LAMPIRAN

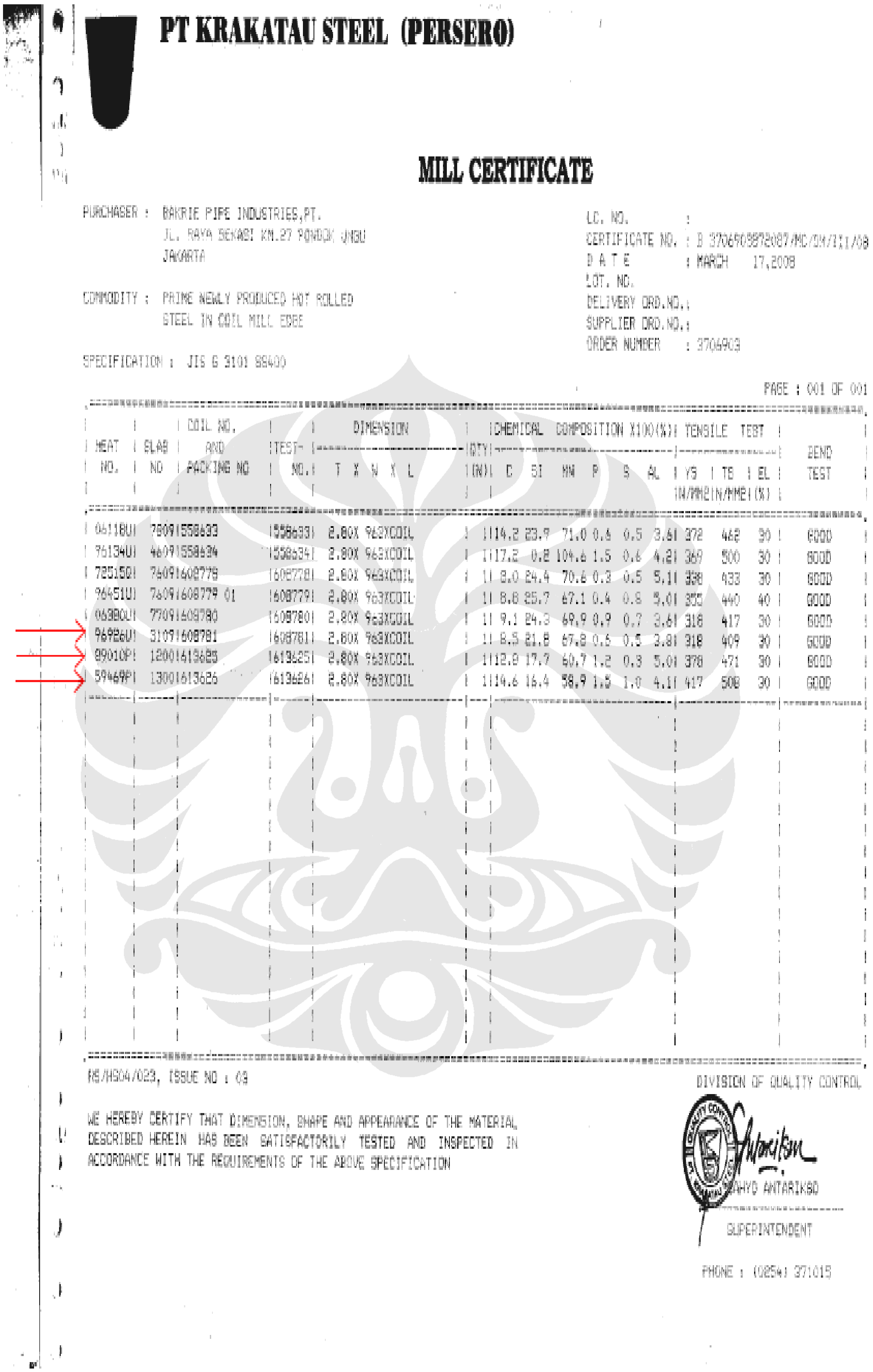
LAMPIRAN 1

Tabel Data komposisi material baja SS 400

Komposisi Kimia (%)					
C	**Si**	**Mn**	**P**	**S**	**Al**
0.12	0.186	0.623	0.011	0.006	0.0043

