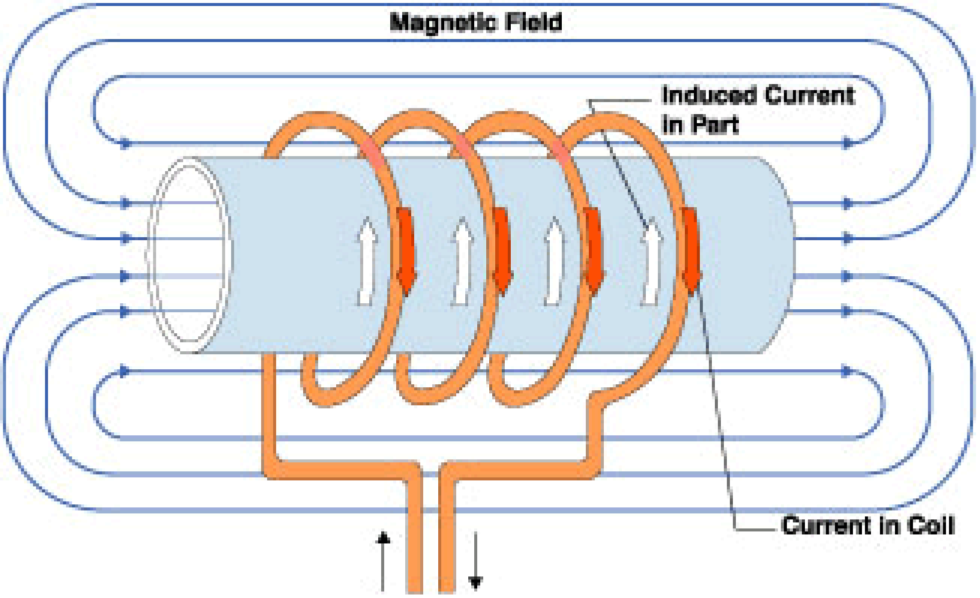
CONTENT

INTRODUCTION



Induction heating system

$$\frac{\Delta P}{P} = \frac{\Delta U}{U} + \frac{\Delta I}{I} + \frac{\Delta \cos\varphi}{\cos\varphi} = \frac{\Delta U}{U} + \frac{\Delta I}{I} + \Delta\varphi \, \mathrm{tg}\varphi$$

Relative precision of the active power

INTRODUCTION

New possibility of

measuring the active power in induction heating systems

A correlation must exist between

the value of the magnetic flux density in a point and the active power

An efficient method using

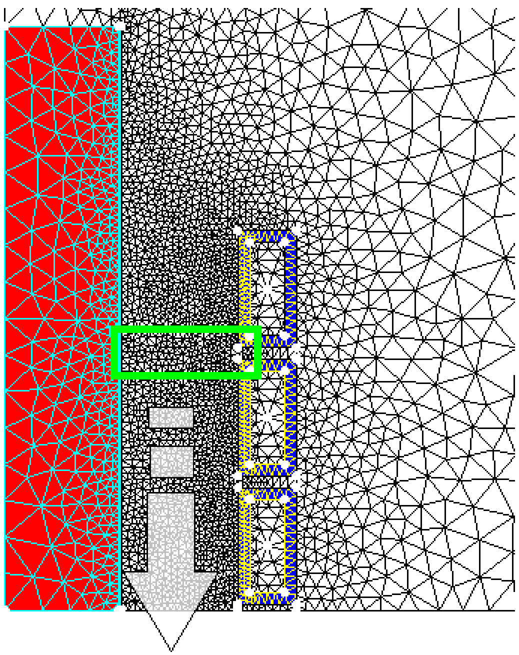
a sensor based on this dependence

An analyze based on

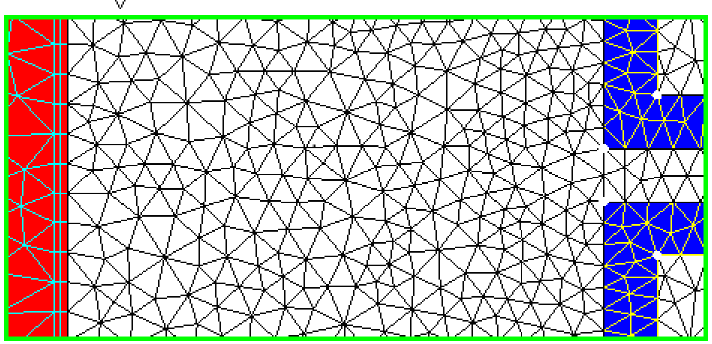
the finite element computation of the electromagnetic field

