Effect of Lift-off on Pipeline Magnetic Flux Leakage Inspection[1]

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Abstract

On pipeline magnetic flux leakage (MFL) inspection, welds and debris are present in all pipelines and cause lift-off of the sensors and/or the magnetizer of the magnetic flux leakage inspection tool, and have the potential to affect the acquired magnetic flux leakage data. By adopting ANSYS software to simulate the effect of lift-off on the MFL signal. The results of this research indicate that lift-off (sensor, magnetizer, and both) causes a reduction on the peak magnetic flux leakage amplitude, sensor lift-off has a substantially greater effect on the peak magnetic flux leakage amplitude than magnetizer lift-off of the same magnitude, lift-off of sensors and magnet simultaneously produces the greatest reduction in measured peak magnetic flux leakage amplitude. Better to understand the effect that lift-off has on MFL inspection results will improve the quality of the magnetic flux leakage inspection data and result integrity assessment in defect.

Keywords: The magnetic flux leakage inspection, lift–off, the magnetic leakage signal, defect

1. Introduction

On pipeline magnetic flux leakage inspection, there are a multitude of factors that can impact MFL inspection data. Welds and debris are present in all pipelines and cause lift-off of the sensors and/or the magnetizer of the magnetic flux leakage inspection tool, and have the potential to affect the acquired magnetic flux leakage data [3-6]. Lift-off causes inaccurate measurement of the true magnitude of MFL field. Analysis of this inaccurate MFL data could lead to defects either being missed or undersized. Better to understand the effect that lift-off has on MFL inspection results will improve the quality of the magnetic flux leakage inspection data and result integrity assessment in defect. Simulating by adopting ANSYS software will qualitatively evaluate the effect of sensor, magnetizer and simultaneous sensor and magnetizer lift-off on the measured MFL signal.

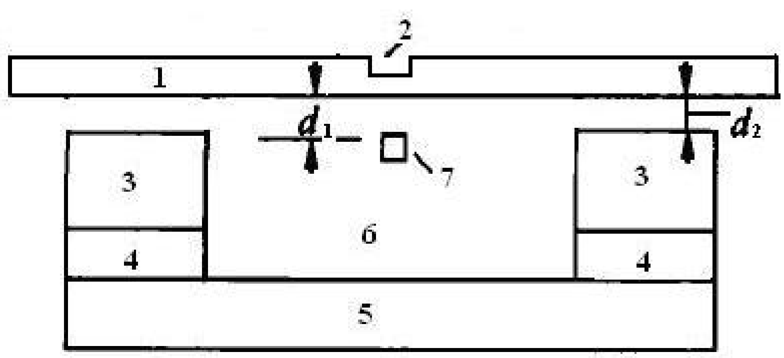

Figure 1 The detailed geometry

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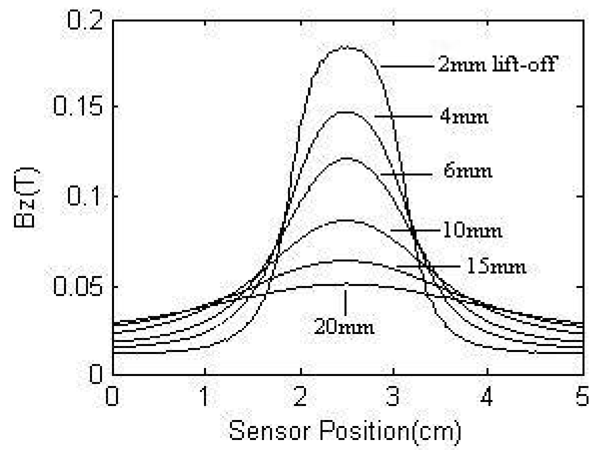
geometry of the MFL inspection system [1, 2]. Here, 1 represents pipe wall, 2 represents the defect, 3 represents steel brush, 4 represents magnet, 5 represents backing iron, 6 represents air, 7 represents sensor, d_1 represents the sensor lift-off and d_2 represents the magnetizer lift-off. The main materials include: the pipe diameter is 377mm with thickness is 8mm, the material of pipe is steel X52, both of the backing iron and steel brush are linear material which relative permeability is 186000H/m, the magnet is Nd-Fe-B permanent-magnet which coercive force is 895000A/m and relative permeability is 1.05. The defect is 8mm length and 50% depth (4mm depth).



