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PROSIDING

SENPATEN

# SEMINAR NASIONAL PENDAYAGUNAAN TEKNOLOGI NUKLIR

## National Seminar on Nuclear Technology Utilization in conjunction with FNCA Workshop on Research Reactor Utilization

**PUSPIPTEK - Serpong, 21 - 23 November 2017**

Nuclear Technology Utilization
in the fields of Food, Health, Industry and Environment
through strengthening regional collaboration

batan

FNCA
Forum for Nuclear Cooperation in Asia

## KATA PENGANTAR

Puji syukur kami panjatkan kehadirat Tuhan Yang Maha Esa atas petunjuk dan karunia-Nya **Prosiding Seminar Nasional Pendayagunaan Teknologi Nuklir (SENPATEN) 2017** dapat diterbitkan. Prosiding ini merupakan dokumentasi yang memuat karya tulis ilmiah para peserta SENPATEN 2017 yang diselenggarakan bersamaan dengan *FY2017 FNCA Workshop on Research Reactor Utilization Project*. Kegiatan tersebut diselenggarakan di Gedung 720 Auditorium Pusat Inovasi dan Bisnis Teknologi, Kawasan PUSPIPTEK Serpong, Tangerang Selatan, pada tanggal 21-23 November 2017, dengan mengambil tema "*Pendayagunaan teknologi nuklir di bidang pangan, kesehatan, industri dan lingkungan melalui penguatan kerjasama regional*".

Pada Seminar Pendayagunaan Teknologi Nuklir 2017 panitia menerima sebanyak 81 makalah dari BAPETEN, BATAN, BPFK-Jakarta, ITB, STIKES Guna Bangsa Yogyakarta, Universitas Indonesia, Universitas Nasional, Universitas Pamulang, dan setelah dilakukan seleksi serta evaluasi, diputuskan 30 makalah dipresentasikan secara *oral,* dan sisanya disajikan dalam bentuk poster.

Setelah melalui proses penyuntingan, dalam Prosiding Seminar Nasional Pendayagunaan Teknologi Nuklir 2017 ini, sebanyak 77 makalah dicantumkan sebagai makalah lengkap yang diklasifikasikan kedalam beberapa bidang yaitu pangan, kesehatan, industri, lingkungan, energi, keselamatan dan keamanan, metrologi serta bidang lainnya yang terkait dengan pedayagunaan teknologi nuklir. Semoga prosiding ini dapat dimanfaatkan sebagai sumber informasi untuk memacu kegiatan penelitian, pengembangan serta pendayagunaan teknologi nuklir di Indonesia. Akhir kata, kami mengucapkan terima kasih kepada semua pihak yang telah membantu penerbitan Prosiding ini.

Serpong, Maret 2018

Dewan Editor

# DAFTAR ISI

# IDENTIFICATION OF SCALING THICKNESS ON 48 INCHES PIPE LINE USING GAMMA SCANNING TECHNIQUE

**Wibisono, Bayu Azmi**

*Center for Isotopes and Radiation Application-BATAN*
*Jl. Raya Lebak Bulus no 49, Jakarta 12440*

*wibi@batan.go.id*

## ABSTRACT

*IDENTIFICATION OF SCALING THICKNESS ON 48 INCHES PIPE LINE USING GAMMA SCANNING TECHNIQUE. Gas pipeline suspected consist of scale inside the wall. A cracking gas flowed from furnish to gasoline fractionation tower has a diameter 48 inches and length 20 meters. Gamma scanning technique performed to diagnose scaling profile and thickness inside the pipe. A gamma source Cs-137 has an activity 80 mCi and other equipment such as a gamma rate meter, NaI(Tl) scintillation detector, induction motor, and two gamma collimators which has a radius 5 mm and a deep 30mm, a computer designed for measuring objects with a radius of 150 cm. The measurement method was scanned the pipe vertically and horizontally. Experiment result observed scale thickness is 32-57 cm in range. This experiment report is guide to maintain schedule for continuous productivity.*

