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Testing by Radiography on Welded Mild Steel (NDT Method)

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Abstract

This abstract gives a clear info about the Radiographic Testing which is the common NDT methods used in the construction and fabrication industries for oil & gas sectors using welding, gas/liquid transmission pipelines, casting foundries, and condition monitoring in existing oil & gas refineries and facilities. Radiographic Testing (RT) is widely used in industries, airport for security checks, medical applications etc. to detect anomalies in materials and human bodies. This paper will discuss radiographic testing sensitivity using industrial X-ray films mainly on welds and castings. No in-depth discussion in related science and physics, merely the perspective of an industrial radiographer based on his experience. This group of information can provide a simple analysis about the radiography and its testing in the real world.
Keywords: Geometric Un-Sharpness, Quantitative, Qualitative, Radiography, Sensitivity

I. INTRODUCTION

The basic principle for the detection of discontinuity using radiographic testing method is the difference in radiation absorption coefficients properties exhibits by different materials like density, thickness, atomic number of the material. The images are captured in a recording medium. The recording medium used may be X-ray film, phosphorous imaging plates, diodes etc.., Industrial X-ray films are the common recording medium used for these applications. In most instances, the electronic image that is viewed, results from the radiation passing through the object being inspected and interacting with a screen of material that fluoresces or gives off light when the interaction occurs. The fluorescent elements of the screen form the image much as the grains of silver form the image in film radiography. The image formed is a "positive image" since brighter areas on the image indicates where higher levels of transmitted radiation reached the screen. The below image is the view of the wave producing with different rays ex: Microwave, IR rays, UV, X-ray and Gamma ray, the wave can be seen with its spline nature and size wavelength.

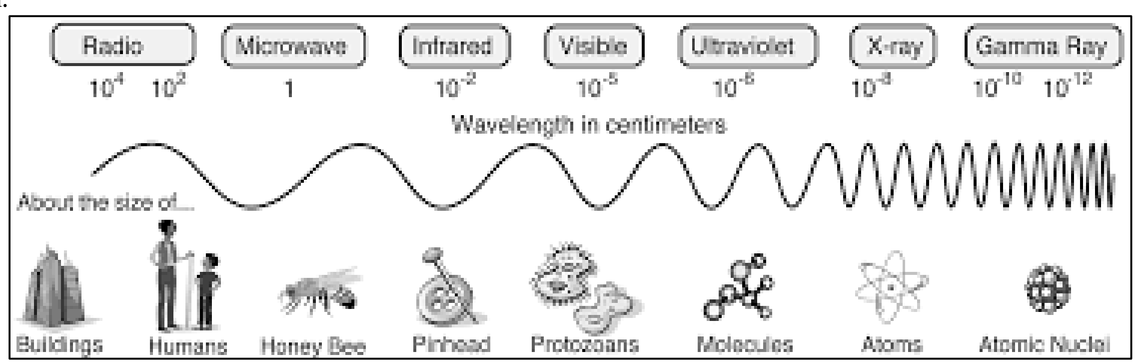


Fig. 1: Electromagnetic Waves

II. RADIOGRAPHIC TESTING SENSITIVITY

Like all other NDT methods, certain detection sensitivity is required for the technique to ensure detect ability of desired anomalies. In industrial radiography, Radiographic Sensitivity is a QUALITATIVE term referring to the size of the smallest detail that can be recorded and discernible on the film/radiograph, or to the ease with which the images of small details can be recorded. Image Quality Indicator (IQI) which provides QUANTITATIVE measurement is used to determine the adequacy of a radiographic technique, but not intended to determine the smallest flaw that can be detected.

