การวิเคราะห์ความเสียหายจากการกัดกร่อนแบบการกัดเซาะของระบบท่อลมขนส่งฝุ่นยาสูบ

Failure Analysis of Erosion Corrosion on Air Pipe System for Transporting Tobacco Dust

Pramual Wangkasem[1] and Tanong Nititeerachote[2]

Department of Mechanical Engineering, Faculty of Engineering, Siam University, Bangkok, Thailand[1]

Department of Humidity Control, The Tobacco Authority of Thailand, Bangkok, Thailand [2]

E-mail: pramual@siam.edu[1]

บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาระบบท่อลมสำหรับส่งฝุ่นยาสูบ พบว่าโรงงานประสบปัญหาความเสียหายบริเวณจุดโค้งของท่อและตามรอยต่อบ่อยครั้ง สาเหตุของปัญหามาจากสองปัจจัย (1) แรงดันภายในทำให้ฝุ่นยาสูบออกแรงที่ผิวท่อและโครงสร้างของท่อ (2) วัสดุที่ใช้ทำท่อ เนื่องจากท่อชนิดเคลือบสังกะสีมีค่าสัมประสิทธิ์แรงเสียดทานสูงกว่าชนิดเคลือบเซรามิก นอกจากนี้ ข้อต่อและความโค้งของท่อยังทำให้เกิดแรงเสียดทานระหว่างท่อกับฝุ่นยาสูบเพิ่มขึ้น นักวิจัยพบว่าความเสียหายที่เกิดจากฝุ่นยาสูบนั้น ขนาดและรูปร่างเป็นปัจจัยที่ส่งผลจึงถูกตรวจสอบด้วยกล้องจุลทรรศน์แบบแสง

ผลปรากฏว่าขนาดของฝุ่นยาสูบ ซึ่งฝุ่นขนาดเล็กกว่า 250 ไมครอน เป็นกลุ่มฝุ่นยาสูบที่ใหญ่ที่สุดมีมากถึงร้อยละ 41.12 การตรวจสอบฝุ่นยาสูบด้วยกล้องจุลทรรศน์แบบแสง พบว่าฝุ่นยาสูบรูปทรงเชิงมุมสามารถทำลายท่อได้ พื้นผิวที่เสียหายจะแตกต่างกันไปตามความหนาที่เกิดการกัดกร่อน ซึ่งแสดงถึงรูปแบบของการกัดกร่อนแบบกัดเซาะ

คำสำคัญ: การกัดกร่อน, ฝุ่นยาสูบ, ระบบท่อ

Abstract

This research aimed to investigate air duct systems for delivering tobacco dust. It was found that the factory encountered the problem that damage of curvature of the pipe and along the joints has often occurred. The causes of the problem are from two factors. (1) Internal pressure causes the tobacco dust to be exert force on the skin and the structure of the pipe. (2) Piping materials because the pipe with zinc coating type has the coefficient of friction higher than ceramic coating type. Moreover, the joints and curvature of the pipe have caused an increase in the friction between the pipe and the tobacco dust. Investigators found that the damage was caused by tobacco dust. Therefore, the size and shape are examined with the optical microscope.

The result pointed that size of the tobacco dust; which smaller than 250-micron dust is the largest group of the tobacco dust with up to 41.12 percent. Microscopic examination of tobacco dust revealed that the

angular shape of tobacco dust can damage pipes. Damaged surfaces vary by thickness, indicating a pattern of erosion-corrosion.

Keywords: Corrosion, Tobacco Dust, Pipe System

1. Introduction

Due to the currently many industrial plants use of a variety of materials in the production line. Transportation process as well as the steps in the production of parts bringing the steel sheet to make the pipeline. Important in Industrial plants are very much in terms of production that requires the wind system to help produce products and in the delivery of goods and raw materials. In addition to the pipes, what is inside the pipe is equally important, making the pipe system is the heart of the industry.

In factory, there is a pipe used to transport raw materials and products because it helps to reduce the cost of energy and manpower, such as the use of pipes to transport liquid products. Petroleum oil transport from crude oil drilling in the sea comes to the refining process until selling to customers, this type of transport must be careful and regularly check the pipeline system. Transporting tap water to supply for homes for consumer consumption, this type of transport must take into account the water quality in the back, inside the pipe must not rust and corrosion. The use of pipes to transport gas products such as natural gas into the gas station, this type of transport requires a systematic knowledge of pressure and regular inspection. If the pipe cannot bear pressure, it may be damaged. As mentioned above, planning and selection of suitable materials for the job and taking into account the steps of maintenance.