FINITE ELEMENT MODEL

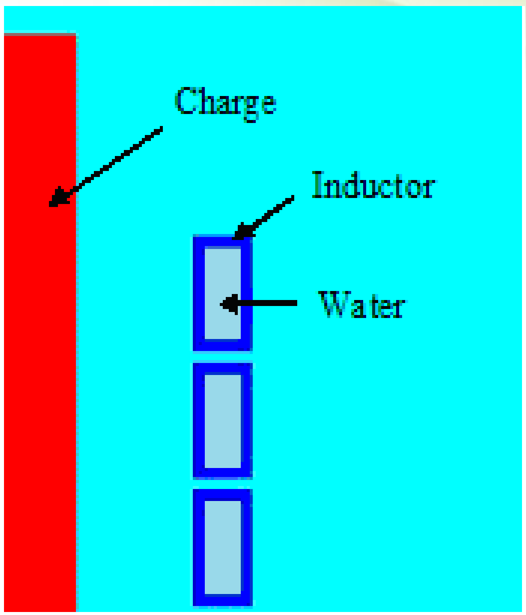
Steady State AC Magnetic



Mesh grid



High mesh density on
- turns
- charge surface



Geometry

FINITE ELEMENT MODEL

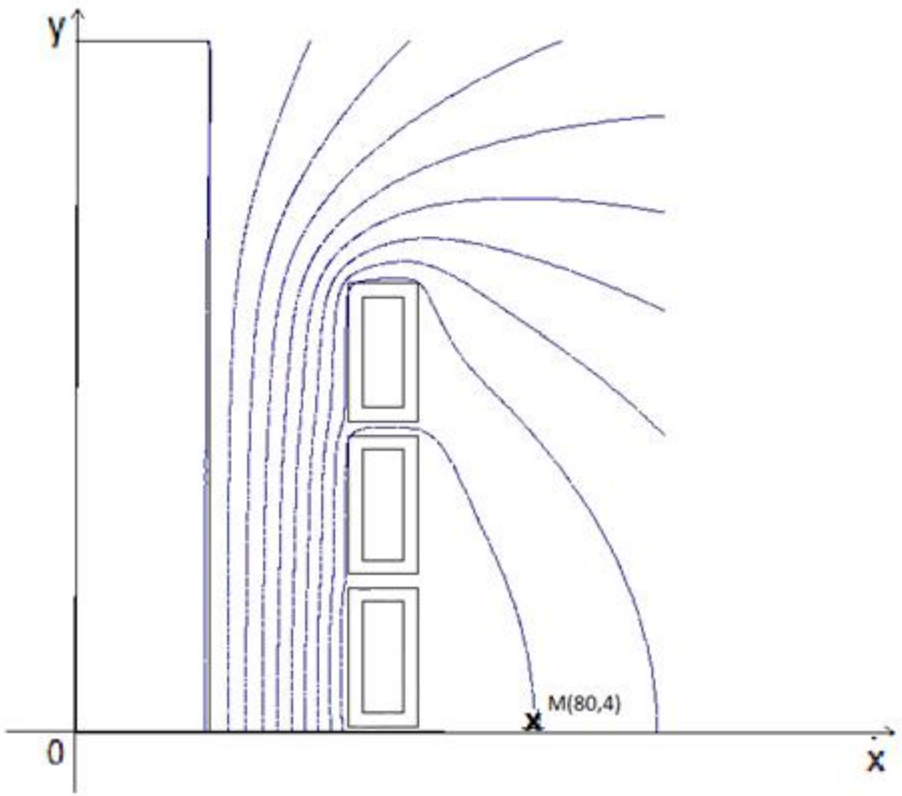
Magnetic flux density measured in a point placed in the device proximity (M(80,4))