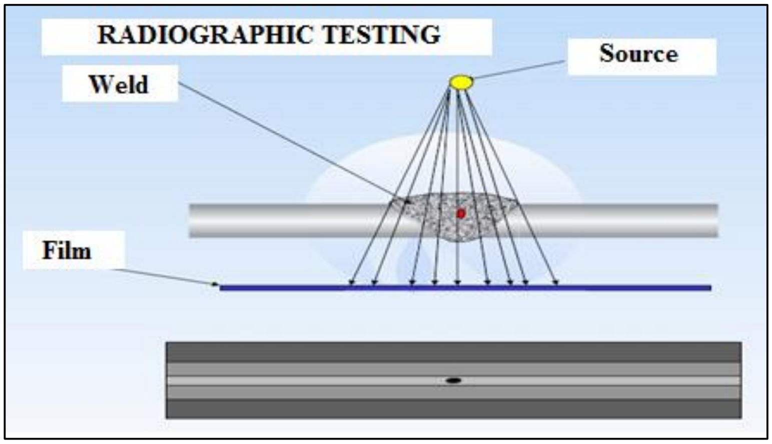


Fig. 2: Radiographic Testing

A. Gamma Ray Sources

- Cobalt-60: It consists of two energy levels 1.17Mev and 1.33Mev. It disintegrates to nickel – 60 steel components from 25mm to 200mm can be radiograph, half life is of 5.3years.
- Iridium-192: Its principle used in radiography for steel up to 75mm thickness generally, half life is 74.2 days.
- Caesium-137: Used for radiography of steel thickness ranging from 40mm to 100mm. Only one gamma energy level exist that is 0.66Mev, half life is 30years.
- Thilium-170: This can be used for very low thickness as low as 0.8mm of steel and has energy levels of 0.084 and 0.052Mev, half-life is 129days.

B. Equipment's

The ray equipment is shown in the below point,

- Camera
- Guide tube
- Crank cable
- Ultrasonic Transducer
- Black Light

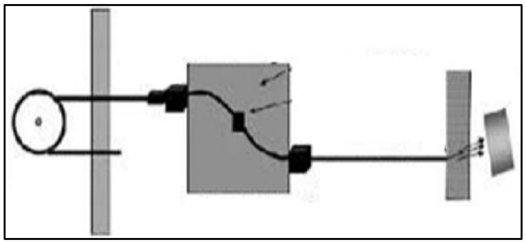


Fig. 3: Gamma Ray Source

C. Working of Iridium-192

As the gamma ray sources emit harmful radiation in all direction, it is necessary to contain them when not in use. To do so a radiographic camera is utilised which is made up of shielding material. E.g.: lead and depleted uranium

1) Procedure

- To remotely operate the Iridium-192 and to protect the radiographer a crank cable is used which drives the source in and out of the camera. The crank cable is connected to one end of the camera and guide tube is connected to other which is utilised to guide the source at a desired location.
- The gamma ray equipment is more portable as it does not require any electricity, therefore it can used on sites without such facility.

- The equipment is more durable and rugged as compared to an x ray tube. It is principle used in radiography for steel up to thickness of 75mm. The Half life is about 74.2 days.

D. Advantages of Iridium-192

- The main use of iridium is as a hardening agent for platinum alloys.
- With osmium, it forms an alloy that is used for tipping pens, and compass bearings.
- Iridium is used in making crucibles and other equipment that is used at high temperatures.
- It is also used to make heavy-duty electrical contacts.
- Iridium was used in making the international standard kilogram which is an alloy of 90% platinum and 10% iridium.
- Radioactive isotopes of iridium are used in radiation therapy for the treatment of cancer.

III. UNSHARPNESS OF IMAGE

The unsharpness is denoted by Ug,

$$Ug = F \times T/SOD$$

Where,
F= focal spot size
T=thickness of component
SOD=source to object distance
SFD=SOD+T
SFD=source to film distance

Table – 1
Unsharpness of Image

Ug	*Thickness*
0.01	*0<T<1*
0.02	*1<T<2*
0.03	*2<T<3*
0.04	*3<T<4*
0.05	*4<T<5*

IV. STRUCTURE OF RADIOGRAPHIC FILM

Radiographic film consists of the following layers,

- Film base
- Emulsion layer
- Super coating/protective layer

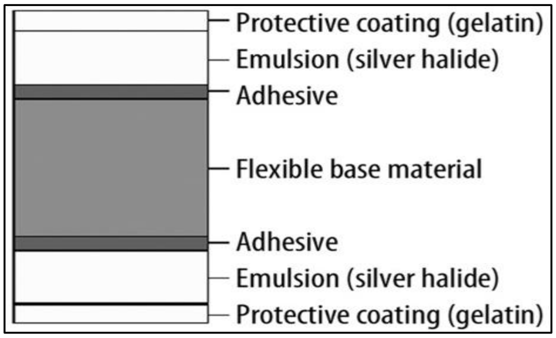


Fig. 4: Radiographic Film

A. X-ray Films

X-ray film is a gelatin-covered polyester base. An emulsion coating both sides of the film contains ting silver halide crystals that are sensitive to such things as visible light X-rays, gamma rays, heat, moisture and pressure. X-ray film should not be used if outdated as it may fog and markedly compromise its diagnostic usefulness.

