Analysis for the Accuracy of Thickness Measurement of Corrode Metal Sheet by Ultrasonic Thickness Gauge

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Abstract— This paper summarizes some of the major aspects of precision ultrasonic thickness gauging. Ultrasonic nondestructive testing (NDT) characterizing material thickness, integrity, or other physical properties by means of high-frequency sound waves has become a widely used technique for quality control. In thickness gauging, ultrasonic techniques permit quick and reliable measurement of thickness without requiring access to both sides of a part. During the thickness measurement of any corrode plate, the reading of ultrasonic equipment gives many different reading for each time of inspection at same position due to there non uniform surfaces. Any material whose thickness is lower than the low limit of the probe due to corrosion of metal piece will cause Measurement errors. Sometimes the displayed reading is twice as big as the actual thickness. To prevent these errors, the critical thin Materials should be measured repeatedly for verification. This paper looks at the root causes of poor performance with ultrasonic and suggests some methods to improve the situation.
Key words: NDT, UT, Corrosion

I. Introduction

Corrosion is one of the serious problem affecting ship, pipe line and aviation industries. It affects the body of ship and thickness of pipe and an aero plane wings, surface, between joints and fasteners. The presences of corrosion underneath the paints of surface and between joints are not easy to be detected. The unnoticed presence of corrosion may cause so many accidents leading to human and money loses. To detect the thickness of the metal surface, various methods and tests are used. These tests conducted should be such that it does not destroy or disassemble the equipment to parts or damage its surface. Hence for the further use of the equipment, Non-destructive tests (NDT) are carried out.

A. *Non-Destructive Tests[13]:*

Non-destructive testing as the name suggests is testing procedure without any damage to the part being tested. The various non-destructive testing methods used are:

(1) Visual inspection
(2) X-ray inspection
(3) Die (liquid) penetration inspection
(4) Magnetic particle inspection
(5) Eddy current inspection
(6) Ultrasonic inspection

B. *Ultrasonic Inspection[9]:*

Ultrasonic inspection is conventionally used for thickness measurement of ship plate, pipe line and Aviation industries. But the conventional inspection method carries with it certain defects like:

– It scans perpendicular to the surface and hence rate of scanning (from point to point) is less and hence highly time consuming.
– Conventional method is not capable of detecting disbonds between layers and cracks at fastener holes.

These defects are overcome by a newly developed inspection method using guided ultrasonic waves.

Guided waves demonstrate an attractive solution where conventional ultrasonic inspection techniques are less sensitive to defects such as corrosion/disbonds in thin multilayered wing skin structures and hidden exfoliation under wing skin fasteners. Moreover, with their multimode character, selection of guided wave modes can be optimized for detection of particular types of defects. Mode optimization can be done by selecting modes with maximum group velocities (minimum dispersion), or analysis of their wave mode structures (particle displacements, stresses and power distributions).

II. Measurement Principles Introduction[12]

Ultrasonic nondestructive testing (NDT) characterizing material thickness, integrity, or other physical properties by means of high-frequency sound waves--has become a widely used technique for quality control. In thickness gauging, ultrasonic techniques permit quick and reliable measurement of thickness without requiring access to both sides of a part. Accuracies as high as ±1 micron or ±0.0001 inch are achievable in some applications. Most engineering materials can be measured ultrasonically, including metals, plastic, ceramics, composites, epoxies, and glass, as well as liquid levels and the thickness of certain biological specimens. On-line or in-process measurement of extruded plastics or rolled metal is often possible, as is measurement of single layers or coatings in multilayer materials. Modern hand held gages are simple to use and highly reliable.

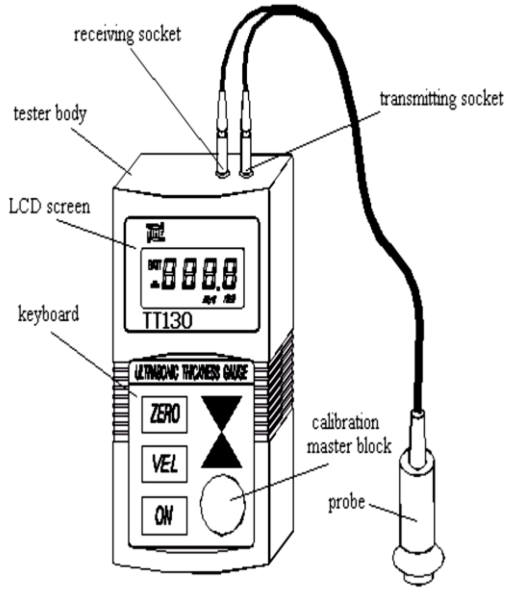


Fig. 1: ultrasonic testing machine [12]

