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Reassesment of the Aging Arterial Gas Pipelines

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***Summary* – The topical problem for transmission pipelines, which are exploited after the end of predicted exploitation lifetime, is the assessment of technical condition and prognostication of residual life. Because of remarkable expenses, which arare necessary for complete renewal of exploited pipelines, currently the exploitation is performed following their technical condition. The usage of nondestructive diagnostic operation methods, where the in-line inspection apparatus is used, lets to detect and identify the significant quantity of defects to determine their geometrical parameters with quite high degree of credibility. There are also cases, when results of in-line inspection do not conform to results of local diagnostics. In these cases the additional calculation of allowable pressure of pipeline section that has certain defect is performed. At this paper one of these cases is discussed. ASME manual for evaluating the remaining strength of corroded pipelines. [5] It is a supplement to the ASME B31 code for pressure piping. The manual was developed in the late sixties and early seventies at Battelle Memorial Institute (USA) and provides a semiempirical procedure for the assessment of corroded pipes. As an example the analysis of corrosive type defect will be performed. The calculation on residual strength will be performed.**

***Key words* - Gas transmission pipelines, analysis of defect, calculating of allowable pressure.**

I. INTRODUCTION

Offshore pipelines transport large quantities of oil and gas vital to our global economy. [4] Any failure to ensure the safe and continuous operation of these pipelines may have serious economic, environmental and life-safety implications. A prerequisite to pipeline safe operation is assurance of structural integrity to a high level of reliability throughout their lives. Such integrity may be threatened by defects introduced into the pipeline system during fabrication, installation or operation. Since it is impractical to prevent all defects from occurring and because not all defects are harmful to pipeline integrity, it is essential to be able to distinguish defects that can be tolerated from those that cannot.

II. METHODOLOGY

Based on analysis results of the corrosion defect database, the DNV RP-F101 method is more conservative then either the ASME B31G or the RESTRENG methods. However, in terms of the variation coefficient, the DNV RO-F101 method proved to be the most accurate of the three methods examined, and the ASME B 31G seems to be most accurate of the methods.[6]

Figure 1 presents a list of methods available for corrosion defect assessment. Methods are grouped vertically by their type, codified methods or others, and horizontally by their applicability, pressure or combined loading etc. Assessment of other methods, except for RSTRENG, was not feasible because of a lack of information. [1]

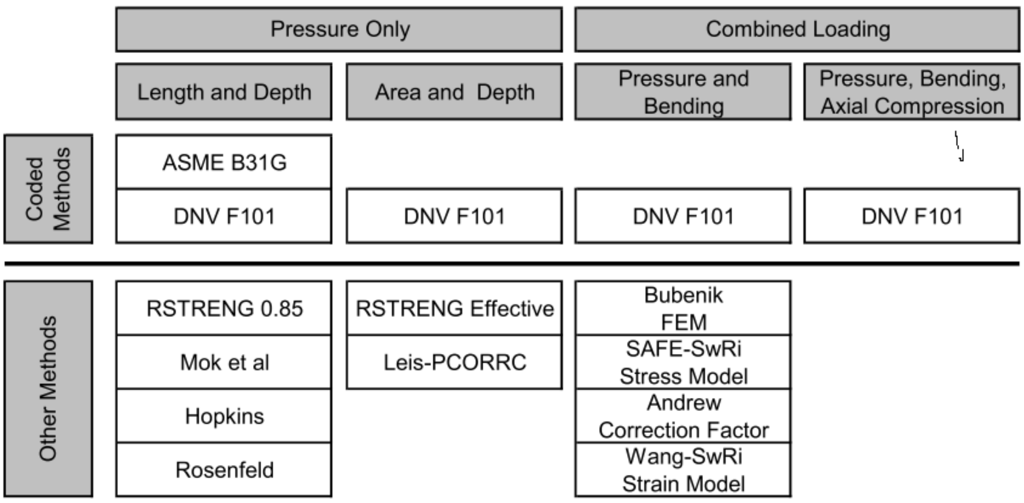

Fig.1. Methods for Corrosion Defect Assessment [1]

ASME B31G is a manual for evaluating the remaining strength of corroded pipelines. [5] It is a supplement to the ASME B31 code for pressure piping. The manual was developed in the late sixties and early seventies at Battelle

Memorial Institute (USA) and provides a semiempirical procedure for the assessment of corroded pipes. Based on an extensive series of full-scale tests on corroded pipe sections, it was concluded that pipeline steels have adequate toughness and the toughness is not a significant factor for the defect calculation. The failure of blunt corrosion flaws is controlled by their size and the flaw stress or yield stress of the material.[2]

Figure 3 presents a flowchart for the B31G method. Input parameters include pipe outer diameter (D) and wall thickness (t), the specified minimum yield strength (SMYS), the maximum allowable operating pressure (MAOP), longitudinal extent of corrosion (L_c) and defect depth (d). The procedure works as follows:

Step 1. Compare the defect depth (d) to the nominal wall thickness of the pipe (t). If d/t is less than 10%, then pipe may remain in service after arresting corrosion. If d/t is greater than 80%, the pipe must be repaired or replaced before return to service. For values of d/t between 10% and 80%, carry on to Step 2.