- The composition of x-ray film is similar to that of a photographic film. Radiation sensitive emulsion is coated on both sides of a transparent base (double emulsion film).
- A thin layer of adhesive is used to achieve firm attachment between the emulsion and base.
- The emulsion is protected from scratches, pressure or contamination during use by a thin layer of gelatin called super Coating. Thickness of a radiographic film is about 0.25mm.

B. The Structure of the X Ray Film

If an undeveloped X-ray film is examined in daylight it will be found to consist of a flexible base of either cellulose acetate or polyester plastic coated on both sides with thin layers of apple-green photographic emulsion.

1) Film Base

Firm film base provides supported to fragile.

2) Film Emulsion

Emulsion is composed of a homogenous mixture of gelatin and silver halide crystals.

3) Film Speed

Speed of an x-ray film refers to the relative sensitivity to a given amount of radiation. Unlike photographic camera films, no numbers are given to indicate speed of x-ray film.

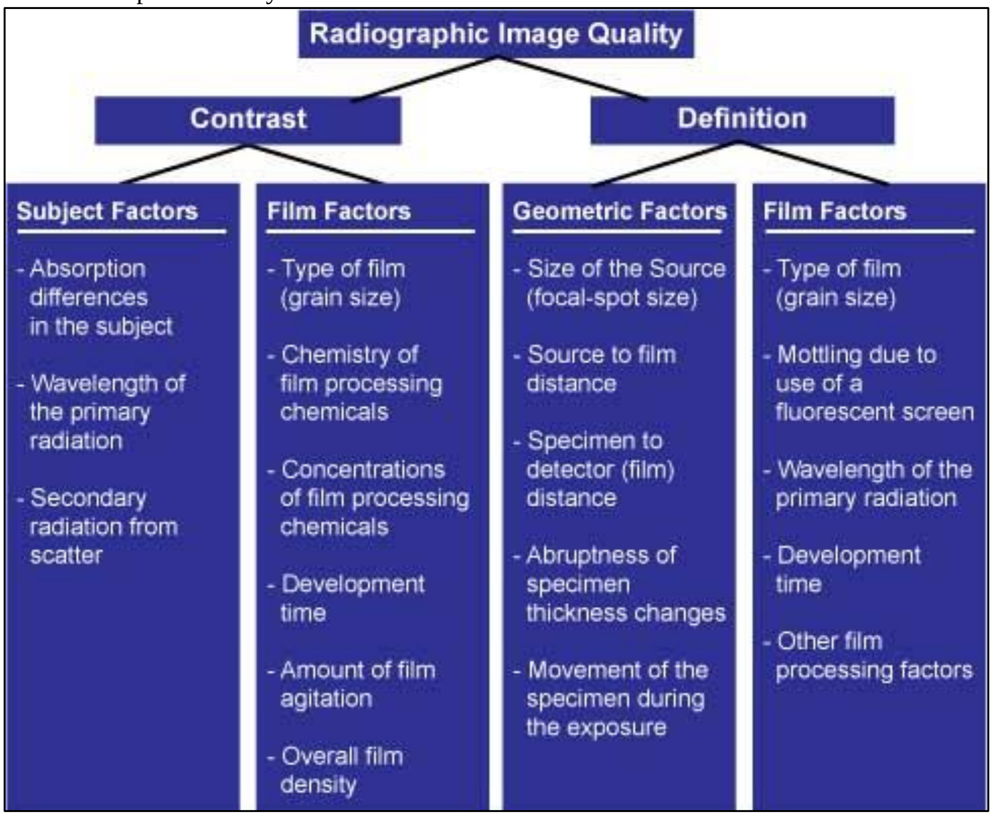


Fig. 6: Radiographic Image Quality

V. EXPOSURE CALCULATION

Table – 2
Exposure Calculation

Inches	*mm*	*Thickness Factor*
¼	*6.35*	*4*
½	*12.7*	*5*
¾	*19.05*	*6*
1	*25.4*	*8*
5/4	*31.75*	*11*
3/2	*38.7*	*15*

