

**THE FUSION EFFECT OF COMPUTED RADIOGRAPHY  
IMAGE OF WELDING PLATE DIFFERENT IN POWER TO  
ITS IMAGE QUALITY  
(PENGABUNGAN RADIOGRAF PELAT LAS COMPUTED  
RADIOGRAPHY BERBEDA TENAGA KEPADA KUALITAS GAMBARNYA)**

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**ABSTRACT**

*Instrument testing which is done in industries are one of methods to maintain the primary condition of instrument with purpose to prevent damage on instrument which will cause accident or death. Testing conducted using non-destructive technique or NDT, which is one of testing which does not leave any damage or harm to the test specimen. Non-destructive testing in industry is leveling up to digital display. This digital radiography uses image plate instead of film. In this research, computed radiography in various energy and current is used. Voltage and current are factors that give effect to the resulting image. Voltage gives effect to contrast, contrast increases the number of x-ray emitted from the x-ray tube, which is higher the current makes the noise higher to image. In this study, the important parameters are voltage and current. Exposure distance and time are 100 cm and 1 minute. With these distance and time, the specimen which is 17 mm thick being exposed to the radiation with various energy and current which is 160 kV, 180 kV, and 200 kV, 3 mA, 5 mA, and 10 mA. The resulting images are analyzed with iSee! and image fusion using MATLAB. Simple fusion method is the simplest way of fusing the image which is done by pixel selection, or with extraction. Image that has been fused divided by two, which is the fused image with the same voltage but different current and vice versa. The comparison is done by determining the SNR in image with iSee!. After fusion, the SNR increases which means the increase of image quality.*

*Keyword: Material, NDT, Radiography, Welding plate*

**ABSTRAK**

*Instrumen pengujian yang digunakan dalam industri merupakan salah satu metode untuk mengendalikan kondisi sebuah instrumen. Metode ini mempunyai tujuan mencegah kerusakan yang mampu menyebabkan kecelakaan fatal. Pengujian yang digunakan dengan menggunakan metode pengujian non destruktif merupakan metode yang tidak meninggalkan kesan-kesan kerusakan kepada spesimen pengujian. Pengujian non-destruktif dalam industri telah menggunakan tampilan digital. Teknik radiografi digital menggunakan pelat imaging dari pada film. Dalam penelitian ini, computed radiography dengan menggunakan berbagai energi dan arus digunakan. Tegangan dan arus memberikan efek terhadap hasil citra. Tegangan memberikan kesan terhadap kontras, sedangkan arus menambahkan jumlah noise terhadap citra. Parameter terpenting adalah tegangan dan arus. Jarak penyinaran dan waktu penyinaran adalah 100 cm dan 1 menit.*

*Spesimen yang diuji mempunyai ketebalan 17 mm dan disinari dengan sinar x dengan tegangan dan arus bervariasi 160 kV, 180 kV, dan 200 kV, 3 mA, 5 mA, dan 10 mA. Citra terhasil kemudian dianalisa dengan menggunakan aplikasi iSee! Dan penggabungan dilakukan dengan menggunakan MATHLAB. Metode penggabungan yang dilakukan dengan cara yang sederhana yaitu dengan pemilihan pixel atau ekstraksi. Citra yang telah digabungkan dibagi menjadi dua, yaitu citra penggabungan dengan tegan yang sama namun arus yang berbeda, dan sebaliknya. Perbandingan dilakukan dengan aplikasi iSee! Dalam bentuk Analisa SNR. Setelah citra dihasilkan, SNR citra bertambah yang berarti penambahan terhadap kualitas citra.*

*Kata kunci : Bahan, NDT, Radiografi, Welding Plate*

## INTRODUCTION

Radiography is one of the technique of testing to analyzed an object without harming or destroying it, which also can be called as NDT (Non- Destructive Testing). Radiography is widely used in either medical or industries. In medical radiography is used for diagnoses, on the other hand in industry radiography is used for NDT to check the deformaty in welding, QA/QC, etc.

The image of radiography could be obtain by exposed the detector with ionizing radiation. The detector is where the image been recorded and processed depends of detectors been used. For conventional radiography the detector used to produce the image is the radiography film, which needed to processed by developing the image in the dark room. The more advanced computed radiography acquire imaging plate (IP) to processed the image with laser scanner. The image of these radiography is fully digital.

Digital Radiography is a technique of radiography using the imaging plate as detector to produce image (de Raad, 2007). There are many type of Digital Radiography

system such as; flat panel, computed radiography, and fluoroscopy. In this article we only discuss about computed radiography. The image that recorded in IP after exposure of radiation is erased after scanned with laser scanner causing the IP could be used multiple times (Harara, 2005), unlike film that only could be used once.

