# Tangential Radiography

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## Abstract

Wall thickness measurement in process equipment and piping is necessary to determine the loss of material due to corrosion, erosion and wear, and is required to determine corrosion rates, remaining life and will be used for Risk Based Inspection (RBI), environmental safety and for insurance purposes.
There are different techniques available, digital thickness gauges and thickness gauges with A Scan displays using the contact method. Where pipelines are insulated or lagged, such as ammonia and steam lines, the removal of the insulation is an expensive time consuming operation.
Tangential Radiography can be used to inspect these lines for wall thickness.
The wall thickness is measured on the radiographic image. Where areas of material loss are observed the lagging may be removed to verify the radiographic measurement by conventional pulse echo thickness gauges or A Scan presentation thickness gauges and flaw detectors.
Radiography and computerized digital images allow for image enhancement and more accurate thickness readings to be made as they cover a larger area, whereas the footprint of a contact thickness measurement is the size of the transducer used. The profile of the wall thickness can be seen along the length of the pipe and density variations will indicate areas of material thinning.
Computerized reporting is possible with comparison to previous results for the determination of rate of material loss and the remaining life of the pipeline.

## Introduction

Tangential radiography is a radiographic technique used for the determination of remaining pipe wall thickness.
Wall thickness measurement in processing pipe is necessary to determine loss of material due corrosion under insulation and internal erosion.
Thickness measurement would assist the engineer in making decisions with regards to the safety of plant, environment and personnel and also for insurance purposes. Environmental safety is of utmost importance and has become a serious issue with environmentalists where leaking pipes have caused contamination of sensitive wetland areas and contamination of other resources. Thickness measurement is used to assist in risk based inspection programs to determine the plant condition and establish future inspection requirements and frequencies.

**Method**

There are different methods by which we can carry out thickness measurements but they all have certain limitations and some are only used for specific applications.
The first criteria to be considered is the type of material, the thickness and the diameters of the pipe when using the tangential radiographic method.
Ultrasonic thickness measurements require the removal of insulation which is time consuming as well as costly as the insulation has to be replaced and may require scaffolding to be built while a ladder or cherry picker may be used for access when doing radiography.
Tangential radiography allows the pipe to be X-Rayed or radiographed without the removal of the lagging and also covers a larger area than the foot print area, of the ultrasonic transducer.
The ultrasonic method will give the average reading of the area below the probe and may not reveal isolated pitting.

The Radiographic source could be a X-Ray machine or a radioactive isotope. The greatest contrast and sensitivity will be obtained with X-Rays then Gamma-rays, such as produced by Selenium-75 and Iridium-192
The different types of radiation source result in decreasing definition due to the type of radiation although the penetration power increases with the above source.
The whole concept of tangential radiography is to penetrate the sidewall of the pipe so that the thickness is projected on to the imaging material. (Fig 1)

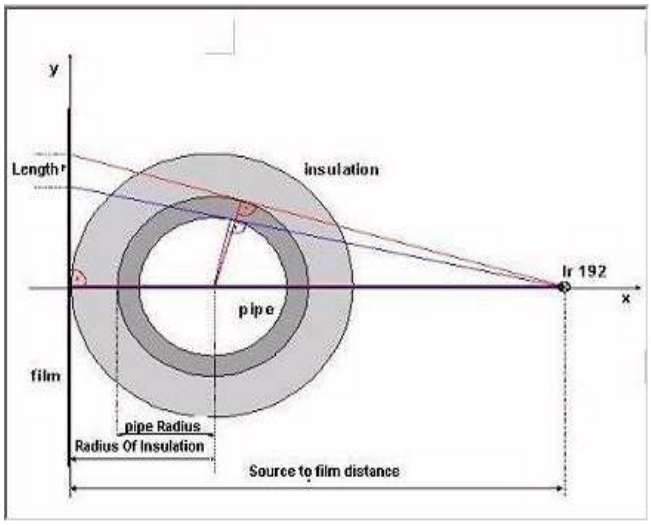


Fig 1 Image projection

As there will be some magnification of the image it is essential that the set-up is controlled.
A suitable source to object distance must be chosen to reduce the geometric unsharpness of the image. The image may be captured on conventional x-ray film which will then be