Sifat Fisik	
Density	**7,87 g/cc**

Uji Kekerasan	
SS 400	**125 BHN**



PT KRAKATAU STEEL (PERSERO)

MILL CERTIFICATE

PURCHASER : BAKRIE PIPE INDUSTRIES,PT.
JL. RAYA BEKASI KM.27 PONDOK UNGU
JAKARTA

COMMODITY : PRIME NEWLY PRODUCED HOT ROLLED
STEEL IN COIL MILL EDGE

SPECIFICATION : JIS G 3101 SS400

LC. NO. :
CERTIFICATE NO. : B 3706903872087/MC/DM/III/08
D A T E : MARCH 17,2008
LOT. NO.
DELIVERY ORD.NO.:
SUPPLIER ORD.NO.:
ORDER NUMBER : 3706903

PAGE : 001 OF 001

HEAT NO.	SLAB NO	COIL NO. AND PACKING NO	TEST-NO.	DIMENSION T X W X L	QTY (N)	CHEMICAL COMPOSITION X100(%) C	SI	MN	P	S	AL	TENSILE TEST YS N/MM2	TS N/MM2	EL (%)	BEND TEST
06118U	7609	558633	558633	2.80X 962XCOIL	1	14.2	23.9	71.0	0.6	0.5	3.6	372	462	30	GOOD
96134U	4609	558634	558634	2.80X 963XCOIL	1	17.2	0.2	104.6	1.5	0.6	4.2	369	500	30	GOOD
72515Q	7609	608778	608778	2.80X 963XCOIL	1	8.0	24.4	70.6	0.3	0.5	5.1	338	433	30	GOOD
96451U	7609	608779 01	608779	2.80X 963XCOIL	1	8.8	25.7	67.1	0.4	0.8	5.0	355	440	40	GOOD
06380U	7709	608780	608780	2.80X 963XCOIL	1	9.1	24.3	69.9	0.9	0.7	3.6	318	417	30	GOOD
96926U	3109	608781	608781	2.80X 963XCOIL	1	8.5	21.8	67.8	0.6	0.5	3.8	318	409	30	GOOD
89010P	1200	613625	613625	2.80X 963XCOIL	1	12.8	17.7	60.7	1.2	0.3	5.0	378	471	30	GOOD
59469P	1300	613626	613626	2.80X 963XCOIL	1	14.6	16.4	58.9	1.5	1.0	4.1	417	508	30	GOOD

RS/HS04/023, ISSUE NO : 03

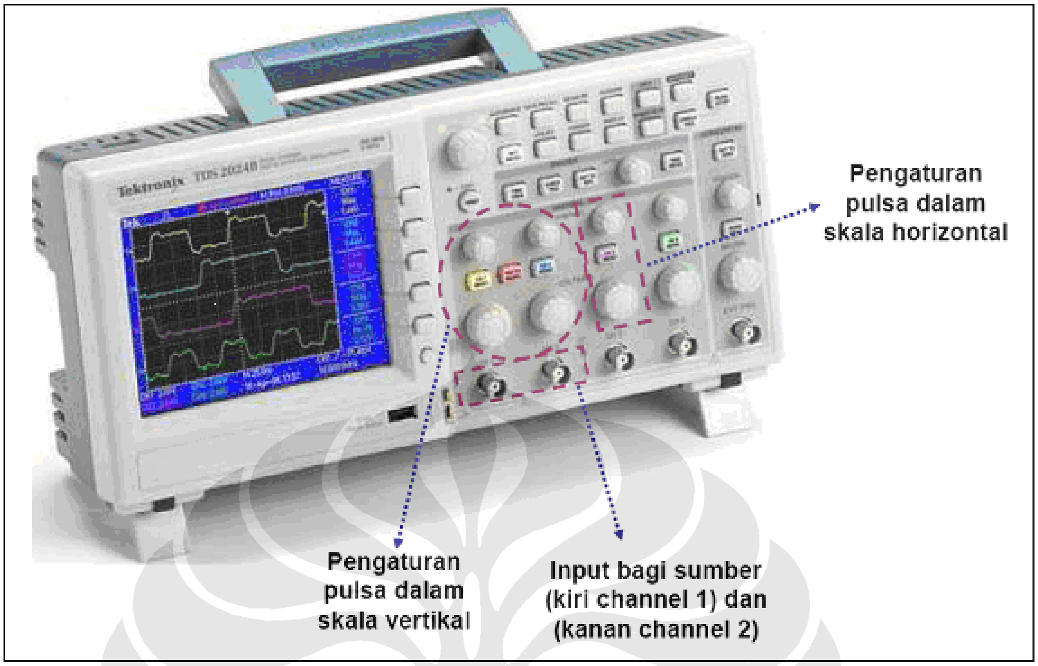
WE HEREBY CERTIFY THAT DIMENSION, SHAPE AND APPEARANCE OF THE MATERIAL DESCRIBED HEREIN HAS BEEN SATISFACTORILY TESTED AND INSPECTED IN ACCORDANCE WITH THE REQUIREMENTS OF THE ABOVE SPECIFICATION