Figuer2 Sensor lift-off varied with zero magnetizer lift-off

2. The effect of sensor lift-off

Sensor lift-off is varied and the effect on the acquired MFL signal is observed for the same artificial defect, while the magnetizer lift-off is zero. To simulate various levels of sensor lift-off, they are from 2.0mm to 20mm. Figure 2 shows magnetic flux leakage signal comparison graphs, while sensor lift-off varied with zero magnetizer lift-off.

As can be seen from the results, the reduction in measured peak amplitude and baseline magnetic flux leakage with increasing sensor lift-off. In addition, low levels of sensor lift-off have a significant affect on the measured peak flux leakage magnitude.

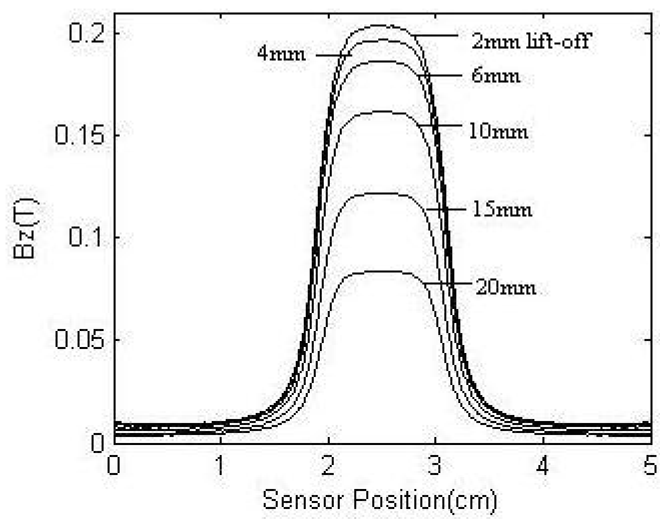


Figure 3 Magnetizer lift-off varied with zero sensor lift-off.

3. The effect of magnetizer lift-off

Magnetizer lift-off is varied and the effect on the acquired MFL signal is observed for the same artificial defect, while the sensor lift-off is zero. To simulate various levels of magnetizer lift-off, they are from 2.0mm to 20mm. Figure 3 shows magnetic flux leakage signal comparison graphs, while magnetizer lift-off varied with zero sensor lift-off.

These graphs clearly show the reduction in measured peak amplitude and baseline magnetic flux leakage with

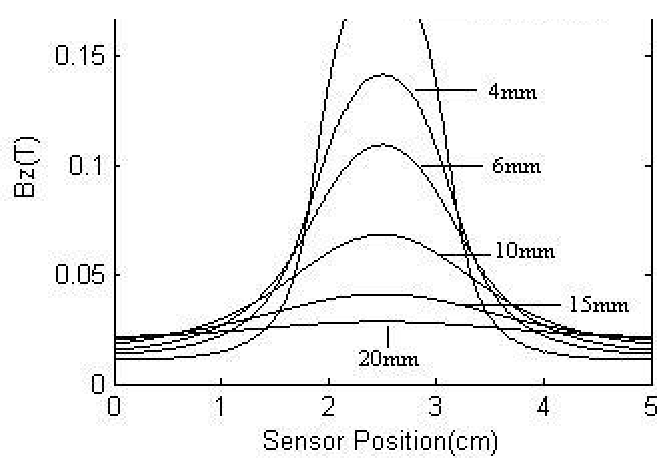


Figure 4 Simultaneous sensor and magnetizer lift-off

increasing magnetizer lift-off. In addition, low levels of magnetizer lift-off have a insignificant affect on the measured peak flux leakage magnitude.

4. The effect of lift-off of sensors and magnet simultaneously

Lift-off of sensors and magnet simultaneously is varied and the effect on the acquired MFL signal is observed for the same artificial defect. To simulate various levels of lift-off, they are from 2.0mm to 20mm. Figure 4 shows magnetic flux leakage signal comparison graphs, while lift-off of sensors and magnetizer simultaneously varied.

These graphs clearly show the significant reduction in measured peak amplitude and baseline magnetic flux leakage with increasing lift-off.

5. The comparison of lift-off in all its forms (sensor, magnetizer, and both simultaneously)

The lift-off in all its forms is simulated and the effect on the acquired MFL signal is observed for the same artificial defect and the same lift-off of 10mm. Figure 5 shows magnetic flux leakage signal comparison graphs about the lift-off in all its forms. Figure 6 is the relation curve between the magnetic flux leakage amplitude and lift-off.

These graphs clearly show sensor lift-off has a substantially greater effect on the peak magnetic flux leakage amplitude than magnetizer lift-off of the same magnitude, lift-off of sensors and magnetizer simultaneously produces the greatest reduction in the measured peak magnetic flux leakage amplitude.