Power range up to 15 kW

Current from 500 A to 7500 A

Frequencies between 50 Hz and 20 kHz

Materials used are copper and steel

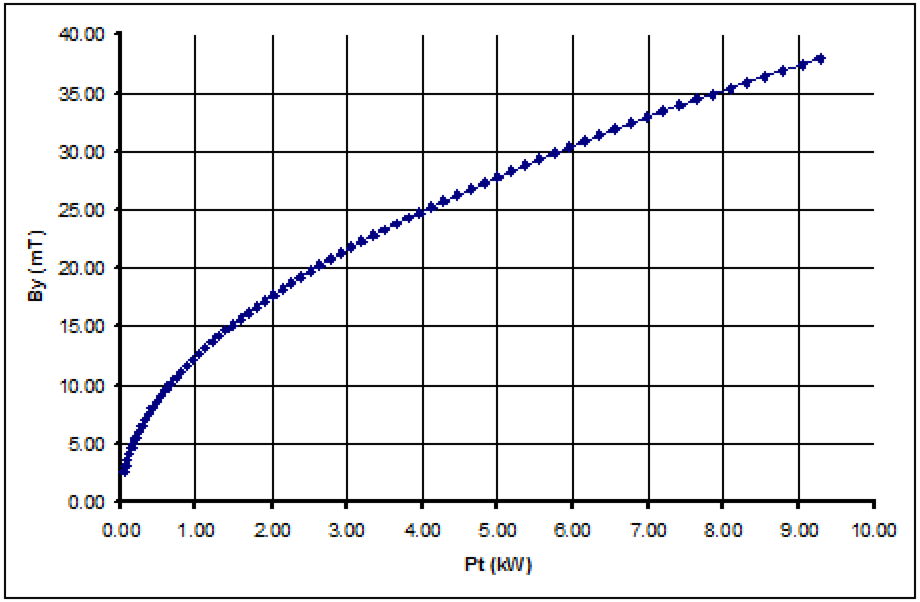


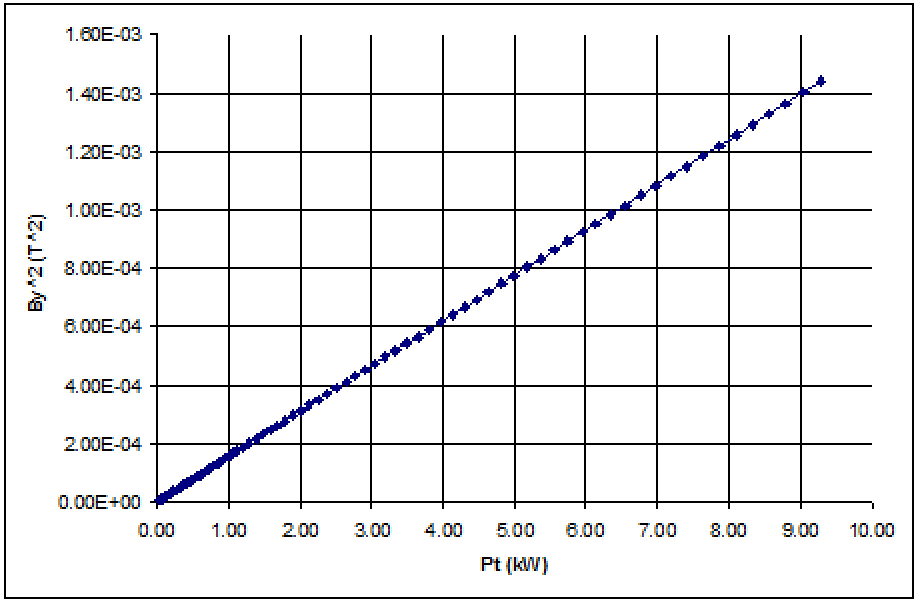
Isoflux lines in the longitudinal inductor