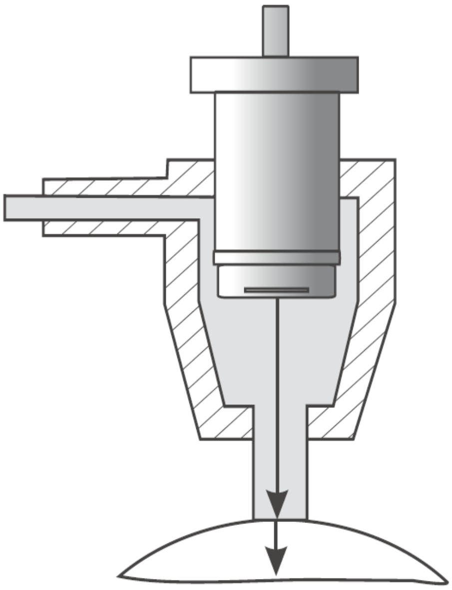


Fig. 2: principle of ultrasonic testing machine[12]

Precision ultrasonic thickness gages usually operate at frequencies between 500 KHz and 100 MHZ, using piezoelectric transducers to generate bursts of sound waves when excited by electrical pulses. A wide variety of transducers with various acoustic characteristics have been developed to meet the needs of industrial applications. Typically, lower frequencies will be used to optimize penetration when measuring thick, highly attenuating, or highly scattering materials, while higher frequencies will be recommended to optimize resolution in thinner, non-attenuating, non-scattering materials.

A pulse-echo ultrasonic thickness gage determines the thickness of a part or structure by accurately measuring the time required for a short ultrasonic pulse generated by a transducer to travel through the thickness of the material, reflect from the back or inside surface, and be returned to the transducer. In most applications this time interval is only a few microseconds or less. The measured two-way transit time is divided by two to account for the down-and-back travel path, and then multiplied by the velocity of sound in the test material. The result is expressed in the well-known relationship:

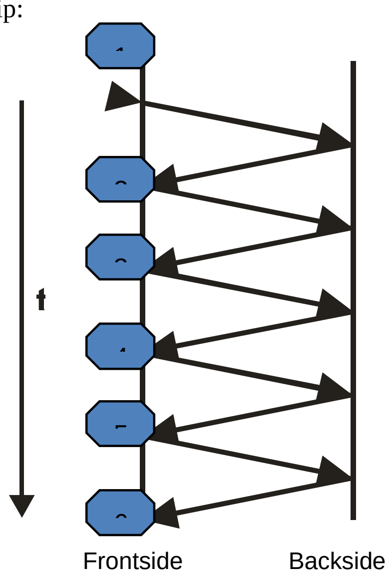


Fig. 3: path of ultrasonic wave

$$Thickness = \frac{time\ of\ flightXsonic\ speed}{2}$$

Additionally, in actual practice, a zero offset is usually subtracted from the measured time interval to account for certain fixed electronic and mechanical delays. In the common case of measurements involving direct contact transducers, the zero offset compensates for the transit time of the sound pulse through the transducer's wearplate and the couplant layer, as well as any electronic switching time or cable delays. This zero offset is set as part of instrument calibration procedures and is necessary for highest accuracy and linearity.

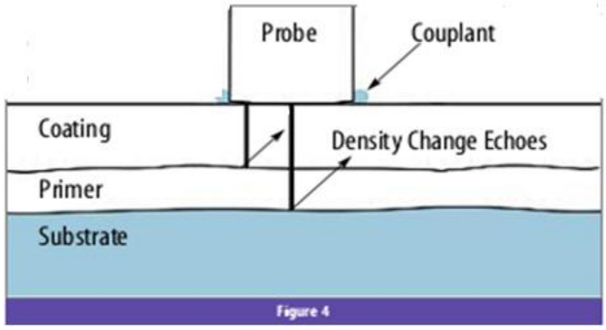


Fig. 4: layers of test material with ultrasonic probe

III. Factors Affecting Performance and Accuracy of Measurment of Thicknss of Corrod Metal Sheet

A. Calibration:

The accuracy of any ultrasonic measurement is only as good as the accuracy and care with which the gage has been calibrated. All quality ultrasonic gages provide a method for calibrating for the sound velocity and zero offset appropriate for the application at hand. It is essential that this calibration be performed and periodically checked in accordance with the manufacturer's instructions. Sound velocity must always be set with respect to the material being measured. Zero offset is usually related to the type of transducer, transducer cable length and mode of measurement being used.

B. Rusty Spots And Eroded Pits[2]:

Fig. 5: internal surface of ship hull structure after 5year[3]

Rusty spots and eroded pits may cause the readings to change irregularly. Under extreme circumstances, there is even no reading. It is hard to discover a small rustyspot. When a eroded pit is found or in suspicion, care is needed to measure thearea. Different positions of angles of the probe cross talk isolating board may beselected to carry measurements for many times.

C. Surface Roughness Of The Test Piece:

The best measurement accuracy is obtained when both the front and back surfaces of the test piece are smooth and parallel. If the contact surface is rough, the minimum thickness that can be measured will be increased because of sound reverberating in the increased thickness of the couplant layer. There will also be potential inaccuracy caused by variations in the thickness of the couplant layer beneath the transducer. Additionally, if either surface of the test piece is rough, the returning echo may be distorted due to the multiplicity of slightly different sound paths seen by the transducer, and measurement inaccuracies will result.