*Keywords: Gamma, industry, nuclear, radiation, scaling, tomography.*

## ABSTRAK

***IDENTIFIKASI KETEBALAN KERAK DI DALAM PIPA 48 INCH DENGAN TEKNIK GAMMA TOMOGRAFI.*** *Pipa aliran fluida gas diduga mengalami penyumbatan pada dinding dalam pipa disebabkan kerak didalamnya. Aliran cracking gas dari furnish ke tower gasoline fraksinasi ini memiliki diameter dalam 48 inci dan panjang 20 meter. Teknik gama tomografi dilakukan untuk mendiagnosa tebal dan profile kerak didalam pipa. Sumber gamma 80 mCi Cs-137 dan perlengkapan lainnya seperti gamma ratemeter, detektor sintilasi NaI(Tl), motor induksi dan kolimator gamma radius 5 mm dalam 30 mm, serta sebuah komputer didisain untuk pengukuran objek berdimensi radius 150 cm. Metode pengukuran adalah dengan memindai pipa secara vertikal dan horizontal. Eksperimen berhasil mengidentifikasi tebal kerak antara 32-57 cm. Laporan investigasi ini akan menentukan jadwal perbaikan yang diperlukan untuk mempertahankan waktu produksi.*

*Keywords:Gamma, industri, nuklir, radiasi, scaling, tomografi.*

## INTRODUCTION

The measurement of phase fractions and phase distributions in full-scale industrial devices operated under authentic conditions is of highest interest for designers and operators [1]. The ability to see the inside of an object is very necessary in industrial processes to diagnose malfunctions or in order to increase production. Gamma-ray has been widely used for industrial process diagnosis because it has high energy and does not need a radiation generator [2]. Gamma ray scanning is an online and completely non- destructive tool for troubleshooting distillation columns and other process unit [3]. This technique is also a fast, efficient, and cost-effective tool for better understanding the dynamic processes that occur in industrial columns and examining the inner details of a distillation column [4]. In comparison to other non-destructive control techniques used in practice, gamma-ray scanning provides, in real time, the clearest vision of the production conditions inside a reservoir of process [5].

Particles residue of gas cracking process was found at BA-106 outline pipeline. These particles are suspected of sticking to the inner wall along the pipe during operation. This pipeline has not been inspected since 30 years of operation. This pipe has a diameter of 48 inches and a length of 20 meters. The temperature of the gas flowing within it is 150 °C so that the pipe is encased in insulation and jacket. The scale inside the pipe will of course decrease the flow due to the reduced effective diameter in the pipe thus compressing the compressor work. The residual particles also become impurities in the next process.

The management will identify the scale profile in the pipe to know the distribution of its thickness along the pipe. Investigation is done off-line as it coincides with the timing of another segment maintenance.

The pipe line will be scanned at several positions vertically and/or horizontally. The scan curve results can represent the condition inside the pipe.

## METHODOLOGY

The investigation was conducted by shooting the gamma rays through the pipe. The gamma rays interact with the pipe and scale. When mono-energetic gamma rays are collimated into a narrow beam and allowed to strike a detector after passing through on absorber of variable thickness, the result should be simple exponential attenuation of the gamma rays as shown in Figure 1 [6]. The interaction of gamma rays when interacting with the material will decrease its intensity exponentially following equation (1) [6].

$$I = B\, I_0 e^{-\mu \rho x} \qquad (1)$$

B= build factor

For practical application of formula (1) is simplified into (2) [7].

$$I = I_0 e^{-\mu x} \qquad (2)$$

Where $I_0$ is the initial intensity, x the length of the passage, and μ is the coefficient of absorption.

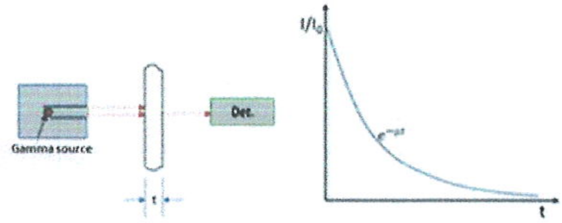


Figure 1. The exponential transmission curve for gamma rays measured under "good geometry" condition.