A. Exposure Formulae

$$SFD^2 x FF x TF / C_i x 1000$$

Where,
FF=Film factor
TF=Thickness factor
Ci=Curie
SFD=Source to film distance

VI. CONCLUSION

Non-destructive testing is a technique for damage assessment, disaster prediction and quality control, to detect the defects without affecting the internal structure. This thesis present and proposes some novel techniques for weld flow classification from industrial radiography for improving the safety of nuclear power plant. To cluster the grainy size weld and to radiograph different metals this technique helps to define such an above clarification. Many industries adopt such experimentation and results can be given according to the metal used.

1) Gamma ray radiography is possible to study concrete reinforcement with unprecedented detail and accuracy.
2) It gave the powerful technique as it enables us to look inside the structure literally.
3) Applications fall outside the scope of the routine inspection of reinforcement concrete beams columns and slabs.
4) Safety issues are there which needs to be taken care of properly, by installing good apparatus.
5) Radiographic testing requires radioactive materials this can cause environmental problems.
6) Standard NDT requires relatively heavy and large devices.

The below is the original experimented report that clarifies the radiographic test by NDT method.

		Date:
CLIENT:	Job N°	UNIT
LORDS INSTITUTE OF ENGG & TECH.	1	-
PLACE:	QC Code	REPORT NO:
GAMMA WELD INSPECTION SERVICES	-	LORDS-2017-01
PROJECT / PLANT:	ITP REF	
-		

RADIOGRAPHIC TEST REPORT

ENGINEERING DOCUMENT N°	SUPPLIER DOCUMENT N°	CODE / SPECIFICATION	OTHER
-	-	ASME B31.1	ASME BPVC SEC V-Article 2

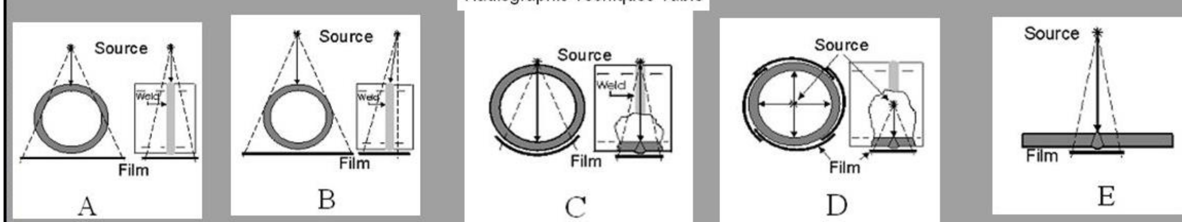
IDENTIFICATION OF MONITORING AND MEASURING DEVICES: PAGE NO -

X Ray		Isotope		Film		IQI		Developer Film	
Type	-	Type	Ir-192	Make:	Agfa	Type	ASTM-WIRE-1B	Manual	√
KV	-	Ci	40	Type	D4	Position	Source Side		
M.A	-	Size	2mm X 2mm	Size	10X10 cm	Sensitivity	#8	Automat	

FILM PROGR. NO.	ISOMETRIC	WELD NR.	FILM LOCATION	MATERIAL	SIZE (Dia Inches)	THICK (mm)	WELDER STAMP				Rad.Tecn (see table)	NDT %	INDICATION				JUDGEMENT	REMARKS
							ROOT		FILL				TYPE OF DEFECT	LOC. DEFECT from A (cm)	LENGHT (mm)	WELDER		
1	-	-	A	mild steel	3	7.62	-	-	-	-	B	-	1	6.2	3	-	NR	LOP
			B															

LEGEND: A = ACCEPTABLE; NX = UNACCEPTABLE RADIOGRAPHY; NR = TO BE REPAIRED; RX = RADIOGRAPHY TO BE REPEATED; NT = TO BE CUT

Radiographic Tecniques Table



Form code: MDT.WL.CDQ.0141

Fig. 5: Inspection Report of Material Welded (Radiographic Test Report)

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