Step 2. Compare the measured longitudinal extent of corrosion (L) to the value from tables provided in the manual for (L_c) or from:

$$L_c = 1.12B\sqrt{Dt} \qquad (1)$$

where D is the pipe outside diameter, t is the nominal wall thickness, and B is defined as:

$$B = \sqrt{\left[\frac{d/t}{1.1d/t - 0.15}\right]^2 - 1} \qquad (2)$$

B may not exceed a value of 4. If L is equal to or less than L_c, then suspend further corrosion and return pipe to service. If L is greater then L_c, carry on to Step 3.

Step3. Compare MAOP to the maximum pressure (P′) calculated from

$$P' = 1.1P\left[\frac{1 - \frac{2}{3}\frac{d}{t}}{1 - \frac{2}{3}\left(\frac{d}{t\sqrt{A^2 + 1}}\right)}\right] \qquad (3)$$

When A, defined below, is less than or equal to 4.0

$$P' = 1.1P\left(1 - \frac{d}{t}\right) \qquad (4)$$

When A is greater than 4.0

P is the greater of the established MAOP or P=2(SMYS)tFT/D with F being the design factor and T being the temperature derating factor from the appropriate B31 code. A is defined as:

$$A = 0.893\left(\frac{L_m}{\sqrt{Dt}}\right) \qquad (5)$$

where L_m is the measured longitudinal extent of the corroded area.

If the established MAOP is equal to or less than P′, repair or replace the section and return pipe to service or reduce the MAOP and return pipe to service.[1]

Results

Maximum allowable operating pressure calculation

TABLE 1. Defect parameters

Defect parameters (in-line inspections results)					
Corrosion Type	Length (mm)	Width (mm)	Depth (mm)	Wall thickness t(mm)	Pipe outside diameter (mm)
External	695	255	3,6	9	720

Maximum allowable operating pressure P′ = 4,5 MPa (in-line inspections results)

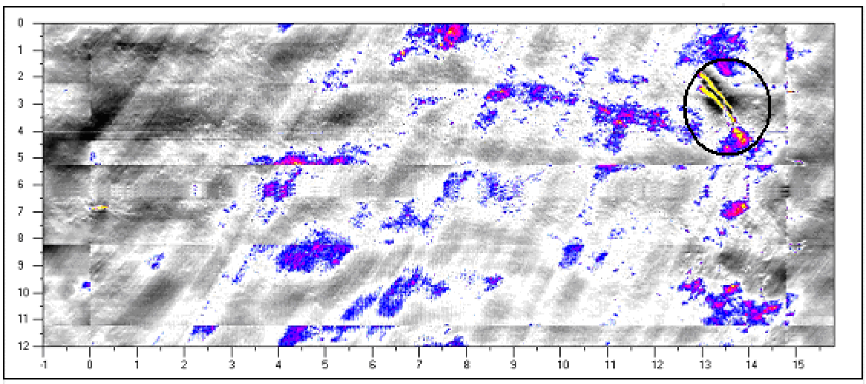

Fig.2. Magnetogram of the defect (horizontal aves – distance in m, vertical axes – time in hours)

Step 1. d/t > 30%
Step 2. Lc > L
Step 3. A = 4.0 ; P' = 5.06 MPa

Maximum allowable operating pressure P′ = 5,06 MPa (local diagnostic results)
Limitations on the use of the B31G procedure include:

It applies to corrosion defects only in the body of the pipe, which have relatively smooth contours and cause low stress concentration.
It applies to pipes under internal pressure loading only. [3]