Cs-137 source was used in this work. Its energy is 662 keV which is sensitive to distinguish material density. The empty cylinder pipe will have a symmetrical and smooth intensity profile when scanned from one side to the other as shown in Figure 2.

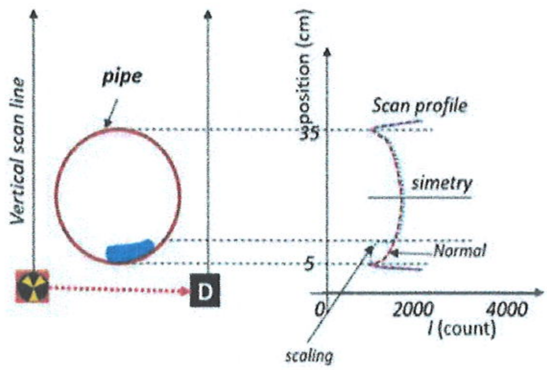


Figure 2. Vertical scan profiles of normal and scaled pipe.

The gamma scan technique was performed by scanning the cross section of the pipe by using a collected Cs-137 gamma radiation source as a transmitter and a pulsed NaI(Tl) detector as a receiver. The radiation source emits radiation (pencil beam) and the detector receives the gamma photons after it has penetrated the object (pipe). [3]. Gamma detector is connected to gamma counter Ludlum 2200 to supply 1000V voltage. The gamma counter is set to calculate gamma ray intensity for three seconds [8]. The radiation source and the detector perform a translation scan at 10 mm per step. It was performed at 15 positions as shown in Figure 3. The detail of scanning position is shown in Table 1.

Gamma scan profiles can represent the inside of the pipe condition. The scale existence is predicted using scan profiles. An unsymmetrical scan profile indicates scale existence inside the pipe.

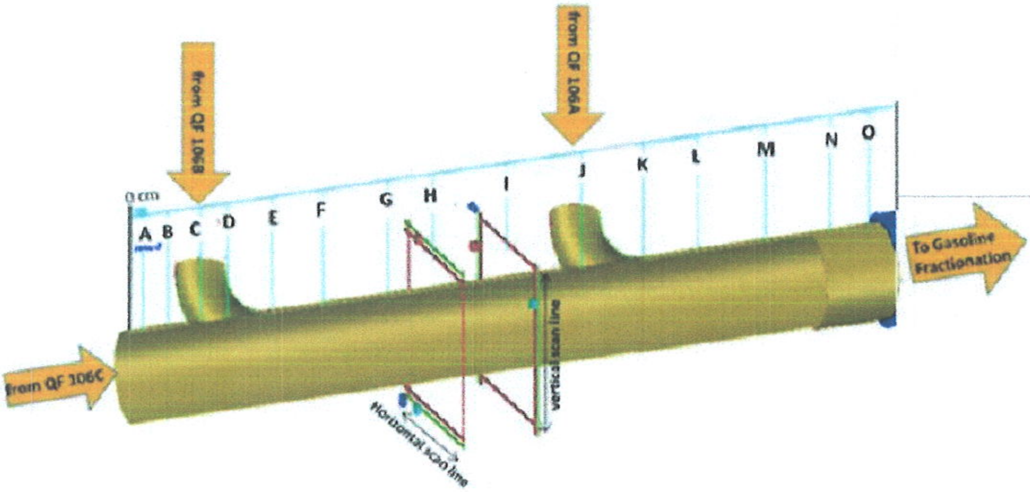


Figure 3. Gamma scanning position

Table 1. Gamma scanning positions.

| No | Code | Position (cm) | Scan line |
|---|---|---|---|
| 1 | A | 200 | Vert / Hor |
| 2 | B | 700 | Vertical |
| 3 | C | 1100 | Vertical |
| 4 | D | 1800 | Vertical |
| 5 | E | 2600 | Vertical |
| 6 | F | 3600 | Vert / Hor |
| 7 | G | 4300 | Vert / Hor |
| 8 | H | 5450 | Vert / Hor |
| 9 | I | 6600 | Vertical |
| 10 | J | 7600 | Vertical |
| 11 | K | 8450 | Vertical |
| 12 | L | 9500 | Vert / Hor |
| 13 | M | 10500 | Vertical |
| 14 | N | 11100 | Vertical |
| 15 | O | 11450 | Vertical |

There are only five positions that can be scanned vertically and horizontally, the rest can only scanned vertically. This is due to field conditions around the pipeline. There are some obstacles such as other units, its support, ladder, and so on.