DIVISION OF QUALITY CONTROL

AHYO ANTARIKSO
SUPERINTENDENT

PHONE : (0254) 371015

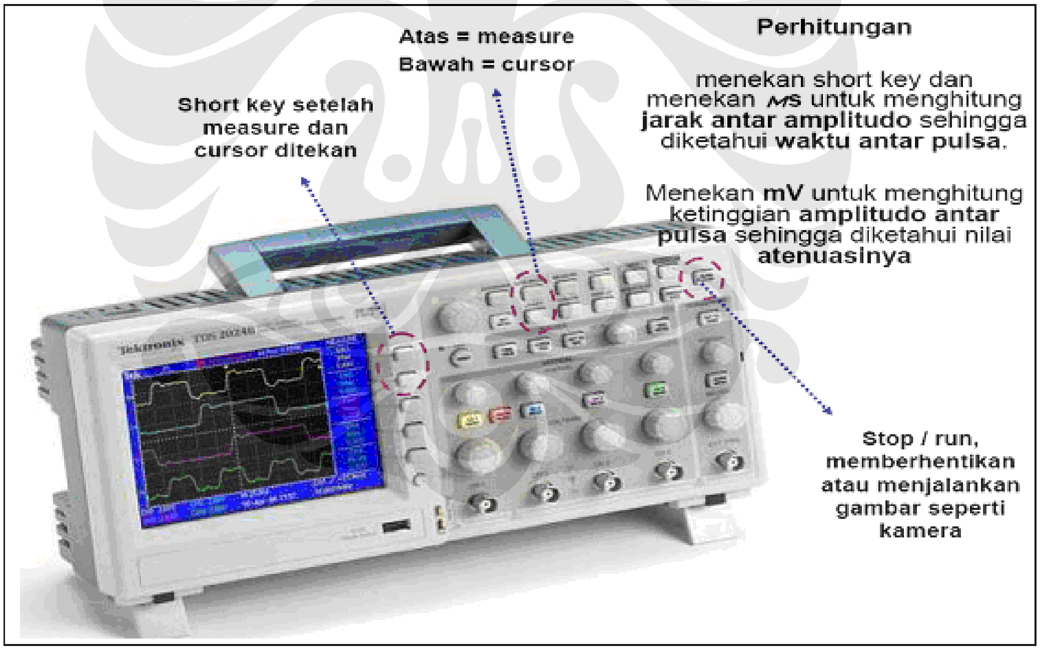
LAMPIRAN 2



Pengaturan pulsa dalam skala horizontal

Pengaturan pulsa dalam skala vertikal

Input bagi sumber (kiri channel 1) dan (kanan channel 2)