RESULTS

No charge

Magnetic flux density – active power dependence for *f* = 50 Hz



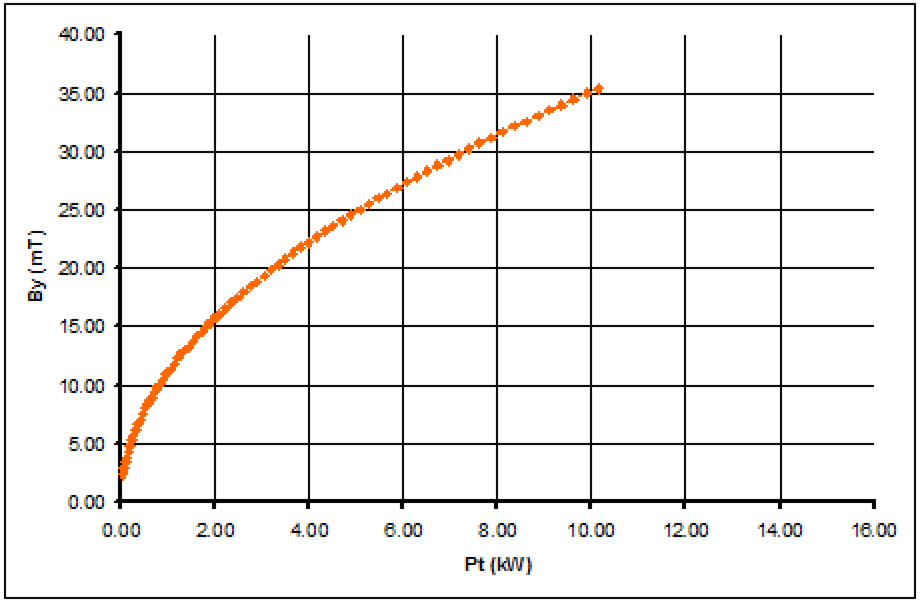


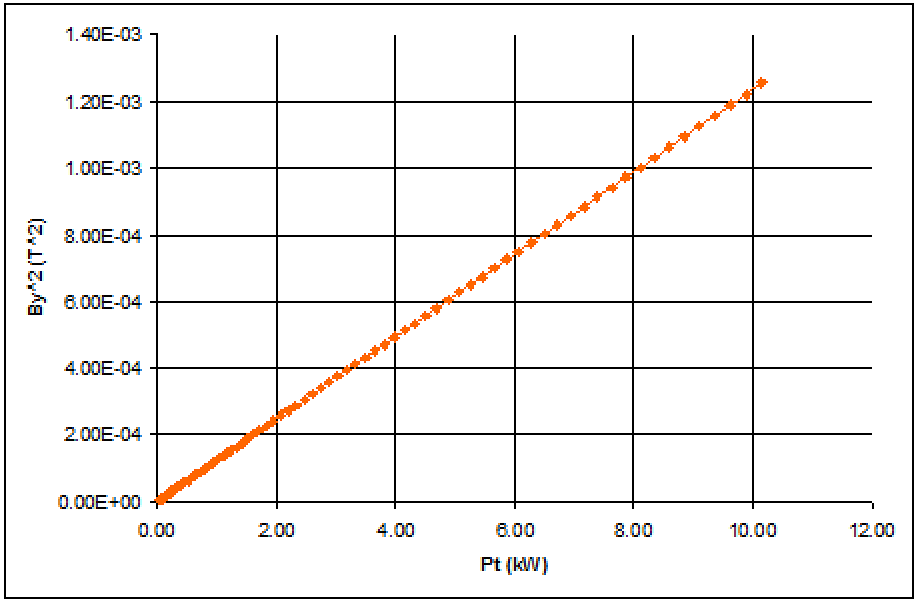
B^2 – P dependence for *f* = 50 Hz

RESULTS

Copper

Magnetic flux density – active power dependence for f = 50 Hz