processed in the normal way by developing, fixing and drying and then viewed on a viewer and the dimensions of the image will be measured on the film with the appropriate correction being made for any magnification caused by the object to film distance.
Film-less radiography can be used with phosphorescent storage imaging plates, (Fig 2) which are then read in a special reader and a digital image captured and displayed on a computer monitor where dimensions can be measured with the appropriate software. Electronic digital imaging plates (Fig 3) employing an array of semiconductors can be used and the data collected by the CCD's is processsed, giving a digital image on the monitor screen. (Fig 4 a, b) Once a digital image has been processed, the image can be enhanced to improve the image quality by contrast, brightness and edge enhancement adjustments of the image.(Fig 5) The diameter of the pipe which can be measured in this way is limited to the upper limits of the pipe diameter being 200 mm-300 mm depending on the equipment available for a 200 mm diameter pipe the L max is 83mm and for a 300 mm diameter pipe it is 103mm. The 'L Max' is the tangential thickness of the pipe wall to be penetrated. Thickness of 100 mm has been radiographed using digital radiography, producing ASME quality radiographic images. In refineries, power-stations and chemical plants pipe thickness can vary up to 50mm thick.
Density measurements in the double wall image can be measured to reveal material loss and thinning due to corrosion, and erosion. Fig 6(a, b)
Tangential radiography is also used in the inspection of polyethylene pipeline joints. The coupling is fitted to each pipe end and the heating elements inside the coupling causes the plastic material to shrink giving a high-pressure thermo-mechanical seal thereby joining the pipe together. If there is any misalignment of the pipe or the coupling has not shrunk to form the proper seal this will be detected on tangential radiography of the joint.
Increasing use is being made of polyethylene pipelines in the water and gas distribution industries. This bonding can also be detected ultrasonically with a very small echo received from a good bond and a large echo from a lack of bonding, however the tangential radiography method allows the gap to be measured.

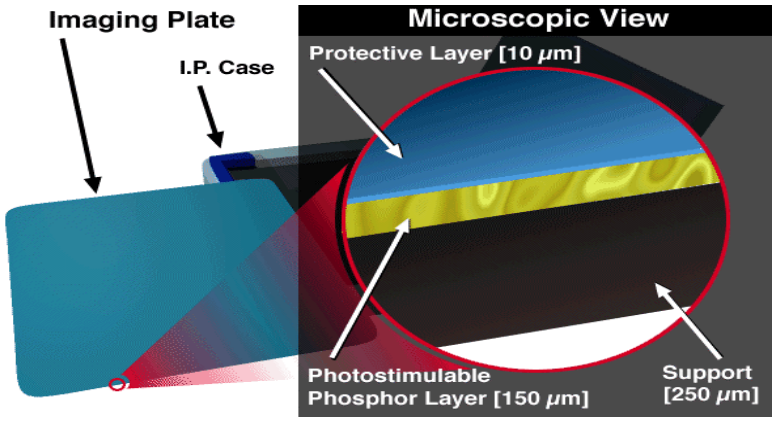


Fig 2 Phospherescent screen

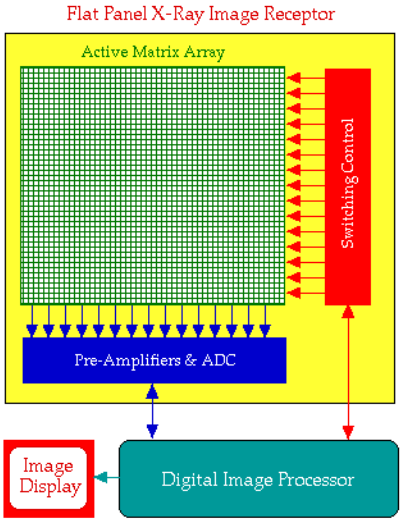


Fig 3 Electronic digital imaging panel

When viewing the following radiographs the change in wall thickness is clearly visible


Fig 4 (a) Digital radiography computer image with measurement capabilities.