D. Measuring Methods[1]:

The instrument provides many measuring methods.

(1) Single point measuring method: use the probe to measure any point of the work piece to be measured and the displayed value is the thickness.
(2) Two point measuring method: Perform two measurements on the same point of the measured surface, in the second measurement, splitting plane of the probe should be 90 degree, take the minimum as the thickness value.
(3) Multiple point measurement method: perform several measurements in a circle about 30mm in diameter and take the minimum value as the thickness value.
(4) Continuous measurement methods: apply the single point measurement method, and take measurements continuously along the designated route, the intervals should be less than 5mm, and take the minimum value as the work piece's thickness.

E. Coupling Technique:

In Mode 1 (direct contact transducer) measurements, the couplant layer thickness is part of the measurement and is compensated by a portion of the zero offset. If maximum accuracy is to be achieved, the coupling technique must be consistent. This is accomplished by using a couplant of reasonably low viscosity, employing only enough couplant to achieve a reasonable reading, and applying the transducer with uniform pressure. A little practice will show the degree of moderate to firm pressure that produces repeatable readings. In general, smaller diameter transducers require less coupling force to squeeze out the excess couplant than larger diameter transducers. In all modes, tilting the transducer will distort echoes and cause inaccurate readings, as noted below.

F. Curvature of the Test Piece:

A related issue involves the alignment of the transducer with respect to the test piece. When measuring on curved surfaces, it is important that the transducer be placed approximately on the centerline of the part and held as nearly normal to the surface as possible. In some cases a spring-loaded V-block holder may be helpful for maintaining this alignment. In general, as the radius of curvature decreases, the size of the transducer should be reduced, and the more critical transducer alignment will become. For very small radiuses, an immersion approach will be necessary. In some cases it may be useful to observe the waveform display via an oscilloscope or other waveform display as an aid in maintaining optimum alignment. Often practice with the aid of a waveform display will give the operator a proper "feel" for the best way to hold the transducer. On curved surfaces it is important to use only enough couplant to obtain a reading. Excess couplant will form a fillet between the transducer and the test surface where sound will reverberate and possibly create spurious signals that may trigger false readings.

G. Taper or Eccentricity:

If the contact surface and back surface of the test piece are tapered or eccentric with respect to each other, the return echo will be distorted due to the variation in sound path across the width of the beam. Accuracy of measurement will be reduced. In severe cases no measurement will be possible.

H. Acoustic Properties of the Test:

Engineering materials that can potentially limit the accuracy and range of ultrasonic thickness measurements:

1) Sound Scattering:

In materials such as cast stainless steel, cast iron, fiberglass, and composites, sound energy will be scattered from individual crystallites in the casting or boundaries of dissimilar materials within the fiberglass or composite. Porosity in any material can have the same effect. Gage sensitivity must be adjusted to prevent detection of these spurious scatter echoes. This compensation can in turn limit the ability to discriminate a valid return echo from the back side of the material, thereby restricting measurement range.

2) Sound Attenuation or Absorption:

In many organic materials such as low density plastics and rubber, sound energy is attenuated very rapidly at the frequencies used for ultrasonic gauging. This attenuation typically increases with temperature. The maximum thickness that can be measured in these materials will often be limited by attenuation.

3) Velocity Variations[12]:

An ultrasonic thickness measurement will be accurate only to the degree that material sound velocity is consistent with gage calibration. Some materials exhibit significant variations in sound velocity from point to point. This happens in certain cast metals due to the changes in grain structure that result from varied cooling rates, and the anisotropy of sound velocity with respect to grain structure. Fiberglass can show localized velocity variations due to changes in resin/fiber ratio. Many plastics and rubbers show a rapid change in sound velocity with temperature, requiring that velocity calibration be performed at the temperature where measurements are to be made.

Materials	**Sound velocity (m/s)**
Aluminum	6320
Silver	3600
Tin	3320
Brass	4430
Aluminum	6320

Silver	3600
Tin	3320
Zinc	4170
Gold	3240
Iron	5900
Copper	4700
Acrylic resin	2730
Zinc	4170
Gold	3240
Iron	5900

Table 1: velocity of different materials [12]

I. Phase Reversal Or Phase Distortion:

The phase or polarity of a returning echo is determined by the relative acoustic impedances (density x velocity) of the boundary materials. Most commercial gages assume the customary situation where the test piece is backed by air or a liquid, both of which have lower acoustic impedances than metals, ceramics, or plastics. However, in some specialized cases (such as measurement of glass or plastic liners over metal, or copper cladding over steel) this impedance relationship is reversed, and the echo appears phase reversed. To maintain accuracy in these cases it is necessary to change the appropriate Echo Detection polarity, or on instruments where that are not possible, adjust the zero offset to compensate for a timing error equal to one-half cycle of the waveform.