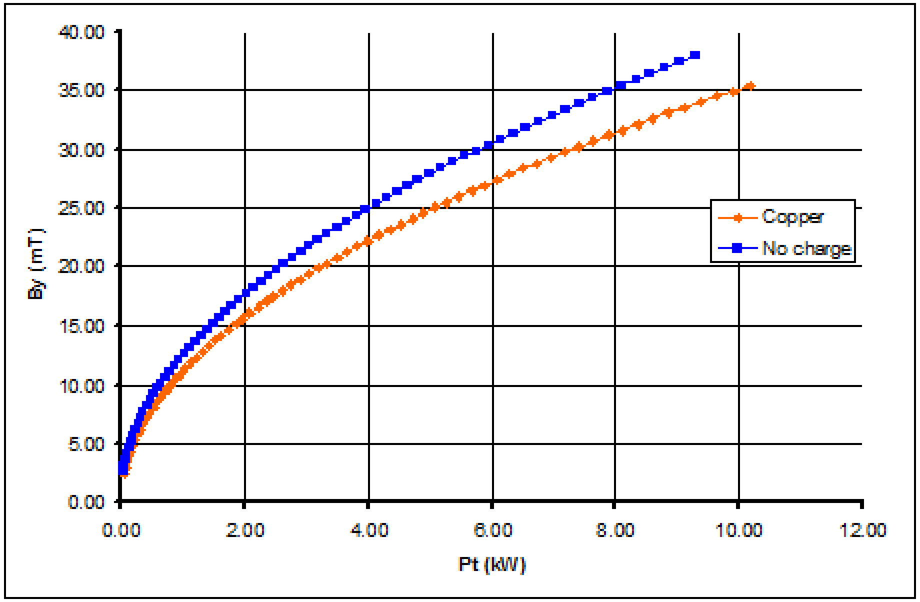


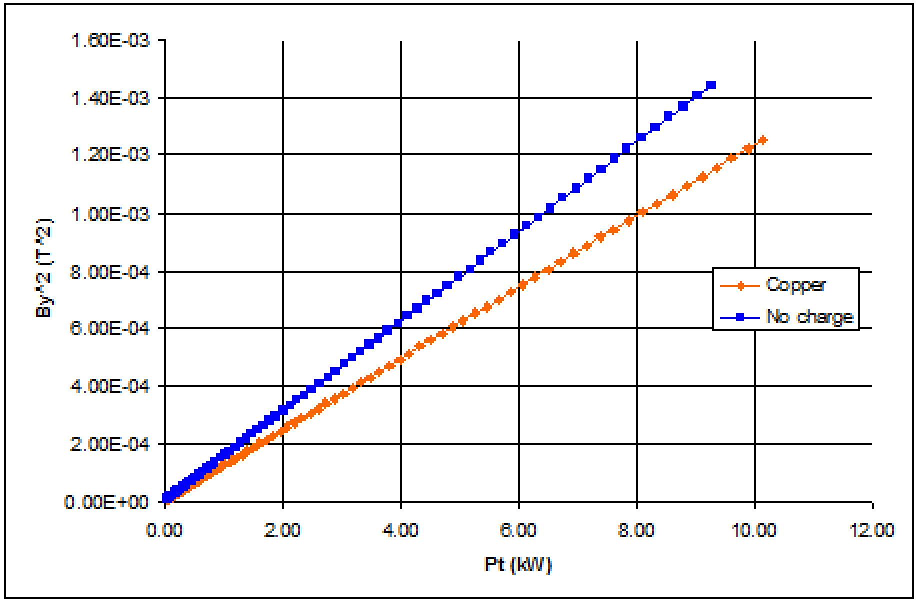
B^2 – P dependence for f = 50 Hz

RESULTS

No Charge/Copper

Comparison between B-P dependences for no charge and copper

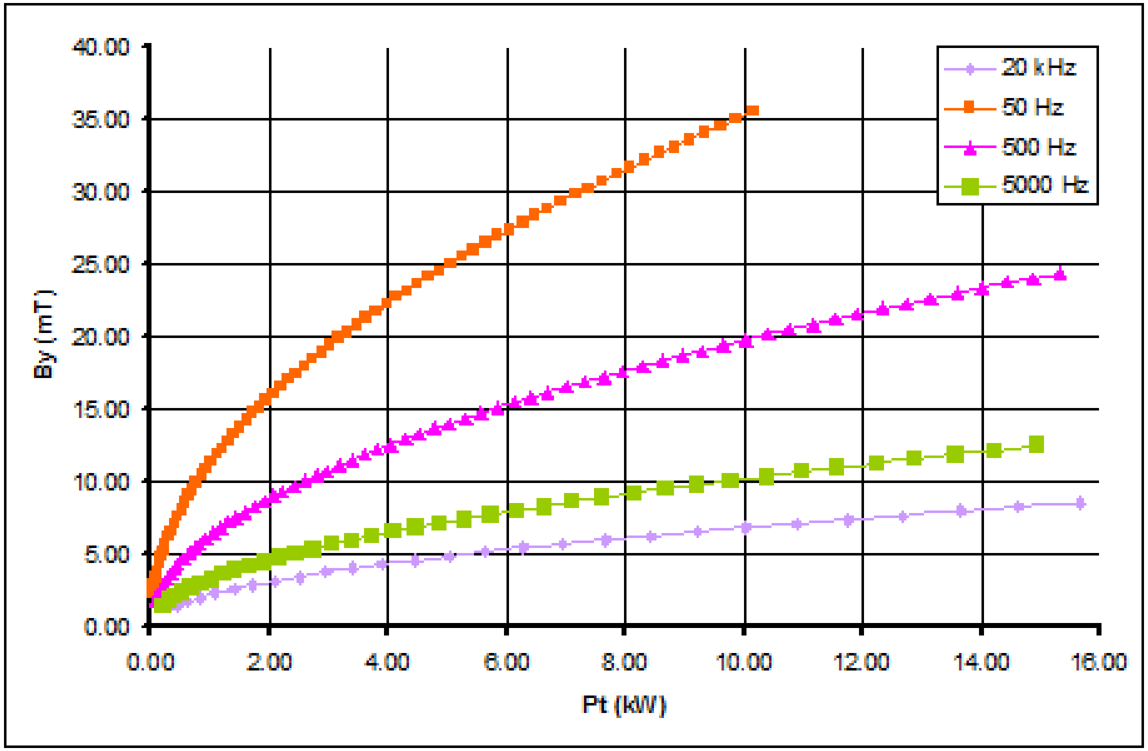




Comparison between B^2-P dependences for no charge and copper

RESULTS