Atas = measure
Bawah = cursor

Perhitungan

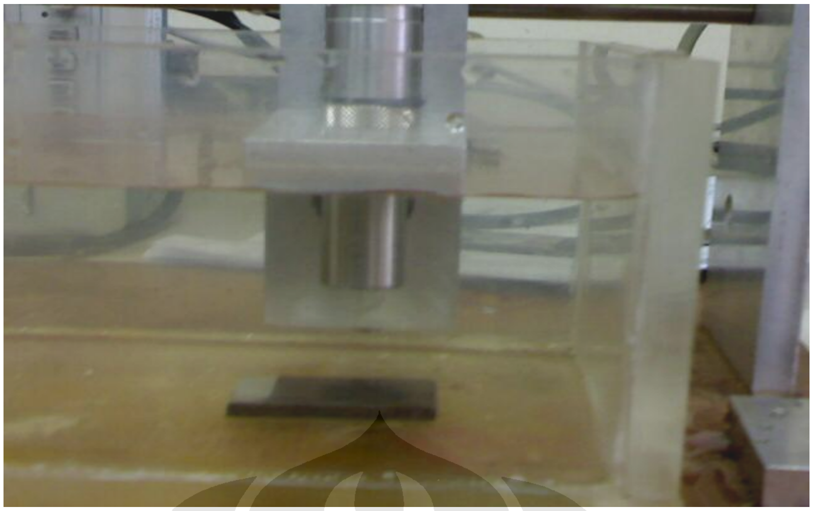
menekan short key dan menekan **ms** untuk menghitung **jarak antar amplitudo** sehingga diketahui **waktu antar pulsa.**

Menekan **mV** untuk menghitung ketinggian **amplitudo antar** pulsa sehingga diketahui nilai **atenuasinya**

Short key setelah measure dan cursor ditekan

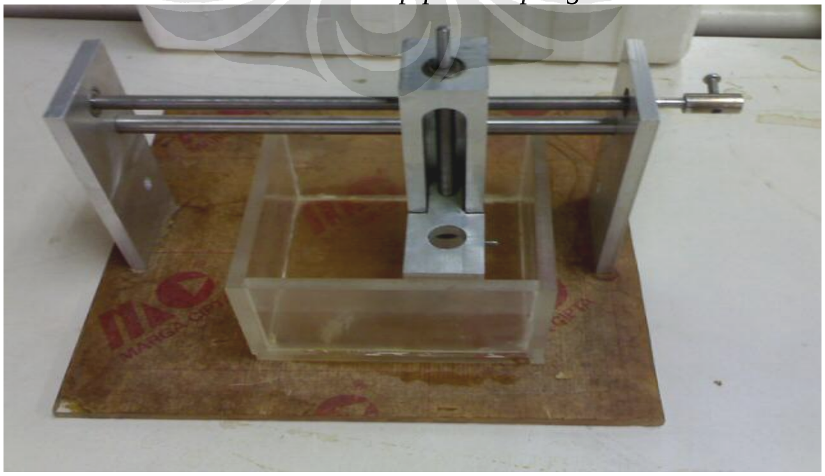
Stop / run, memberhentikan atau menjalankan gambar seperti kamera

Gambar osiloskop *panametric*
sumber : *Puspiptek Serpong*



Gambar Pengujian *water immersion*
sumber : *Puspiptek Serpong*

Gambar *Ultrasonic Pulser-Receiver* merek *Panametric* tipe 5703
sumber : *Puspiptek Serpong*



Gambar Peralatan untuk *water immersion testing*

LAMPIRAN 3

Designation: E 797 – 95 (Reapproved 2001)

Standard Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method[1]

This standard is issued under the fixed designation E 797; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice[2] provides guidelines for measuring the thickness of materials using the contact pulse-echo method at temperatures not to exceed 200°F (93°C).

1.2 This practice is applicable to any material in which ultrasonic waves will propagate at a constant velocity throughout the part, and from which back reflections can be obtained and resolved.