Gamma and X-ray is two types of ionizing radiation that widely used for radiography in Industries and Medical. X radiation is common for medical radiography because of the safety advantages, but gamma ray is often used in indsutries for the mobility purpose and the penetrating energy its offer. Each radiation has its own advantages and disadvantages, those can be seen in the table below.

Table 1. The difference between X-ray and Gamma ray

	X-ray	Gamma	
<b>Advantage</b>	Disadvantage	Advantage	Disadvantage
<b>Switch</b>	Using electricity	Do not use electricity	No switch
<b>Adjustable energy level</b>	Difficult to move around	Mobile source	Non adjustable energy level
<b>Good contrast image quality</b>	Low energy	High energy	Bad contrast image quality

Based on the table above, the image that could be obtain by two different type of radiation is different. Gamma ray could make the image had a bad contrast due to its energy properties that is unstable, different to x-ray that has stable energy making image contrast relatively good. Using the different energy for radiography could also generate the different image. High energy of radiation could cause the darker image depend on the thickness of specimen. The thick specimen need more time and energy for radiation to penetrate it.

Computed radiography had a dynamic range to root the system could generate the image that only need one exposure for various thickness of specimen, eventhough the image quality is still different with conventional radiography. Deformity and crack still not fully detected which could be dangerous to the test specimen. To solve this problem is using the image processing or image fusion. Using double technique could produce the complete data using image fusion (de Radd, 1997).

In this article the welding plate is exposed by x-ray different in energy and current to produc various image of radiography. The produced image with low and high energy of x-ray is fused with MATLAB to obtain the better image quality. The fused image quality will be measured by using Signal-Noise-Ration (SNT) with Isee! software.

Image fusion had already used in medical to obtain the better image quality. Hybrid tool like PET/CT is constructed in order to obtain the better image quality. Theoretically, image fusion can be done with some method. The first method is waht is

called as mental fusion is where the two image set next to each other and an examiner will fused the image in their mind. This method is quite economic but take a longer time to process, and the inaccuracy is must be put in to consideration. The other method is using software or hybrid modality such as PET/CT (Dallesio, 2003).

Gros stated the data fusion is could give the synergist information from many sources to help understanding the phenomenon completely. Image fusion is not current to mdical field, but this is also not new to industry radiography for example, tomography used for image construction of deformity in the material. NDT could filtered and fused the collected data that give new relative perspective to the system (Elshafiey et al., 2011).

### **Computed Radiography (CR)**

Computed Radiography is a technique of producing the radiography image in the form of digital data. In order to produce the image, radiography is performed by using Imaging Plate (IP) as the detector. IP is consist of numerous atom of phosphor which used in scanning and processing the image in pc/computer. The scanning process is undergoes in the laser scanner. The atomic phosphor that been exposed by the x-ray had deposit the energy in the atom. When it is interacted with laser in the scanner, the atom is illuminated and emitted the length of energy and captured by the scanner. The latent image which deposit in the form of energy get erased in the IP causing IP

reusable for the next radiography imaging.

## TOOLS AND EQUIPMENT

Tools and Instrument:

1. Welding Plate
2. Imaging Plate (IP)
3. Duplex Wire
4. Computed Radiography (CR)
5. X-ray Set Machine (ISOVOLT Titan E)
6. Isee!
7. MATLAB

### ISOVOLT Titan E

In this paper the x-ray sources is using the ISOVOLT Titan E which manufactured by General Electronic. This x-ray machine has a great range of control to 300 ft and having the special characteristic of tube protection from automatic heating. The control panel is constructed with button to control the energy, current and maximum voltage of the machine. ISOVOLT Titan E have a specification with the following table.

Table 2. The Specification of High-power Generator

Maximum output Voltage	160 kV	225 kV
Maximum output Current	45 mA	45 mA
Maximum Power	4.5 kW	4.5 kW
High Ripple Voltage	5 V/mA	5 V/mA
Insulator	Minyak	Minyak

Source: GE Measurement Control

## METHODOLOGY

### Image Production

The first step of this study is to produce the image of Computed Radiography different in voltage and current. The parameter need to

determine before exposing the welded plate to the radiation. The independent and dependent should be determine.

The independent variable is a variable which independent from the result of the study. In this study the independent variable is voltage and current. The voltage used was 160 kV, 180 kV, 200 kV. The current was 3 mA, 5mA, 10 mA. The dependent variable is the image product of computed radiography. The distance of source to the welding plate is made same in all exposition which is 100 cm.

After all the variable and parameter determined, the tools and equipment were prepared, and the computed radiography conducted. The radiography began with the voltage of 160 kV and current of 3 mA to 10 mA. The exposure continued to the current of 180 kV and 200 kV with the same range of current.