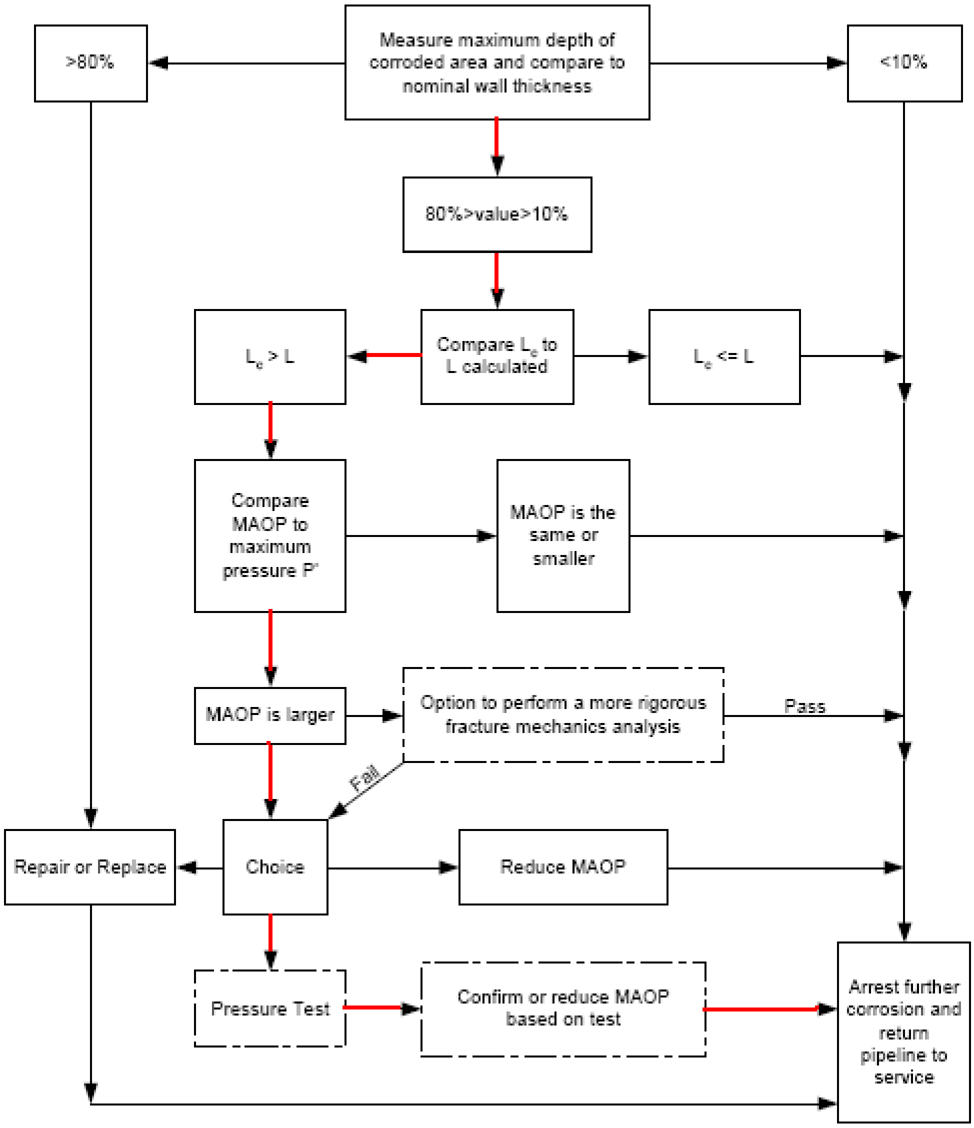

Fig.3. ASME B31G Assessment Procedure [5]

TABLE 2. Defect parameters (local diagnostic result)

Defect parameters (local diagnostic results)								
Corrosion Type	Length (mm)	Width (mm)	Depth (mm)	Lc (mm)	dc (mm)	Surface Finish	Wall thickness t(mm)	Pipe outside diameter (mm)
External	555	223	2,5	567	2.5	-	9	720

III. Conclusion

As the result we can perform following conclusions:
In-line inspection results and local diagnostic results are different. European operators sometimes use in-line inspection tools for pipeline diagnostic. It is very expensive method, and as the result it often gives to operators incorrect results. It is more efficiently to use in-line inspection in complex with local inspection. Usage of those methods in complex gives to operators more correct results.

Literature

1. *Appraisal and development of pipeline defect assessment methodologies:* final report phases I and II, report for the United States Minerals Management Service, June 2000;
2. **Altschuler E.** Nonlinear model of flaw detection in steel pipes by magnetic flux leakage, 1995;
3. **Shandong P.R.**, „Detection and estimation of oil-gas pipeline corrosion defects", publication 2002;
4. *An introduction to pipeline pegging*, PPSA Publication 2004;
5. „ASME/ASME B 31 G. Determining Remaining of Corroded pipelines: Supplement to B 31 Code" – Pressure Piping. 1991;
6. **Климов П.В.** "Анализ нормативно – технической базы в области промышленной безопасности магистральных газопроводов республики Казахстан". АО "Интергаз Центральная Азия", г. Астана, Республика Казахстан. Full text: www.ogbus.