1.3 The values stated in either inch-pound or SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 317 Practice for Evaluating Performance Characteristics of Ultrasonic Pulse-Echo Examination Systems Without the Use of Electronic Measurement Instruments[3]

E 494 Practice for Measuring Ultrasonic Velocity in Materials[3]

E 1316 Terminology for Nondestructive Examinations[3]

2.2 *ASNT Document:*

Nondestructive Testing Handbook, 2nd Edition, Vol 7[4]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology E 1316.

4. Summary of Practice

4.1 Thickness (T), when measured by the pulse-echo ultrasonic method, is a product of the velocity of sound in the material and one half the transit time (round trip) through the material.

$$T = \frac{Vt}{2}$$

where:

T = thickness,

V = velocity, and

t = transit time.

4.2 The pulse-echo ultrasonic instrument measures the transit time of the ultrasonic pulse through the part.

4.3 The velocity in the material being examined is a function of the physical properties of the material. It is usually assumed to be a constant for a given class of materials. Its approximate value can be obtained from Table X3.1 in Practice E 494 or from the *Nondestructive Testing Handbook*, or it can be determined empirically.

4.4 One or more reference blocks are required having known velocity, or of the same material to be examined, and having thicknesses accurately measured and in the range of thicknesses to be measured. It is generally desirable that the thicknesses be "round numbers" rather than miscellaneous odd values. One block should have a thickness value near the maximum of the range of interest and another block near the minimum thickness.

4.5 The display element (CRT (cathode ray tube), meter, or digital display) of the instrument must be adjusted to present convenient values of thickness dependent on the range being used. The control for this function may have different names on different instruments, including *range, sweep, material standardize*, or *velocity*.

4.6 The timing circuits in different instruments use various conversion schemes. A common method is the so-called time/analog conversion in which the time measured by the instrument is converted into a proportional dc voltage which is then applied to the readout device. Another technique uses a very high-frequency oscillator that is modulated or gated by the appropriate echo indications, the output being used either

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[1] This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.06 on Ultrasonic Testing Procedure.

Current edition approved Dec. 10, 1995. Published February 1996. Originally published as E 797 – 81. Last previous edition E 797 – 94.

[2] For ASME Boiler and Pressure Vessel Code applications, see related Practice SE-797 in Section II of that Code.

[3] *Annual Book of ASTM Standards*, Vol 03.03.

[4] Available from the American Society for Nondestructive Testing, 1711 Arlingate Plaza, Columbus, OH 43228.

Designation: E 1001 – 04

Standard Practice for
Detection and Evaluation of Discontinuities by the Immersed Pulse-Echo Ultrasonic Method Using Longitudinal Waves[1]

This standard is issued under the fixed designation E 1001; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice describes procedures for the ultrasonic examination of bulk materials or parts by transmitting pulsed, longitudinal waves through a liquid couplant into the material and observing the indications of reflected waves (Fig. 1). It covers only examinations in which one search unit is used as both transmitter and receiver (pulse-echo) and in which the part or material being examined is totally submerged in the couplant (immersion testing). This practice includes general requirements and procedures which may be used for detecting discontinuities and for making a relative or approximate evaluation of the size of discontinuities.

1.2 This practice complements Practice E 214 by providing more detailed procedures for the selection and calibration of the inspection system and for evaluation of the indications obtained.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 1212 Practice for Fabricating Ceramic Reference Specimens Containing Seeded Voids

C 1336 Practice for Fabricating Non-Oxide Ceramic Reference Specimens Containing Seeded Inclusions

E 127 Practice for Fabricating and Checking Aluminum Alloy Ultrasonic Standard Reference Blocks

E 214 Practice for Immersed Ultrasonic Examination by the Reflection Method Using Pulsed Longitudinal Waves

E 317 Practice for Evaluating Performance Characteristics of Ultrasonic Pulse-Echo Testing Systems Without the Use of Electronic Measurement Instruments

E 428 Practice for Fabrication and Control of Steel Reference Blocks Used in Ultrasonic Inspection

E 1316 Terminology for Nondestructive Examinations

2.2 *ASNT Documents:*

SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing[3]

ANSI/ASNT-CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel[3]

2.3 *Military Standards:*

MIL-STD-410E Nondestructive Testing Personnel Qualification and Certification (Eddy-Current, Liquid Penetrant, Magnetic Particle, Radiographic, and Ultrasonic)[4]

NAS-410 Nondestructive Testing Personnel Qualification and Certification[4]

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this practice, see Terminology E 1316.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *effective beam diameter*—that distance through which a search unit can be traversed across a calibration reflector so that the corresponding echo amplitude is at least one half (-6 dB) of the maximum amplitude. The effective beam diameter is not a characteristic of the search unit alone, but is dependent on propagating medium, distance to the discontinuity, reflector geometry, etc.