### Image Production

After exposed by x-ray, IP was scanned using laser scanner to change the latent image from the IP to computer as a digital data. This method could also be called as the digital radiography. To determine the quality of CR (Computed Radiography) is to determine the SNR (Signal Noise Ratio). The high value of SNR indicated the high quality of digital radiography image. The SNR before image fusion must be determined beforehand to compare the change in its quality. SNR is determine using software called iSee! Image content is should be analyzed by observation. The content here is the impurities and crack revealed in

the image. Observe qualitatively and the number of impurities were counted.

### Image Fusion

The Computed Radiography image was fused to study the image quality after fused. The fusion scheme can be seen in the following table.

Table 3. Scheme for image fusion

Front Image	Back Image	Result
Computed Radiography (160 kV, 3 mA)	Computed Radiography (160 kV, 5 mA)	Result 1
Computed Radiography (160 kV, 3 mA)	Computed Radiography (160 kV, 10 mA)	Result 2
Computed Radiography (160 kV, 5 mA)	Computed Radiography (160 kV, 10 mA)	Result 3
Computed Radiography (180 kV, 3 mA)	Computed Radiography (180 kV, 5 mA)	Result 4
Computed Radiography (180 kV, 3 mA)	Computed Radiography (180 kV, 10 mA)	Result 5
Computed Radiography (180 kV, 5 mA)	Computed Radiography (180 kV, 5 mA)	Result 6
Computed Radiography (200 kV, 3 mA)	Computed Radiography (200 kV, 5 mA)	Result 7
Computed Radiography (200 kV, 3 mA)	Computed Radiography (200 kV, 10 mA)	Result 8
Computed Radiography (200 kV, 5 mA)	Computed Radiography (200 kV, 10 mA)	Result 9

Image was fused will be compared each with the iSee! Software. The

comparison is by comparing the SNR after and before fusion.

The image from the computed radiography were fused with MATLAB

## RESULT AND DISCUSSION

### Signal Noise Ratio (SNR) Analysis

Table 4. SNR analysis in 160 kV image.

Current	SR <sub>b</sub>	SNR
3 mA	14.4%	46
5 mA	11.4%	50.4
10 mA	13.9%	71.2

Table 4 is the SNR analysis of the radiograph with 160 kV and 3 mA, 5mA, and 10 mA. From the table can be found the initial SNR before image fusion.

Table 5. SNR analysis in 180 kV image.

Current	SR <sub>b</sub>	SNR
3 mA	14.0%	40.7
5 mA	17.8%	78.6
10 mA	19.5%	92.1

Table 5 is the SNR analysis of the radiograph using 180 kV and 3 mA, 5mA, and 10 mA exposure factor. This is the initial SNR before the fusion occurred.

Table 6. SNR Analysis in 200 kV image.

Current	SR <sub>b</sub>	SNR
3 mA	16.7%	60.9
5 mA	19.0%	59.9
10 mA	12.5%	95.2

Table 6 is the SNR analysis of the radiograph using 200 kV and 3 mA, 5 mA, and 10 mA exposure factor. This

is the initial SNR before the fusion occurred.

From Table 4, Table 5, and Table 6 can be seen Single-Noise-Ratio or SNR is increase with the increase voltage and current. The number of voltage is determined the quality of x-ray produced from the tube, and the number of current is to determined the quantity of photon released from the tube. Quality and quantity of x-rays photon is increase proportionally with the number of voltage and current.

Table 7. The Fusion Image SNR analysis in different in Current.

	160 kV	180 kV	200 kV
Fused image of 3 mA and 5 mA	92.1	81.3	84.2
Fused image 3 mA and 10 mA	77.1	87.5	106
Fused image 5 mA and 10 mA	119	207	102

Table 7 is shown the data of image fusion different in current. The data shown that 180 kV image fused with the 5 mA and 10 mA is gave the highest SNR. From the table above the SNR is increase with the event of fusion, but the increase rate is undependable from the voltage or/and the current.

Table 8. The Fusion Image SNR analysis different in Voltage.

	3 mA	5 mA	10 mA
Fused image of 160 kV and 180 kV	56.3	105	113
Fused image 160 kV and 200 kV	66.4	89.9	130
Fused image 180 kV and 200 kV	79.9	110	149

Table 8 shown the data of fused radiograph from different in voltage. The SNR is increase significantly in 10 mA image using 180 kV and 200 kV. The fused image from 10 mA is giving the highest SNR in each fused image different in Voltage.

## CONCLUSION

From the data above can be conclude that the SNR is increasing after the fusion of the image. The impurities and the cracked identified in the image is also can be seen clearly, but unfortunately due to the lack of the position accuracy between each image, the overlapping of the image result of the doubled or shadowed of the impurities thus causing the image in observation has a bad result quantitatively.

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