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Aleksejs Batrakovs. Novecojošu maģistrālo gāzes vadu izvērtēšana
Mūsdienās naftas un gāzes rūpniecībā cauruļvadu transportam ir ļoti liela loma. Pirmām kārtām tas ir sakāms par gāzes rūpniecību, kur cauruļvadi ir vienīgais gāzes transportēšanas veids no tās ieguves vietas līdz patērētājiem. Avārijas cauruļvadu maģistrālēs bieži vien noved pie cilvēku upuriem, izraisa saindēšanos, vides piesārņojumu un lielas ekonomiskās izmaksas, kas saistītas ar avāriju likvidēšanu un ražošanas atjaunošanu. Šodien līdzās sistēmas caurlaidības palielināšanas uzdevumam ir jānosaka vēl arī esošās sistēmas tehniskais stāvoklis, kā arī jāveic tās remonts, lai uzturētu šīs sistēmas darbspēju. Maģistrālajiem gāzes vadiem, kuri tiek ekspluatēti līdz kalpošanas laika beigām, aktuāla problēma ir noteikt to tehnisko stāvokli un prognozēt atlikušo resursu. No daudzajiem faktoriem, kuri nosaka gāzesvadu resursu, ir jāizdala visdažādāko defektu radīto ietekmi, kā arī vispārējo un lokālo fiziski-mehānisko metāla cauruļu īpašību degradāciju. Lai paaugstinātu ekspluatējamo cauruļvadu objektu drošību, arvien plašāk tiek pielietotas cauruļvada sienas stāvokļa testēšanas diagnostikas metodes ar īpašu diagnostikas ierīču, kas tiek ielaistas cauruļvadu iekšienē. Nesagraujošās caurules iekšējās diagnostikas kontroles metodes ļauj ar pietiekoši augstu precizitātes pakāpi atklāt un identificēt lielu defektu skaitu, nosakot to ģeometriskos izmērus. Bet gadās arī, ka iekšējās diagnostikas kontroles rezultāti neatbilst lokālās apsekošanas rezultātiem. Šajos gadījumos veic papildus aprēķinus, lai noteiktu pieļaujamo spiedienu caurulē ar konkrētu defektu. Sekojošā darbā tiks apskatīts viens no šiem gadījumiem. Kā piemērs, tiks analizēts korozijas defekts. Tiks izpildīts atlikušās stiprības aprēķins. Pētījuma rezultāti palīdzēs izdarīt slēdzienu par defekta bīstamības novērtējumu.

Алексей Батраков. Оценка состояния устаревающих магистральных газопроводов.
На сегодняшний день роль трубопроводного транспорта в системе нефтяной и газовой промышленности чрезвычайно велика. В первую очередь это относится к газовой промышленности, где трубопроводы являются единственным средством транспорта газа от мест добычи к потребителям. Аварии на магистральных газопроводах зачастую приводят к человеческим жертвам, отравлению, загрязнению окружающей среды и большим экономическим издержкам, связанным с ликвидацией аварий и восстановлением производства. Наряду с задачей увеличения пропускной способности системы, стоит задача определения технического состояния уже существующей системы и ее ремонта для поддержания работоспособности. Актуальной проблемой для магистральных газопроводов, эксплуатируемых по окончанию срока службы, является оценка технического состояния и прогнозирование остаточного ресурса газопровода. Из множества факторов, определяющих ресурс газопроводов, следует выделить влияние всевозможных дефектов, а также общую и локальную деградацию физико-механических свойств металла труб. Для повышения надежности эксплуатируемых объектов трубопроводов всё более широко применяются методы тестового диагностирования состояния стенки трубопровода при помощи пропуска специальных внутритрубных диагностических снарядов. Использование методов неразрушающего контроля внутритрубной диагностики позволяют с достаточно высокой степенью точности обнаруживать и идентифицировать значительное количество дефектов для определения их геометрических параметров. Но есть так же случаи, когда результаты внутритрубной диагностики не соответствуют результатам локального обследования. В этих случаях проводятся дополнительные расчеты на допустимое давление в трубопроводе с определенным дефектом. В данной работе будет рассмотрен один из таких случаев. В качестве примера будет рассмотрен анализ коррозионного дефекта. Будет выполнен расчет для определения остаточной прочности. Результаты исследования помогут сделать вывод об оценке опасности дефекта.