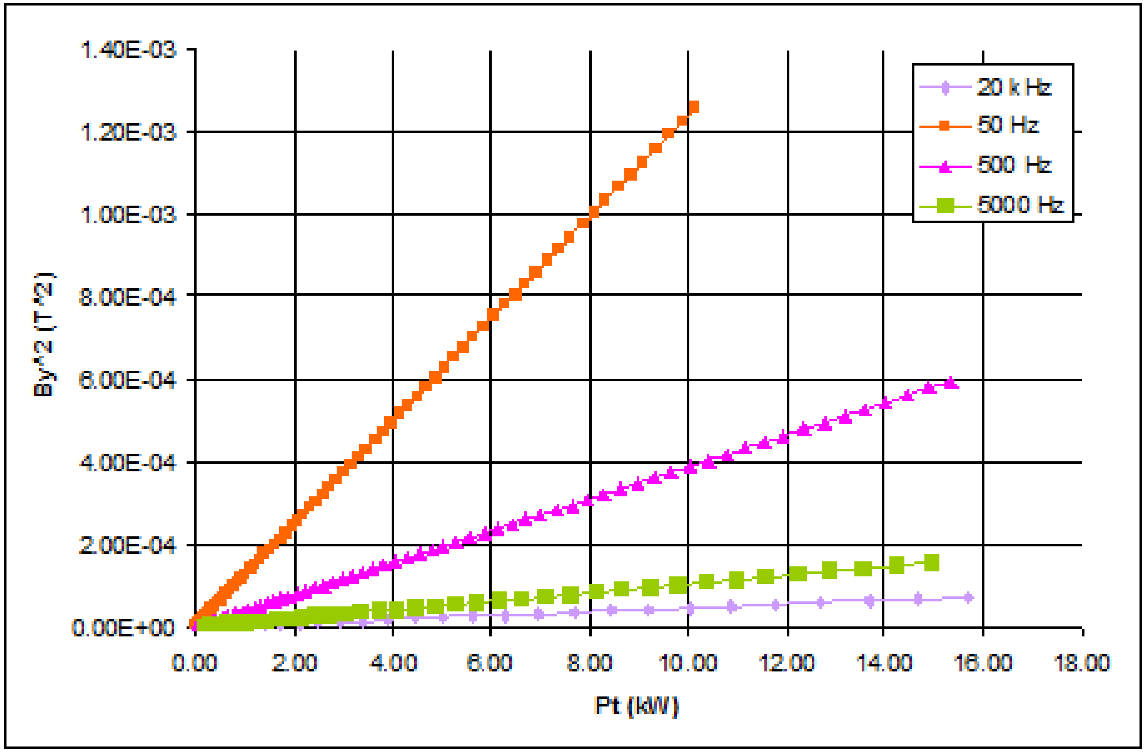
Copper



Magnetic flux density – active power dependences

RESULTS

Copper

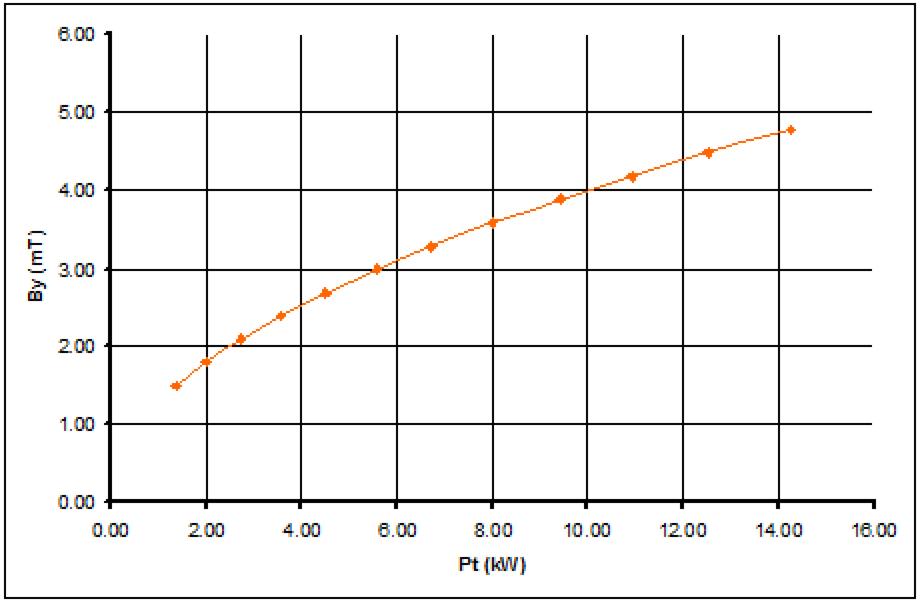


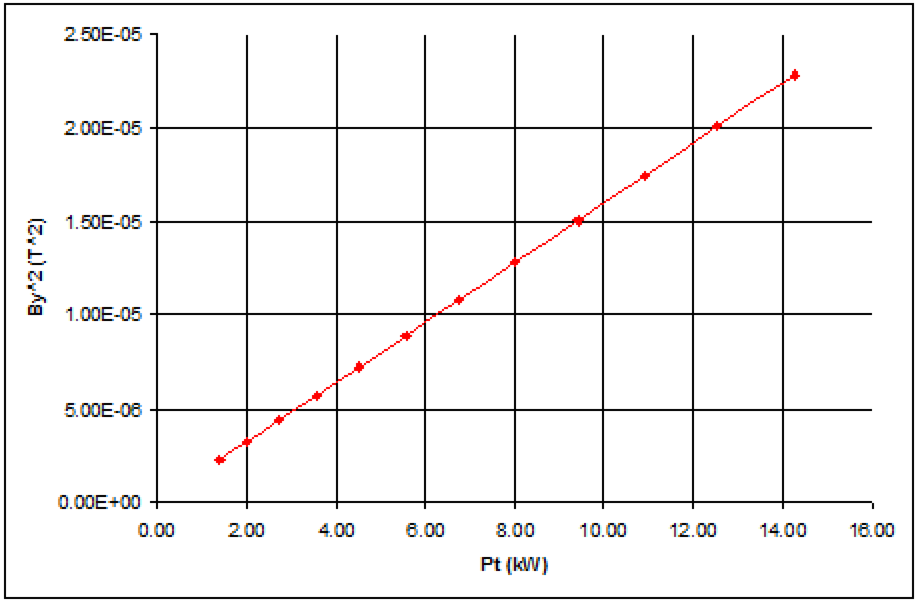
B² – P dependences

RESULTS

Steel

Magnetic flux density – active power dependence for *f* =20 kHz