Corrosive due to erosion is the shedding of the material surface in a specific area that is subjected to physical forces (impact, friction, etc.), causing the metal surface to lose its passive film. Therefore, the fluid can corrode the metal surface and causing the metal to lose its ions causing more corrosion and slip away in a short time. As it is mechanical erosion, erosion can occur on both metals and non-metals. The rate of erosion is directly proportional to the speed and turbulence of the fluid. This type of corrosion occurs on metals with high movement or abrasive metal with high-moving fluids and the area where the fluid changes direction. Areas of erosion indicate flow, pits, hills, traces of wave formation, which indicates the direction of flow such as the inner tube area of the chemical conveying pipe, the damage of the turbine blades due to the impact of water droplets or damage to the propeller caused by the impact of air bubbles, etc.

From working in the Thailand tobacco monopoly, there are problems in the selection of materials for making pipes that are not suitable for work. It makes frequent damage on curves or pipe joints which the inside of the pipe is solid and fine tobacco dust. This problem caused the wind force in the system to fall because the wind system in the factory is a circulating wind system and the tobacco leaves that are the main raw material to be sent to the machine without delay, the production process to stop. Therefore the cause of this research is to find the cause of damage to the pipeline in the transportation system as mentioned above.

2. Inspection process

Failure analysis of various equipment parts must start from the history or background information of the damaged parts. This pipe has been used since 1979, after 6 years of use the first maintenance is performed, after 3-4 years the second maintenance is performed. The most common maintenance method is to seal pipe leaks that are caused by break through pipe wall. It was the cause of the pressure drop in the piping system. The total usage time of the pipes before being analyzed for damage has been in use for more than 8 years and has been repaired twice.

Visual inspection reveals traces of perforated pipe walls of varying thickness, a form of erosion corrosion. The area, where the pipe penetrates is the thickness of the pipe that is less than the area, where the pipe is not eroded.

(1) The analyzer decides where to cut the damaged parts in order to obtain a position that can be identified cause of damage. Cut and split especially in the area where the leak comes to examine with a light microscope to find the erosion marks caused by tobacco dust that causes the metal surface of the pipe to damage.

(2) Remove the tobacco dust that is considered to be the cause of corrosion by separate the scale with a sieve that can be separated from 250 microns to 850 microns.

(3) Take the isolated part to check the shape of the tobacco dust with a light microscope

However, researchers have checked the material used to make pipes, the pressure of the air used in the system, and the heat generated on the outer surface of the pipe while moving the tobacco dust.

3. Result and discussion

The examinations of the factors which may cause the damage of the pipes in the tobacco dust delivery system are as follows:

(1) The pressure used in the air supply system 80-100 bars, results to tobacco dust particles which made a strong impact and friction on the pipe surface causing corrosion of the pipe by erosion-corrosion on the pipe surface.

(2) The temperature of various areas in the tobacco dust pipeline system resulting to the coating of the pipe surface is softened and the surface hardness of the pipe is reduced. Typical temperatures are greater than room temperature at 25 ° C, as shown in Table 1

(3) The tobacco dust particles in the pipes have different sizes. From checking the size between 250-850 microns it can be seen that the size and quantity of tobacco dust varies. Separate table for particle size and average quantity was shown in table 2

From table 2 it was found that the quantity of dust particles of tobacco, smaller than 250 microns, had the highest amount, representing 41.12 percent of the total volume. Followed by the size of 300-425 microns, which table 2 can be displayed.

In addition to analyzing the size and quantity of particles in this research, the structure of tobacco dust was analyzed by optical microscope as shown in Figure 1.

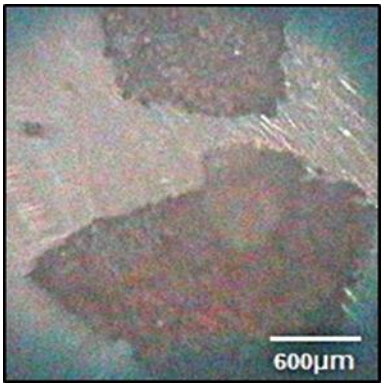
Figure 1, it can be seen that the tobacco dust particles are angular at a pressure of 80-100 bar; it forms a corrosion-erosion pattern.

Table 1 Various temperature conditions in the system

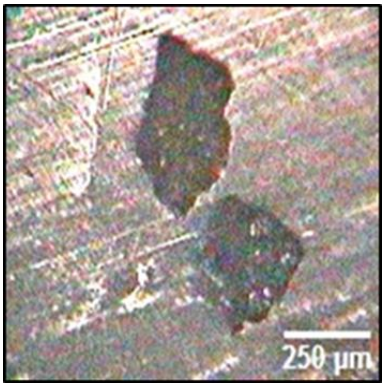
Area	Temperature °C
Outside the tobacco dust cabinet	42.9
Outside the tobacco dust pipe	43.0
Outside the end of the tobacco dust pipe	38.5