## RESULT AND DISCUSSION

The vertical and horizontal scans plotted to the pipe image to predict the abnormality inside the pipeline. As mentioned before, under normal pipe conditions (without scale) the pipe profile will be symmetrical as shown in Figure 2. The asymmetry scan profile indicates existence of foreign material inside the pipe.

The scale at point A is identified using vertical and horizontal scan profiles. The horizontal scan shows low intensity at position 100-150 cm. The same condition is also happened in the position of 30-50 cm. The intensity of the vertical scan position of 20-40 cm and 100-140 cm looks low relative to 70-100 cm. Scale profile prediction on point A is shown in Figure 4.

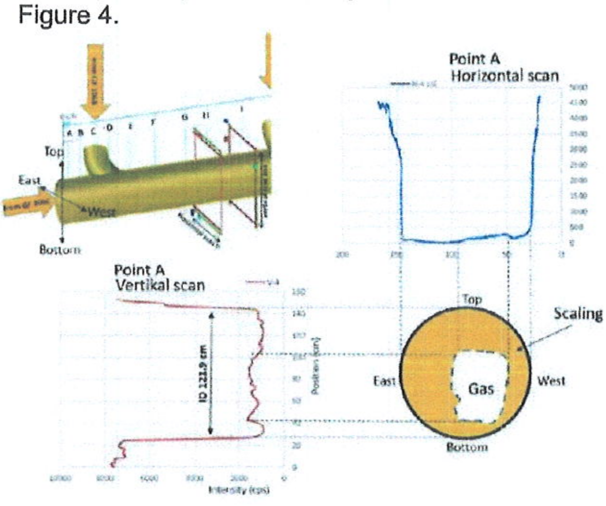


Figure 4. Scale profile prediction on point A.

In the same way, the scales prediction at point B-O is shown in figure 5. The scale profiles of point A, F, G, H, and L were built from vertically and horizontally scan, whereas the other points were predicted using vertically scan data.

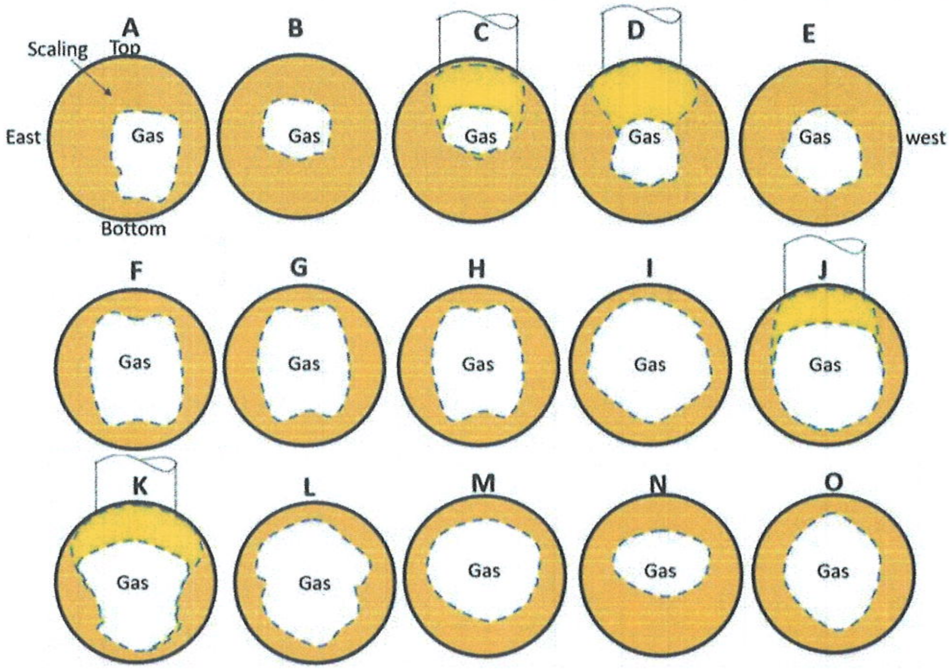


Figure 5. Scale profile prediction of 15 scanning points.