3.2.2 *scan index*—the length of the step created by rastering the search unit over the part, that is continuously scanning in

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[1] This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.06 on Ultrasonic Testing Procedure.

Current edition approved January 1, 2004. Published February 2004. Originally approved in 1984. Last previous edition approved in 1999 as E 1001 - 99a.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from The American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518.

[4] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

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Measurement of thickness of layer and sound velocity in multi-layered structure by the use of angular ultrasonic transducers

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Kaunas University of Technology

Abstract:

The possibilities of measurement of thickness of layer and the velocity propagation of ultrasound signals in layered structures by the use of the angular electroacoustical transducers with known parameters are analyzed. It is shown that, when the velocity propagation of ultrasound signals in the separate layer of structure is unknown, the thickness and the velocity propagation of signals in them may be measured by the use of the single measuring channel with angular ultrasonic transducers. The algorithms for determination of thickness of separate layers and ultrasound velocity in them are developed, when the layered structure is iradiated at a known angle to the surface of structure. The modeling of a measuring channel with the angular ultrasonic transducers is performed. When modeling the propagation and reflection of ultrasound signals in duralumin – plexiglass layered structure and the spatial and temporal distributions of them on the surface of layered structure are revealed. The variation of temporal and spatial distributions of received signals is investigated when the angle of incidence to the layered structure is changed. It is shown that temporal and spatial distributions of shear and longitudinal waves do not coincide to each other and alter differently, when the angle of incidence is changed. The results of experimental investigation are presented.

Keywords: ultrasound velocity, angular ultrasonic transducer, layered structure, shear wave, longitudinal wave.

Introduction

Ultrasonic measuring methods of thickness and other physical parameters of layered structures are widely used in industry and non-destructive testing [1-4]. But at present the multi-layered structures become more complicated, consisting of materials with different mechanical and acoustical properties, such as plastics and metals or metals, liquids and plastics. Difference of mechanical impedances of these materials causes many problems. Especially it is evident when the measuring information must be obtained only from one side of the layered structure [5,6]. In this case not always it is possible to obtain the measuring information about parameters of all layers or some of them. This is stipulated by the losses of ultrasound signals in separate layers as well as by loses of ultrasound signals in the boundaries between them. These loses depend on the differences of acoustical impedances and on the acoustical properties of the materials of different layers. Other difficulties occur because the acoustical properties of the materials of different layers often cannot be exactly known. For that reason the measurement of thickness and other parameters of the separate layers is problematic. The problems are related to the fact that the velocities of propagation of acoustic waves of different types in the separate layers of structure are unknown. In such a case the determination of thickness of separate layer is possible only by using of two separate measuring channels. At least in one channel the layer must be irradiated at an angle to its surface. Though, when sounding at the angle to the surface of the layer structure, the longitudinal, shear and other types of ultrasound waves are excited [1]. It allows increase the measurement possibility by the use of ultrasound wave mode conversion. The velocity propagation of shear waves is about two times less than the velocity of longitudinal waves. In this case the time of propagation of acoustical signals in the layer becomes almost twice longer. It enables improve the resolution and accuracy of measurement of thickness. But often in multi-layer structures the velocities of propagation of different types of waves in separate layers are unknown, especially for ultrasonic shear waves. In that case the angles of propagation and reflection of ultrasound waves of different types are not known too.