J. Super-Thin Materials:

Any material whose thickness is lower than the low limit of the probe will causemeasurement errors. instrument should be connected again for measuring thesame material in order to obtain the result of the minimum thickness. in measuring super-thin materials, there might be such erroneous results as "dual deflection" sometimes. that means that the displayed reading is twice as big as theactual thickness. another error is known as "pulse envelope, cyclic jumping". Theresult is bigger than the actual thickness. to prevent these errors, the critical thinmaterials should be measured repeatedly for verification.

K. Error In Materials Identification:

Though the device has been corrected by one material, there is still mistakewhen measuring another materials, so proper sound velocity should beselected.

L. Wear Of The Probe:

The probe surface is made of acrylic resin. After using for a long times, theroughness may increase, thus causing the sensitivity declines. If it has beendetermined that the error is caused by roughness, the sand paper or oil grindingstone may be used to grind the surface of the probe so that it will become smoothand parallel. If the reading is still unstable, the probe must be replaced.

Fig. 6: ultrasonic thickness measuring equipment probe

M. The Effect Of The Metal Oxide Layer:

Dense oxide layer may be found in some metals, such as aluminum etc. This oxidelayer contacts with the substrate tightly without clear interface. But ultrasonic wavetransmits with different velocities in these two materials, which will causemeasurement error. Different thickness of oxide layer will result in differentmeasurement errors. It should be cautious to deal with this kind of situation. It'sapplicable to select one block of testing material as sample, measure its thicknessby vernier caliper or micrometer and use this sample to calibrate the gauge.

N. Abnormal Reading:

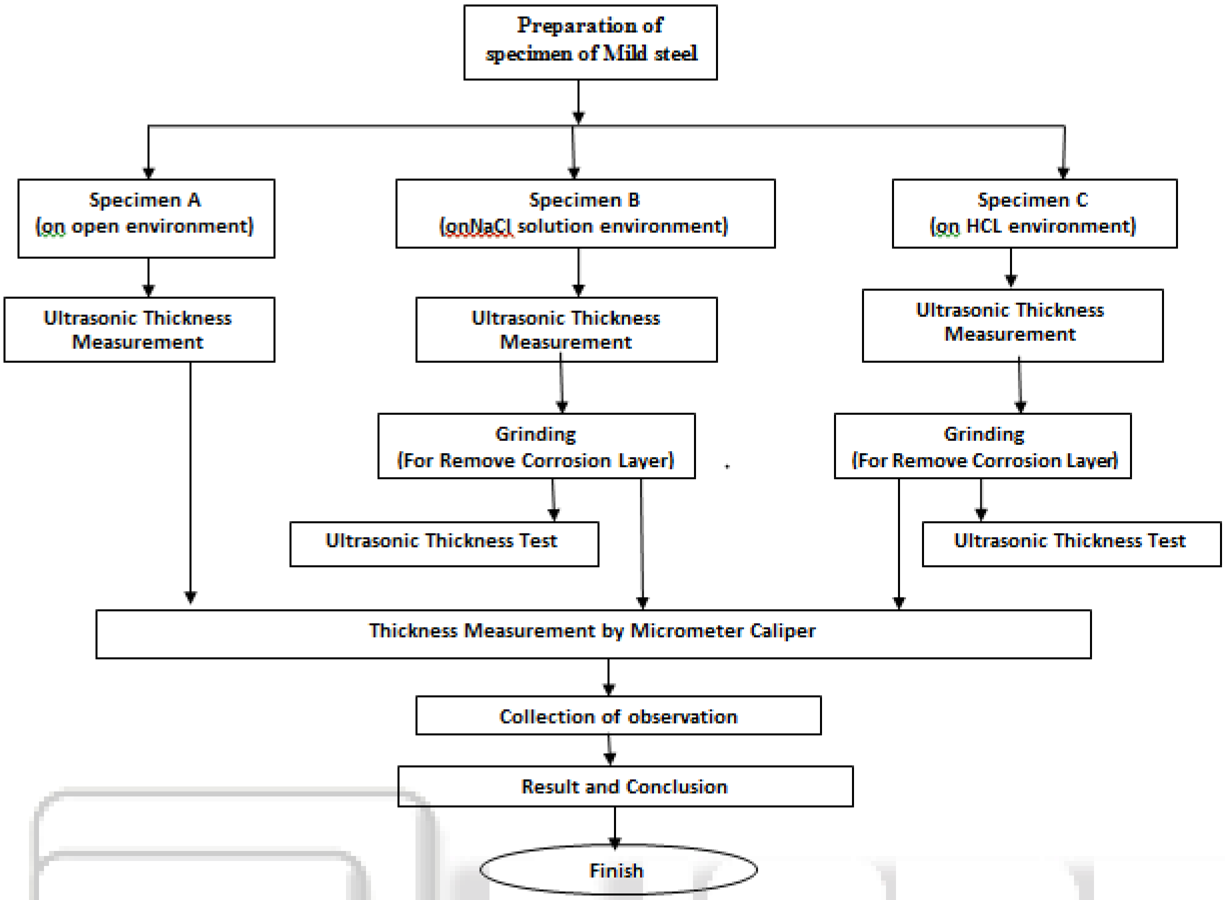
Operators should have the ability of identifying abnormal readings. Usually, rustySports, corroded pits and the interior flaws of the test materials can all causeabnormal readings. For solution, see chapter 9 and 10 of this manual.