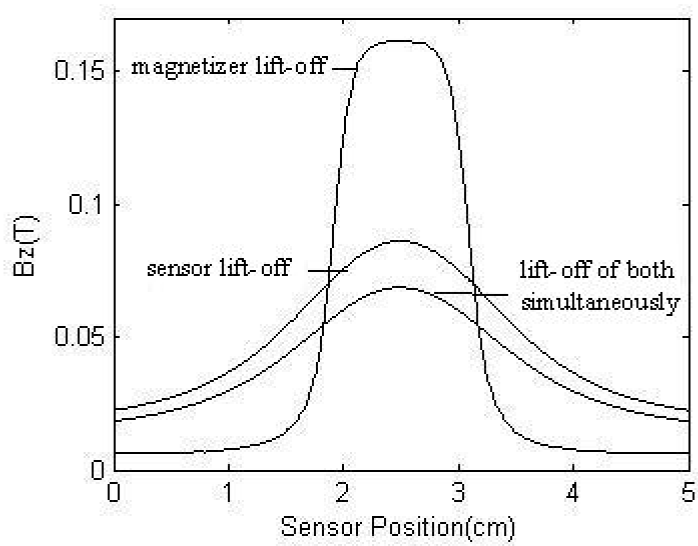


Figure 5 The lift-off in all its forms

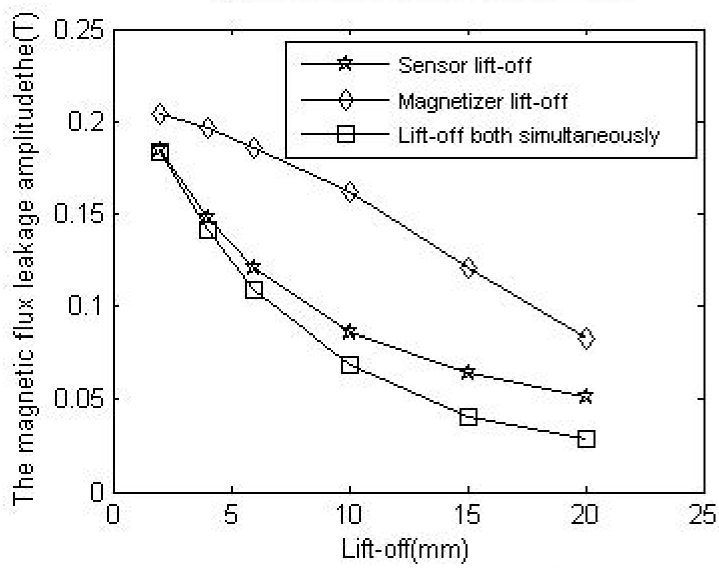


Figure 6 the relation curve between the magnetic flux leakage amplitude lift-off

6. Conclusions

Lift-off (sensor, magnetizer, and both simultaneously) causes a reduction in the measured peak and baseline magnetic flux leakage amplitudes, reduction in the measured peak causes inaccurate measurement of the true magnitude of MFL field, analysis of this inaccurate MFL data could lead to defects either being missed or undersized. Prior to a magnetic flux leakage inspection, the pipeline should be evaluated to determine whether debris is present. If it determined that debris is present, even in small quantities, the pipeline should be cleaned using the appropriate pipeline cleaning method. This will improve the quality of the magnetic flux leakage inspection data and resulting integrity assessment.

Reference

[1] Yang Lijian et al, Research on intelligent pipeline magnetic flux leakage tester, Nondestructive Testing, Volume 24 Number 3, March 2002, P100-102

[2] Wang Yousheng et al, Anslysis and simulation on magnetic flux leakage signal of flaw inside pipe based on ANSYS, Computer Measurement & Control, Volume 13 Number 3, March 2005, P273-275.

[3] Kershaw, Christopher F., "The Importance of Enhanced Cleaning for In-line Inspection", The Pipeline Pigging Conference, Houston, TX, 3-6, Feb. 1997.

[4] Payne, Larry, "Cleaning and Geometry Inspection Prior to Corrosion Inspection", The Pipeline Pigging Conference, Kuala Lumpur, Malaysia, June 29 1998 – July 2, 1998.

[5] Valentine, Francisco, "Effect of Pipeline Debris on Geometry Tool Inspection Results", Pipeline & Gas Journal, January 2000.

[6] Francisco Valentine, P.E. "Effect of Debris-Induced Lift-off on Magnetic Flux Leakage Inspection Results"，Morgantown, West Virginia，2000