Detection of the Thickness Variation of a Stainless Steel sample using Pulsed Eddy Current

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1. Introduction

The Pulsed Eddy Current (PEC) system has been developed for the detection of thickness variation of stainless steel. The sample was machined as step configuration using stainless steel for thickness variation from 1mm to 5mm step by step as shown in fig1 (a). The LabView computer program was developed to display the variation in the amplitude of the detected pulse by scanning the PECT probe on the flat side of the sample. The pickup Sensor measures the effective magnetic field on the sample, which is the sum of the incident field and the field reflected by the specimen due to the induced eddy currents in the sample. We use the hall sensor for the detection [1]. Usage of hall sensor instead of coil as a field detector improves the detectability and special resolution [2]. This technology can be used in detection of local wall thinning of the pipeline of nuclear power plant.

2. Exciting circuit and sensor probe

The equipment for the experiment has pulse amplifier to drive the exciting coil, hall sensor voltage reading circuit, A/D converter, scanner and a computer. The impotent parameter in the excitation is asymptotic value of the current of pulse, larger the current then the generated magnetic field will be larger and hence the resulting eddy currents in the specimen will be more. This will increase the sensitivity and signal to noise ratio [3]. The exciting probe consisting a coil of 30turns, which is wounded on a cylindrical cup type ceramic ferrite core as shown in fig1 (b). The detecting sensor placed at the bottom axial center of the exciting coil, that is the sensor is parallel to surface of the sample and it detects the field which is normal to the surface. The coil parameters are given in the table I. The pulse of 1amp having the pulse width of 20µsec is

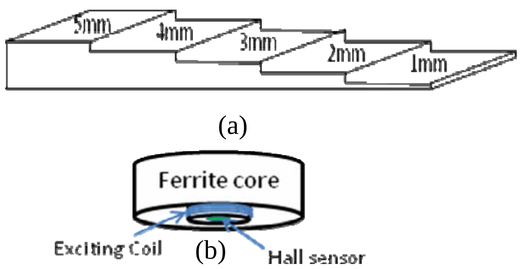


Fig. 1. (a)Tested sample, (b) PECT probe

applied to the exciting coil to generate the field in the specimen. The pulse repetition rate is 100Hz. The advantage of the applying pulsed eddy currents with the low duty cycle of the pulses put less average power through the small probe coils, which allows for he operation at high instantaneous currents during the pulse it self.

Table I: coil parameters

Inner diameter	10mm
Outer diameter	14mm
Height	4mm
Turns	30
inductance	37µH

3. Results and discussion

The excitation of coil by the narrow pulse, the resultant pulse responses for different thick nesses of the sample are shown in fig.2 (a). Two important characteristics of a output pulse are the height of the

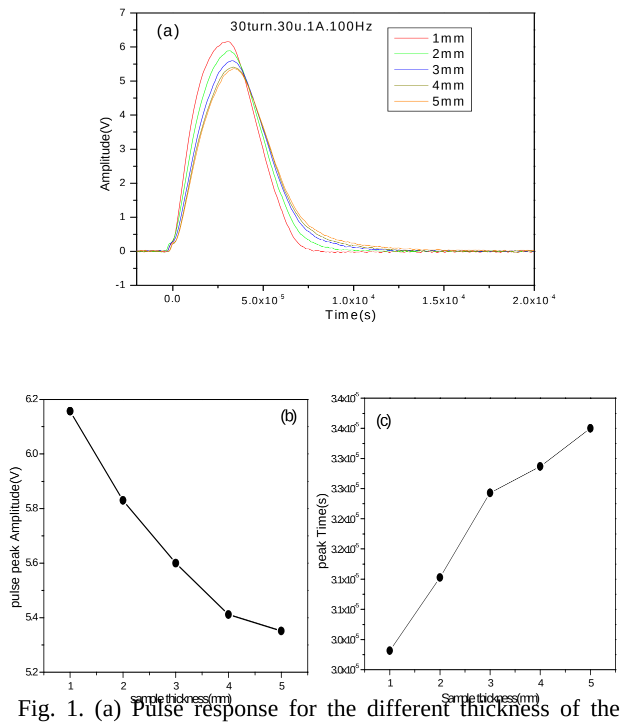


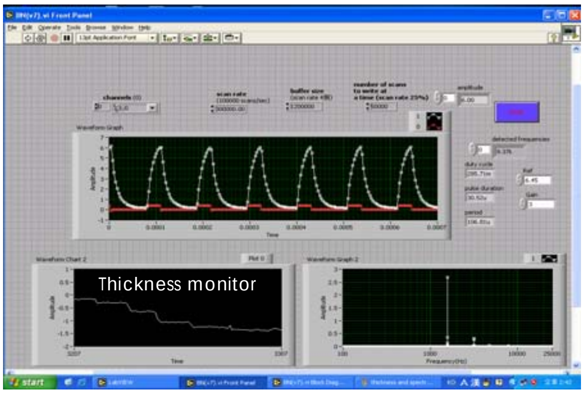
Fig. 1. (a) Pulse response for the different thickness of the sample, (b) pulse peak amplitude versus sample thickness,(c)sample thickness versus peak arrival time of the pulse

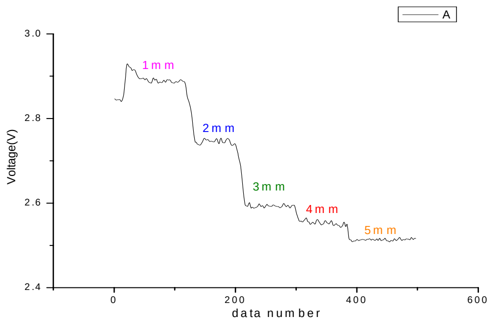
peak and the time delay from the beginning of the pulse to the peak of that pulse [4]. Note that if we use the coil detector instead of hall sensor the zero crossing of the coil response corresponds to the maximum value of the field measured by hall sensor R.A.smith et.al.,[2].

When the probe is placed on the sample, field rises more slowly to maximum peak value and decays longer times. The decay time is increases with increasing the specimen thickness [5]. In our results it is observed from the fig.2 (b) the peak amplitude is decreased with increasing the sample thickness and the decay time of the pulse increased with increasing the sample thickness. This is due to presence of the low frequency components in the detected field. From the fig.2(c) the time to peak amplitude is increased with increasing the thickness of the specimen [6, 7].

3.1 thickness monitoring

A computer program is developed to display the thickness of the specimen while scanning the PECT probe on the flat side of the sample as shown in fig.1 (a). The reference signal can be selected as the response from the probe without the sample that is air signal, or the probe response when it is placed on the defect free sample [8], the later is good for the measuring the corrosion, crack etc measurements. In our system we are measuring the thickness of the sample so we used the air signal as reference and is subtracted from the signal, which is obtained in the presence of sample.





(a)

(b)

Fig. 1. (a) Computer program to monitor the thickness of the sample, (b) graph drawn with the thickness variation data

3. Conclusions

The PEC system has bee developed for the detection of wall thinning of stainless steel pipe, and applied in the detection of thickness variation of stainless steel sample. A pulse amplifier, PEC probe composed of Hall sensor and driving coil and a real time control program were developed for the continuous monitoring of thickness variation of the sample. The change of thickness variation of the sample associated with pulse amplitude has been successfully displayed on the computer screen.

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