O. Use and Choice of Coupling Agents:

Coupling agent is used for transmitting high frequency ultrasonic energy between the probe and the test material. Incorrect selection of the types of coupling agents orimproper usage may cause errors or flashing of the coupling sign, making it unableto measure the thickness. Coupling agent should be used in proper amount andcoated evenly.

It is important to select the proper type of coupling agents. When the surface of thetest material is smooth, low viscosity coupling agent should be used (couplingagents and light machine oil are provided with the instrument). High viscositycoupling agents (such as glycerin paste and lubricating fatetc.) may be chosen forrough surface or vertical surface or peak surface.

IV. EXPERIMENTAL PROCEDURE



V. Experimental Work

A. Experimental Set Up Used In Thickness Measurement Operation:

Equipments used to perform ultrasonic thickness measurement is shown

S/NO	Equipment/ Material used
1	Power hacksaw
2	Ultrasonic thickness Gauge
3	Single Element Transducer/ 2.25MHz Probe
4	Calibration Block
5	Micrometer/Vernier caliper
6	Couplant/Gel
7	Corroded plate(specimen)

Table 2: List of Equipment and material used for thickness Measurement Operation

1) Power Hack Saw:

A power hacksaw (or electric hacksaw) was a type of hacksaw that was powered either by its own electric motor. A hacksaw is a fine-tooth saw with a blade under tension in a frame, used for cutting materials such as mild steel into small pieces so is to keep the plate into rectangular shape. Power hacksaw is shown in Figure

Fig. 6: power hack saw used for cutting purpose

2) Ultrasonic Thickness Gauge (MP1200DL):

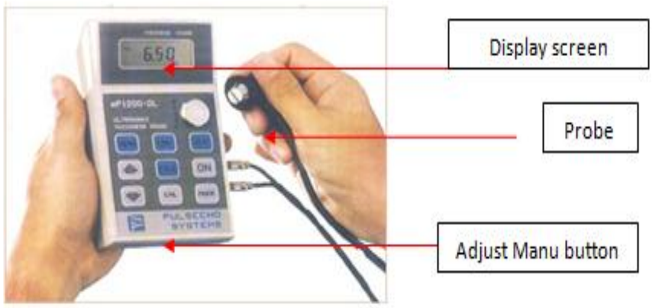


Fig. 7: Ultrasonic thickness gauge

Ultrasonic Testing (UT) uses high frequency sound energy to conduct examinations and make measurements. Ultrasonic inspection can be used for flaw detection/evaluation, dimensional measurements, material characterization, and more. To illustrate the general inspection principle, a typical pulse/echo inspection configuration as illustrated below will be used.

3) Single Element Transducer:

The acoustic pressure field (ultrasound wave) is generated by an ultrasound transducer, which usually employs a piezoelectric material. An electrical pulse, generated by a pulser/receiver unit, is converted into an acoustic pressure field. The inverse piezoelectric effect is used to receive the ultrasound wave, Here the pressure wave is converted into an electrical signal. The construction of a single element transducer is shown in Fig.

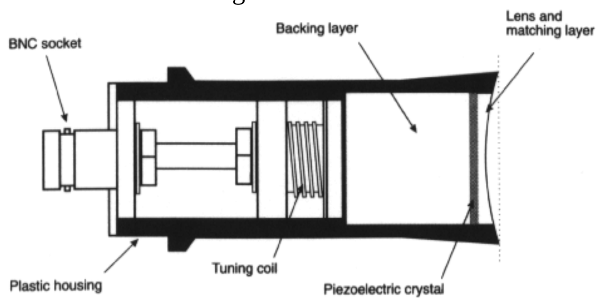


Fig. 8: single element Transducer

4) Micrometer Caliper:

The micrometer caliper is used to make very fine measurements beyond the hundredths of a centimeter. As its name implies, distances are measured to 0.000001m or 10-6 m (recall the SI prefix for an order of magnitude of –6 is micro) which is equal to 0.0001 cm. This device uses the uniformity in the spacing of threads on a bolt. If a nut is threaded on the bolt and the bolt is rotated one complete evolution, the end of the bolt will have moved a linear distance equal to the width of a thread. If instead of a nut, we attach a rotating scale as well as place a calibrated line (also called the fixed scale) along the length of the bolt, then it becomes possible to measure small fractions of a rotation (and small fractions of the width of a thread).Figure