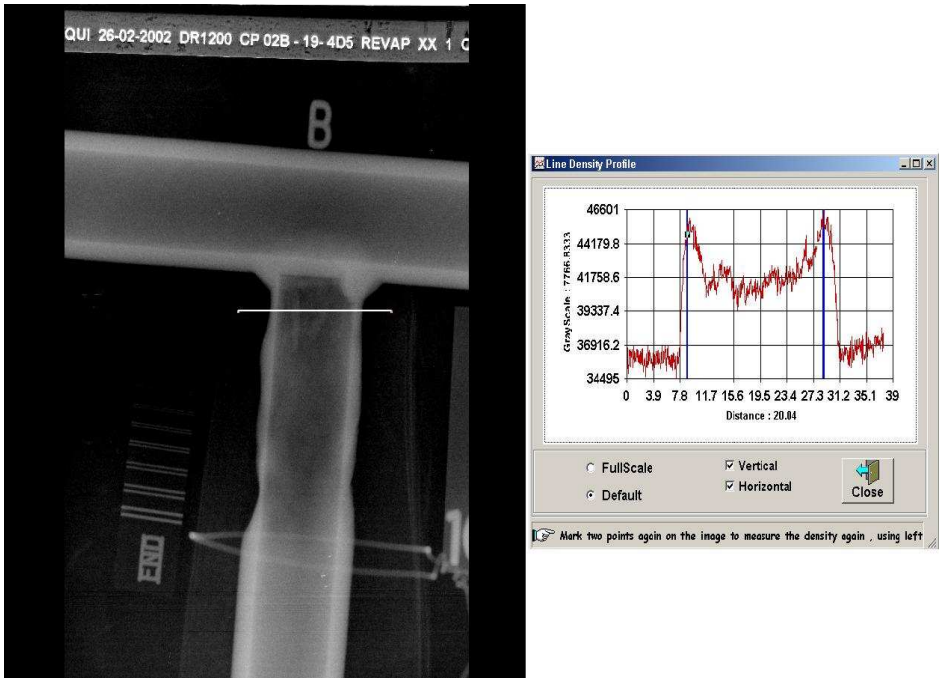


Fig 4 (b) Digital image with profile measurement

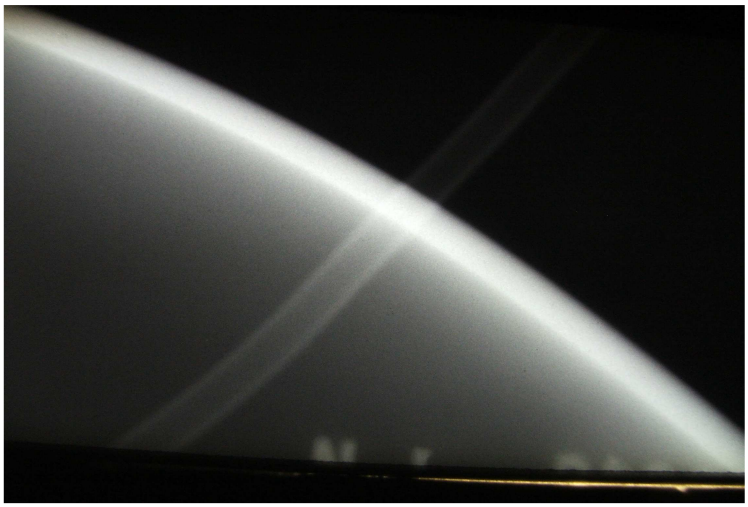

Fig 5 Wall-thickness measurement of a pipe bend

Digital radiography computer programs allow thickness readings to be made by placing the cursor over the area to be measured

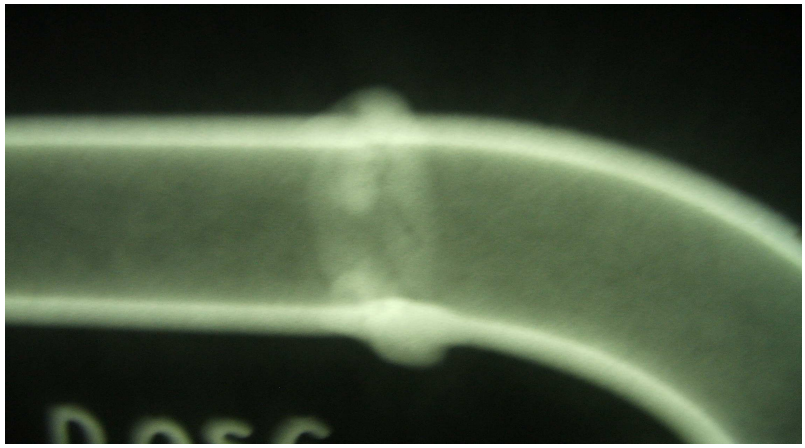

Fig 6(a) Evidence of corrosion

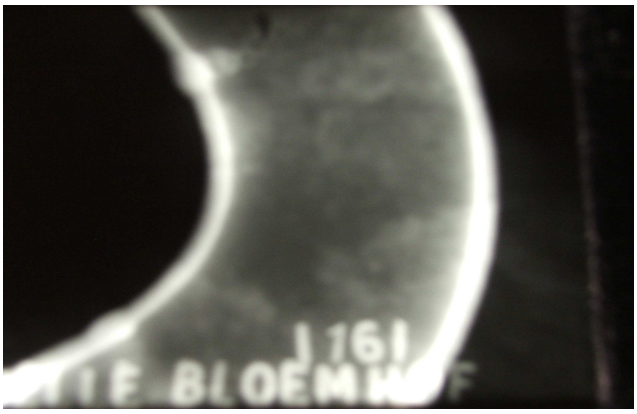

Fig 6(b)

The cost saving made by not having to remove the insulation is considerable
Where suspect areas are found, limited insulation can be removed and the remaining thickness verified by a thickness gauge or the corrosion depth measured by laser beam profile measurements of corrosion.

## CONCLUSION

Tangential radiography can be used for the detection of under insulation corrosion and internal corrosion / erosion without the removal of insulation resulting in considerable savings and for examination of thermo-mechanical bonding of polyethylene pipeline joints assuring the quality of the joints and the pipelines.

**References**


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