An oblique incidence method for excitation of longitudinal and shear waves is very convenient for measurement of an unknown ultrasound velocity and thickness by the use of two measuring channels [6,7]. In both cases two measurements are performed for different distances and delay times. But in analysis presented [6,7] there is no information about ultrasound wave mode conversion and about propagation of shear waves in separate layers of the layered structure. In these articles no information about the use and selection of different types of waves and information about the use of angular transducers for that purpose is given. Therefore the objective of this paper is analysis and verification of a new method for thickness and ultrasound velocity measurement in multi-layer structures using information about parameters of angular transducers.

Theoretical investigation

Suppose that we have a medium, which consists of *n* parallel layers with different physical properties. The plane acoustic wave is radiated to this structure at an angle α_0 by the use of angular ultrasonic transducer. The velocity of longitudinal wave propagation in the wedge of the transducer is c_0. This wave at every boundary of layers is transformed to the reflected and refracted longitudinal and shear waves (Fig.1). With the purpose do not overburden Fig.1 by information only one from the refracted waves is shown in it. The angle α_I of propagation of any wave in the *i* layer is determined by the Snell's law

$$\frac{\sin\alpha_0}{c_0} = \frac{\sin\alpha_i}{c_i}, \qquad (1)$$

LAMPIRAN 4

Datakekerasan

Sampel (870oC, 1 jam)			
1.153	1.177	1.165	179.33
1.152	1.200	1.176	175.6862
1.209	1.181	1.195	169.6437
1.183	1.158	1.1705	177.4944
BHN			**175.5386**

Sampel (870oC, 2jam)			
1.133	1.107	1.12	195.4571
1.165	1.137	1.151	184.1304
1.137	1.102	1.1195	195.6481
1.048	1.028	1.038	230.9096
BHN			**201.5363**

Sampel (870oC, 3jam)			
1.144	1.118	1.131	191.3231
1.219	1.182	1.2005	167.9514
1.222	1.175	1.1985	168.5639
1.094	1.072	1.083	210.3756
BHN			**184.5535**

Sampel (910oC, 1 jam)			
0.970	0.952	0.961	273.6916
1.003	1.004	1.0035	248.7425
1.026	0.985	1.0055	247.6534
1.063	1.065	1.064	218.7005
BHN			**247.197**

Sampel (910oC, 2 jam)			
0.855	0.822	0.8385	371.1695
0.909	0.902	0.9055	312.3648
0.897	0.873	0.885	328.762
0.873	0.850	0.8615	349.2169
BHN			**340.3783**

Sampel (910oC, 3 jam)			
1.183	1.108	1.1455	186.0681
1.150	1.098	1.124	193.9387
1.156	1.130	1.143	186.9589
1.112	1.038	1.075	213.8225
BHN			**195.197**

Sampel (950oC, 1 jam)			
0.855	0.839	0.847	362.8181
0.900	0.869	0.8845	329.1781
0.898	0.903	0.9005	316.2481
0.856	0.835	0.8455	364.2709
BHN			**343.1288**

Sampel (950oC, 2 jam)			
0.892	0.902	0.897	319.01
0.922	0.854	0.888	326.2821
0.965	0.903	0.934	291.5454
0.983	0.934	0.9585	275.2747
BHN			**303.0281**

Sampel (950oC, 3 jam)			
0.857	0.887	0.872	339.8455
0.939	0.893	0.916	304.4408
0.972	0.842	0.907	311.2138
BHN			**318.5**

LAMPIRAN 5

Data kedalaman difusi standar pada foto mikro

Sampel	Kedalaman difusi standar untuk foto mikro (mikron)	Besar deviasi (penyimpangan) (%)
870^{o}C, 1 jam	316.2780656	32.97037543
870^{o}C, 1 jam	309.8013817	23.62759582
910^{o}C, 1 jam	307.642487	24.58778947
910^{o}C, 2 jam	255.8290155	5.539240506
910^{o}C, 1 jam	302.2452504	2.565714286
950^{o}C, 1 jam	273.1001727	1.061818182
950^{o}C, 2 jam	305.4835924	22.09074205
950^{o}C, 3 jam	296.8480138	19.58981818