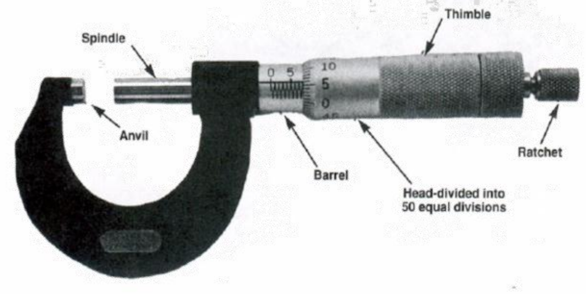


Fig. 9: Micrometer caliper

As shown in Figure 4 the basic parts of a micrometer are labeled. The object to be measured is placed between the anvil and spindle. Turn the thimble until the object fits snugly. Do not force the turning of the thimble, since this may damage the very delicate threads on the spindle located inside the thimble. Some calipers have a ratchet, which helps protect the instrument by not allowing the thimble to turn when forced. The barrel is graduated in millimeters and it also has graduations in halves of millimeters, which are indicated by the lower set of graduations on the barrel. The threads on the spindle are made so it takes two complete turns of the thimble for the spindle to move precisely one millimeter. The head (rotating scale) is divided into fifty equal divisions—each division indicating 0.01 mm, which is the precision of the instrument. Since our eye can still estimate another decimal place between marks on the rotating scale (or 0.001mm, which is 0.000001 m), this device is called a micrometer.

5) Couplants:

In order to take measurements a gel or oil must be used in-between the probe and the surface of the material. This is called couplant. Typical couplants are water based and contain glycerin, others are oil based. After the measurements are taken, spots of couplant will remain on the paint. With water based couplants, these will dry and can be washed off with water without any problem. Oil based couplants are more difficult to remove therefore are less preferable. It is important to properly remove couplants before recoating otherwise paint defects will occur when recoating.

Fig. 10: couplant

Water based couplants can also be hydroscopic therefore promoting corrosion if applied on bare steel and not removed. Some water based couplants include rust inhibitors.

6) Preparation Of Sample:

To make sample for the experiment made 3 piece of a steel plate (plain carbon steel) of the size of 12cmX10cm X6cm each .after getting piece of metal plate need to smoothly clean the surface for getting better corrosion effect in few days. now measuring the thickness of each plate by the help of micrometer gauge and ultrasonic thickness gauge initially.Steel plate was dipped in two bowl container, containing HCL(hydrochloric acid and another in the NaCl solution for the long period of 2 month after this period, specimen being with sunlight open in environment for 1day.due to expose on direct sunray and the open environment both plate gets corrode continuously.This process being done two or three time in the period of six month. after the period of six month we finds the a thin layer of corrosion covered over the throughout surface. Now the specimen ready to test.

Following procedure was followed after the specimen preparation

Calibrate are carried out of the ultrasonic thickness gauge with the help of reference calibration block by calibration technique. After the calibration divided the specimen in 12 part with the help of marker to define their position number on both side .Measured the thickness of each position by ultrasonic thickness gauge.

Taking all the observation of each plate after the corrosion and after the grinding of each surface of steel plate.

After t grinding of surface of specimen are measured by thickness gauge and micrometer caliper.

7) Specification Of Specimen:

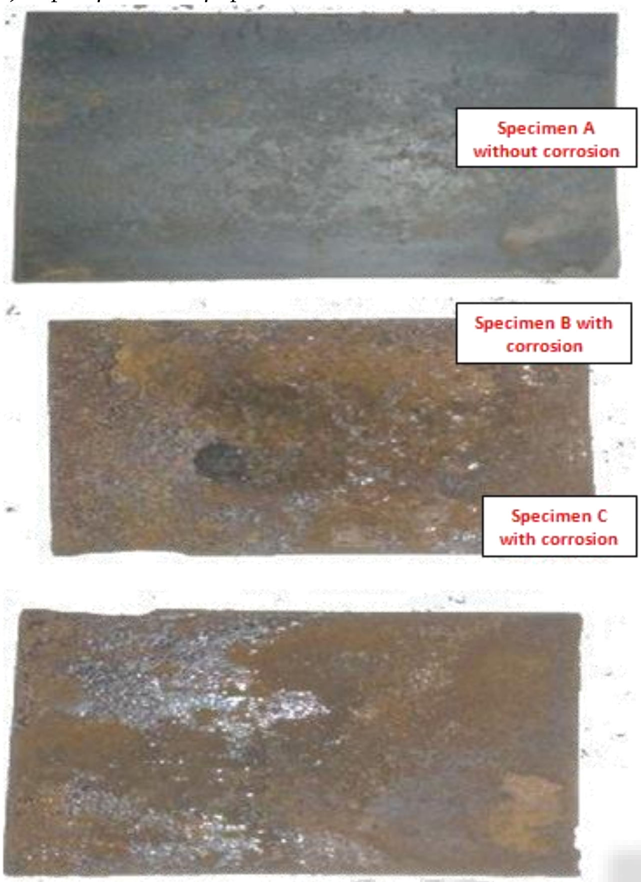
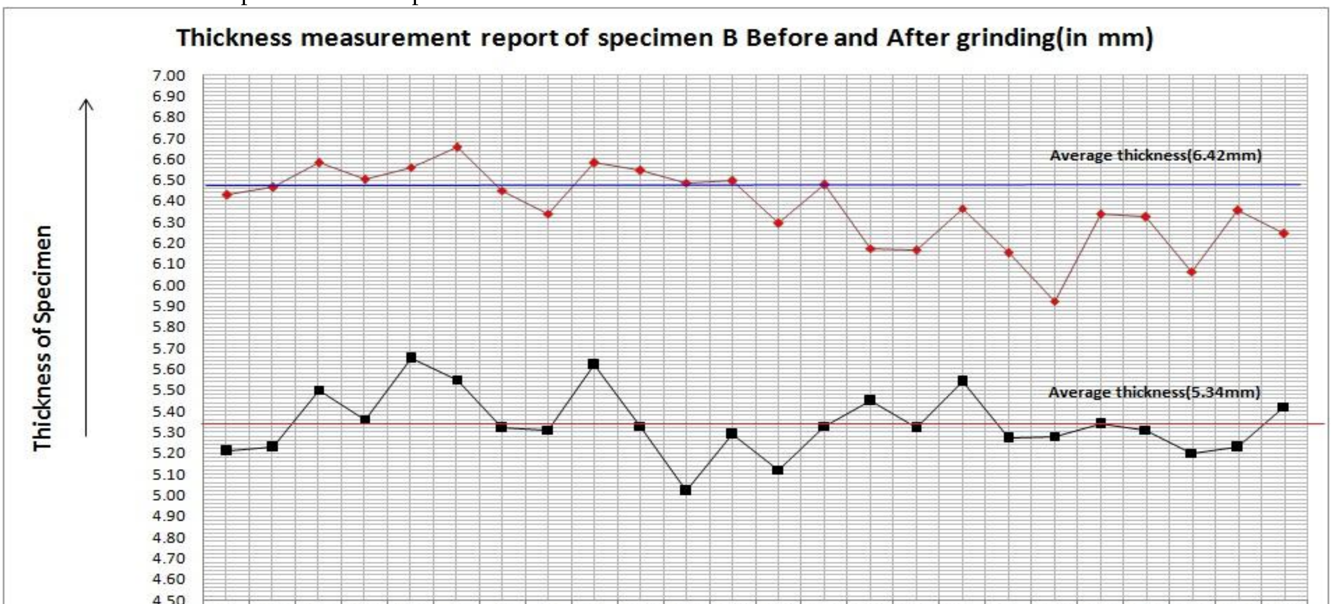


Fig. 11: corrode metal plate after 6 month under corrosion condition

Specimen	Size (LxBxT)in mm	Material
Specimen A	120x100x6	Mild steel
Specimen B	120x100x6	Mild steel
Specimen C	120x100x6	Mild steel

Table 3: Specification of specimen



	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	BB1	BB2	BB3	BB4	BB5	BB6	BB7	BB8	BB9	BB10	BB11	BB12
Before Grinding	6.43	6.47	6.58	6.50	6.56	6.66	6.45	6.34	6.58	6.55	6.49	6.50	6.29	6.48	6.17	6.16	6.36	6.15	5.92	6.34	6.32	6.06	6.35	6.25
After Grinding	5.21	5.23	5.5	5.36	5.65	5.55	5.32	5.31	5.62	5.33	5.02	5.29	5.12	5.33	5.45	5.32	5.54	5.27	5.28	5.34	5.31	5.2	5.23	5.42

VI. RESULTS AND DISCUSSION

A more complex situation can occur in corrode metal sheet, where material conditions result in the existence of multiple sound paths within the beam area. In these cases phase distortion can create an echo that is neither cleanly positive nor negative. Careful experimentation with reference standards is necessary in these cases to determine measurement accuracy. If the effect is consistent it will usually be possible to compensate by means of a zero offset adjustment, but if echo shape is variable, highly accurate thickness measurements may not be possible.

If we ignore the error of corrosion pitting, the performance characteristics of our probes and use an ultrasonic technique not more suited to finished product thickness measurement, we arelikely to reduce probability of error of measurement and sacrifice measurement accuracy.

Here I am showing some observation of calibrated ultrasonic thickness gauge over the non corroded versus corroded metal plate of mild steel 6 mm thick plate after the effected with six month open environmental corrosion condition.