The scale profiles are considered as representation of the segments along the pipeline so that it can be assumed the profile along the pipeline in three dimensional visualization image as shown in Figure 6. Gamma tomography technique is important as a complementary data to get the cross-section visualization of scale profile inside the pipeline.

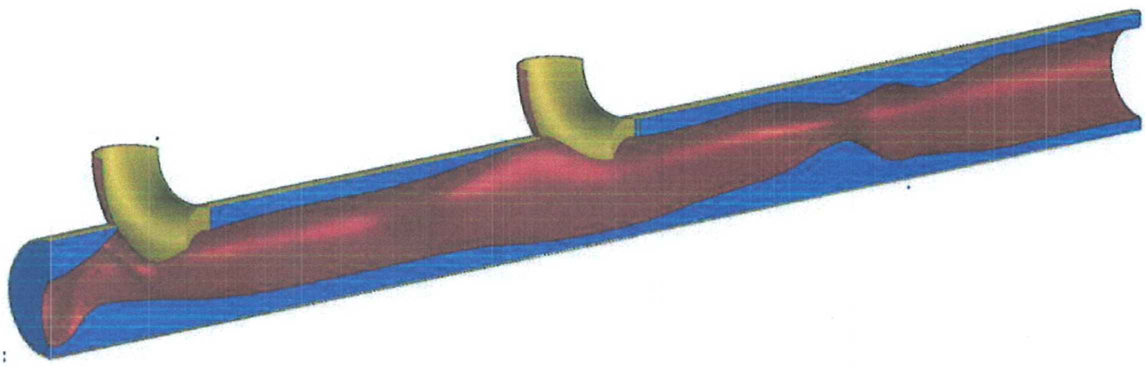

Figure 6. Three dimensional scale profile prediction in the pipeline

## CONCLUSSION

Gamma scanning technique is able to identify existence of scale inside the pipeline. Experiment result observed scale thickness is 32-57 cm in range. Gamma tomography technique is important as a complementary data to get the cross-section visualization of scale profile inside the pipeline.

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## REFERENCES

[1] A. Bieberle, D. Hoppe, and U. Hampel, "Process diagnostics and non-destructive testing using high-resolution gamma-ray tomography," *2010 IEEE Int. Conf. Imaging Syst. Tech. IST 2010 - Proc.*, pp. 261–265, 2010.

[2] J. S. Charlton, *Radioisotope Techniques for Problem-solving in Industrial Process Plants*. Leonard Hill, 1986.

[3] H. Shahabinejad and S. A. H. Feghhi, "Design , optimization and performance of source and detector colli- mators for gamma-ray scanning of a lab-scale distillation column," *Appl. Radiat. Isot.*, vol. 99, pp. 25–34, 2015.

[4] P. A. Vasquez, F. E. Costa, W. A. P. Calvo, M. M. H. Ã, and P. A. Va, "Development of a scintillator detector system for g -ray scan measurements of industrial distillation columns," *Nucl. Instruments Methods Phys. Res.*, vol. 537, pp. 458–461, 2005.

[5] K. Laraki, R. Alami, R. C. El, A. Bensitel, and L. El Badri, "An expert system for improving the gamma-ray scanning technique," vol. 578, pp. 340–344, 2007.

[6] Glenn F. Knoll, *Radiation Detection and Measurement*, 2nd ed. John Wiley & Sons, Ltd, 2010.

[7] S. Sugiharto, "On-line Diagnosing on Trayed Column of Etylene Plant Using Gamma Ray Scanning," *Atom Indones.*, vol. 38, no. 3, pp. 138–146, 2012.

[8] Ludlum Measurements, "Ludlum Model 2200 Scaler Ratemeter," 2005.