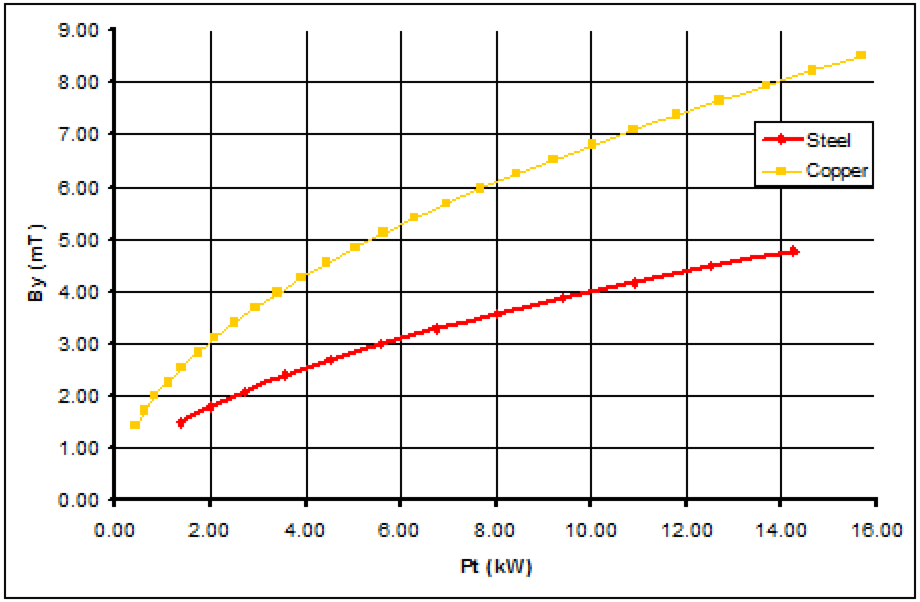


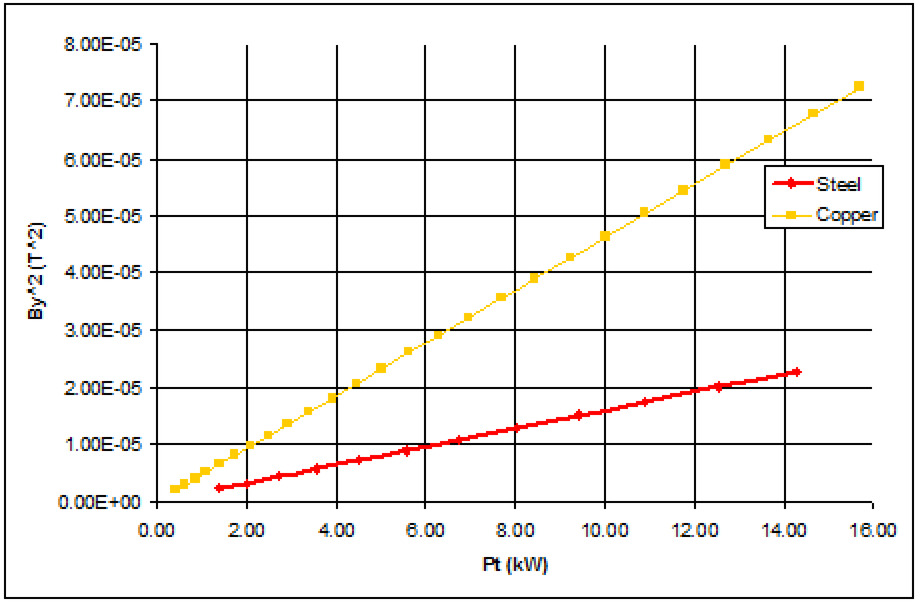
B^2 – P dependence for *f* = 20 kHz

RESULTS

Steel/Copper

Comparison between B-P dependences for steel and copper





Comparison between B^2-P dependences for steel and copper

CONCLUSIONS

New method for

measuring the active power absorbed by an induction heating system

Value of the magnetic flux density is

dependent on the value of the absorbed active power

Correlation between

squared value of magnetic flux density and active power

Possibility of

using a sensor based on this linear dependence

THANK YOU!