Specimen B					Specimen C				
Position no	**Before Grinding**	**After Grinding**	**Diff**	**% error**	**Position no**	**Before Grinding**	**After Grinding**	**Diff**	**% error**
B1	6.43	5.21	1.22	0.19	C1	6.51	5.21	1.30	0.20
B2	6.47	5.23	1.24	0.19	C2	6.38	5.23	1.15	0.18
B3	6.58	5.5	1.08	0.16	C3	6.34	5.5	0.84	0.13
B4	6.50	5.36	1.14	0.18	C4	6.37	5.36	1.01	0.16
B5	6.56	5.65	0.91	0.14	C5	6.45	5.65	0.80	0.12
B6	6.66	5.55	1.11	0.17	C6	6.34	5.55	0.79	0.12
B7	6.45	5.32	1.13	0.18	C7	6.64	5.32	1.32	0.20
B8	6.34	5.31	1.03	0.16	C8	6.45	5.31	1.14	0.18
B9	6.58	5.62	0.96	0.15	C9	6.68	5.62	1.06	0.16
B10	6.55	5.33	1.22	0.19	C10	6.27	5.33	0.94	0.15
B11	6.49	5.02	1.47	0.23	C11	6.30	5.02	1.28	0.20
B12	6.50	5.29	1.21	0.19	C12	6.56	5.29	1.27	0.19
BB1	6.29	5.12	1.17	0.19	CB1	6.26	5.12	1.14	0.18
BB2	6.48	5.33	1.15	0.18	CB2	6.22	5.33	0.89	0.14
BB3	6.17	5.45	0.72	0.12	CB3	5.89	5.45	0.44	0.08
BB4	6.16	5.32	0.84	0.14	CB4	5.97	5.32	0.65	0.11
BB5	6.36	5.54	0.82	0.13	CB5	6.04	5.54	0.50	0.08
BB6	6.15	5.27	0.88	0.14	CB6	5.92	5.27	0.65	0.11
BB7	5.92	5.28	0.64	0.11	CB7	5.69	5.28	0.41	0.07
BB8	6.34	5.34	1.00	0.16	CB8	5.85	5.34	0.51	0.09
BB9	6.32	5.31	1.01	0.16	CB9	5.94	5.31	0.63	0.11
BB10	6.06	5.2	0.86	0.14	CB10	5.73	5.2	0.53	0.09
BB11	6.35	5.23	1.12	0.18	CB11	5.77	5.23	0.54	0.09
BB12	6.25	5.42	0.83	0.13	CB12	5.66	5.42	0.24	0.04
Thickness Sum	152.97	128.2	24.77	0.16	Thickness Sum	148.23	128.2	20.03	0.14
Avg Thickness	6.37	5.34	1.03	0.16	Avg Thickness	6.18	5.34	0.83	0.14

Table 2: Comparatively study of 6mm thick plate before and after corrosion

Thus, from above observation Specimen B having % error from the observation of corrode plate without grinding is 16 and similarly the specimen C also having % error of 14 therefore it can be said that the average percentage error for the both specimen are calculated by the following relation:

Average % error for the both specimen

$$= \frac{\text{Average \% error of the specimen B} + \text{Average \% error of specimen C}}{2}$$

$$= \frac{0.16+0.14}{2} = 0.15$$

= 15%

So, finally we can conclude if the mild steel plate is under the corrosion condition and having light corrosion while the expose for maximum six month, we can say that thickness measurement of the plate by using ultrasonic thickness gauge it gives 15%(Approximate) higher thickness as compare to same plate which is already removed their corrosion layer or Oxide layer from their surface.

VII. CONCLUSIONS

The conclusions drawn from the present investigation are as follows:

1. The results confirmed that if the measurement taken without the surface finish of metal surface it gives wrong or incorrect values always.
2. This error occurred due to the uneven surface and dust particle presence in plate surface.
3. It is found that the propagation of the ultrasonic wave in the metal plate is little bit slow due to the change in medium i.e. when passing through metal plate to oxide layer.
4. Ultrasonic thickness gauge always include the layer of oxide in the count of thickness measurement when passing through it.
5. By the investigation of thickness measurement report we can conclude, if reduce the additional thickness which are measured by ultrasonic thickness gauge due to corrosion layer we can achieve actual thickness which are closer to exact thickness.
6. This prediction gives the freedom to measure the corrode metal plate without surface preparation by the UTG.
7. The accuracy in measurement gives more reliability for any product and for their life also.

The results from this research indicate that the technology has the potential to be a useful tool in evaluating the thickness measurement of corrodes plates by reducing the factors which is involved in measurement error.

Thus in the case of corroded metal plate we must should considering the lowest reading on measurement for the better safety condition for design.

Techniques which are most suitable for reducing the error in measurement of thickness can be summarized by following lines:

1. Before measurement, it is necessary to clean the dust, dirt or rusty matters andcoatings of the surface off the test object
2. Too rough a surface may cause errors or no reading. Before measurement starts, measures should be taken to keep the test surface smooth by way of grinding,polishing and filing. High viscosity coupling agent may also be used.
3. Due to unfinished surface or irregular surface some time ultrasonic thickness measurement equipment gives different value of thickness at same time frequently on this case it is very necessary to take more reading by equipment or repeating the measurement for getting more accurate value.

The use of above techniques can improve probability of better thickness measurement and careful consideration of the relevant defect andcan optimize measurement accuracy.

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