Table 2 Average particle size and volume

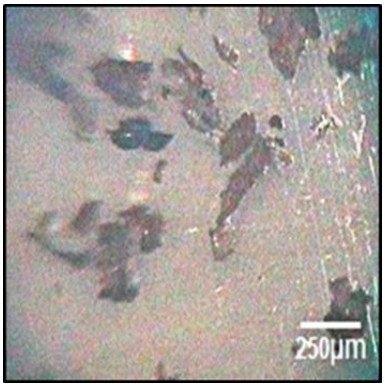
Particle size (micron)	percentage
Larger than 850	3.20
600-850	10.32
425-600	16.30
300-425	18.68
250-300	9.06
Smaller than 250	41.12
Loss	1.32
Sum	100.00



(a) larger than 850 micron



(b) 250-300 micron



(c) less than 250 micron

Fig. 1 Structure of tobacco dust

(a)

(b)

(c)

(d)

Fig. 2 Piping of tobacco dust during curves and arched parts of damaged pipes

(4) Figure 2 (a) is the curve of the pipe. Figure 2 (b) (c) and (d) are parts of the pipe cut off the tobacco dust. It can be seen that the pipe is shaped like a steel plate, intermittently connected, maybe another factor that causes the pipe to damage frequently.

Figure 3 is a picture obtained from the optical microscope shows that the welded range is torn and the skin near the area (Thin Area: TA) was defects which is the form of corrosion damage. The cause is due to many factors, including the wind force in the system.

4. Conclusion

Based on the analysis, it was found that the cause of damage to the tobacco dust transport system is caused by two factors.

(1) The pressure inside the pipe causes tobacco dust to have a strong impact on the structure of the pipe.

(2) Material for making pipes and the design of the joints of the pipes by the pipes used in the surface is zinc. In the metal, there is a higher coefficient of friction than the ceramic coated pipe as well as the joints and curves of the pipe affect increasing friction between the pipe and the tobacco dust.

Both factors caused erosion-corrosion damage in this tobacco pipe transportation system.

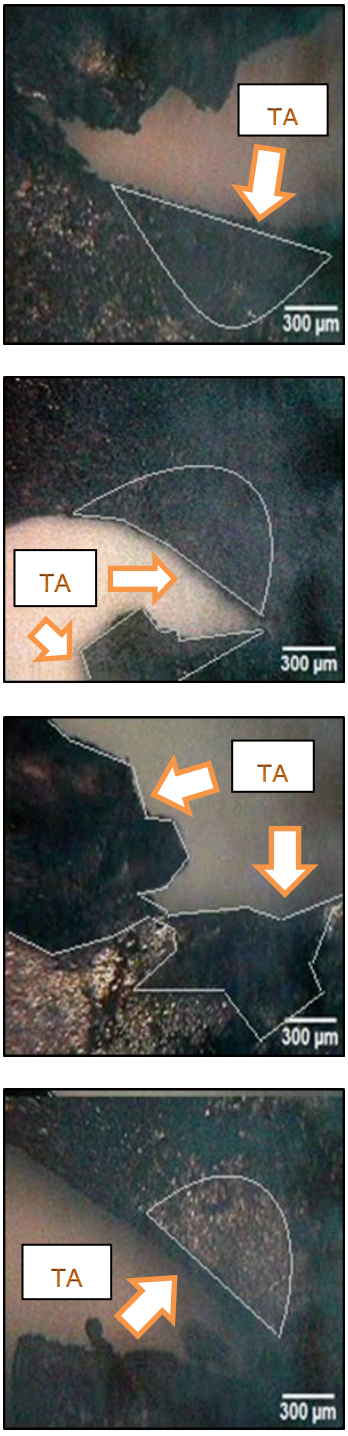


Fig. 3 Parts of the damaged pipe from a light microscope

Suggestion from the problems encountered, there are many possible solutions, such as selecting a pipe with a low friction coefficient (slip surface) in a circulating air duct system, design the pipe joints to bend into a single piece of material without excessive joints, and design the removal of tobacco dust from the beginning of the separation without going through the circulating air duct system.

Acknowledgment

Thank you to the Thailand Tobacco Monopoly, Department of Humidity Control, The Tobacco Authority of Thailand for support and cooperation in this research.

Reference

[1] G.Kreysa and M.Schutze. (2004), "Corrosion Handbook Atmosphere Industrial Waste Gases", Wiley-VCH, Vol. 6

[2] P.R. Roberge. (2012), "Handbook of Corrosion Engineering", McGrawHill.

[3] H. Kaesche. (2003), "Corrosion of Metals Physicochemical Principles and Current Problems", Springer.

[4] Samuel A. Bradford. (1993), "Corrosion Control", Van Nostrand Reinhold.

[5] Bruce E. Larock, Roland W. Jeppson and Gary Z. Watters. (2000), "Hydraulics of pipeline system", CRC Press.

[6] Kanchana Takulku. (1989), "Corrosion Technology", Crave Man Press.

[7] C. Kanchanomai. (2009), "Failure of engineering material", Thammasat University Press.

[8] P. Jongjitphaisan. (2007), "Pneumatic Conveying System", Technology Promotion Association (Thailand-Japan).