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The Validation of the Method of Estimating Losses from Defects in Gas Distribution Pipes Buried

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Abstract

This article presents the validation of the method of calculating estimated losses of gas through pipes buried corrosion defects. The method of calculation was published in the Bulletin of the Scientific UPG Ploiesti [3]. The mathematical model of gas flow through pipes buried in soil defects is approached through a numerical method using finite element program ANSYS version 10.0. This paper presents a case study of a corroded gas pipeline in 5 places. The amount of gas loss recorded by the company is close to that resulting from predicting the validated method.

Key words: *gas losses, pipe, corrosion, soil, pressure*

Introduction

This article presents the validation of the method of calculating estimated losses of gas through pipes buried corrosion defects. The method of calculation was published in the Bulletin of the Scientific UPG Ploiesti [3].

The mathematical model of gas flow through pipes buried in soil defects is approached through a numerical method using finite element program ANSYS version 10.0.

Using this methodology, knowledge of absolute permeability and viscosity of the soil gas pressure gradient can be calculated in the defect area, thus estimating gas flow is lost.

Mathematical model

Process flow-flat radial isothermal gas through a porous medium is homogeneous and isotropic equation modeling

$$\frac{\partial}{\partial x}\left(\frac{k}{\mu}\frac{\partial P}{\partial x}\right)+\frac{\partial}{\partial y}\left(\frac{k}{\mu}\frac{\partial P}{\partial y}\right)=0 \qquad (1)$$

where k is the permeability of the porous environment, P - gas pressure in the square by shifting POOS environment and dynamic viscosity of gas.

Numerical model approach

To solve equation (1) for a buried pipeline, using the program ANSYS version 10.0. In this case we considered a perpendicular section through a pipe buried at a depth of 1 m in diameter of 300 mm. Figure 1 is a schematic diagram of the geometric model.

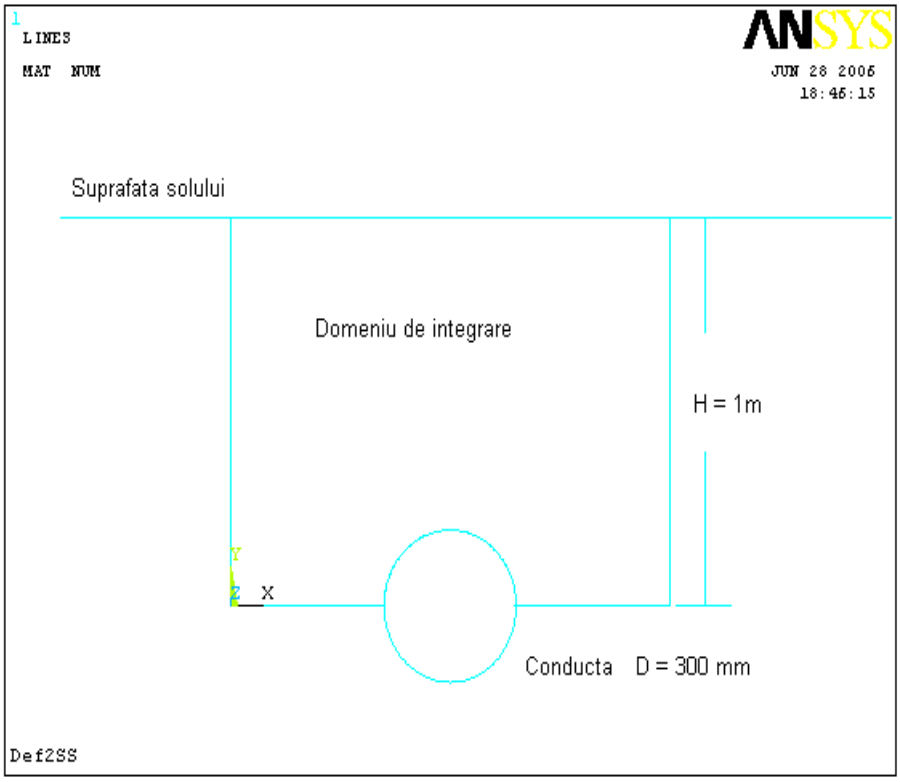

Fig. 1. Geometric scheme of the problem

For domain modeling program called ANSYS Plane 55 element was used. This element is defined by four nodes and the orthotropic properties of the material. Orthotropic material directions correspond to the element coordinate directions. This item type can be used for modeling thermal diffusion, but also for stationary fluid flow through porous medium by setting the property KEYOPT9 = 1.

Images studied for a defect

For a corrosion defect consisting of 5 holes, each with a radius of 1 mm, Tirgu Jiu District met in a 300 mm diameter pipe, gas pressure 2.5 bar, in Figure 2. pressure distribution is shown suggestively around the perfectly, and the vector in Figure 3 shows the flow of gas leaving the pipeline.

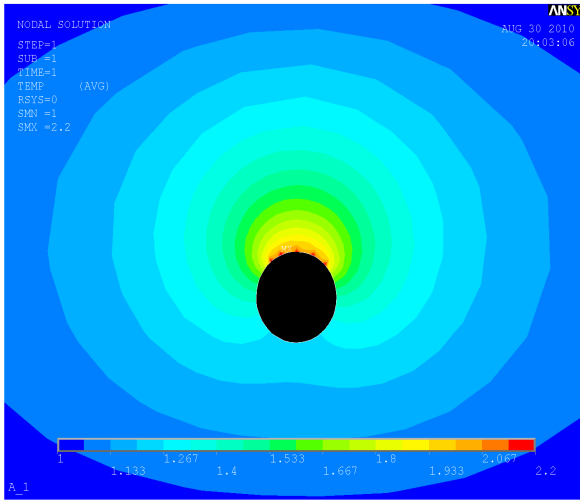

Fig. 2. Pressure distribution around the defect

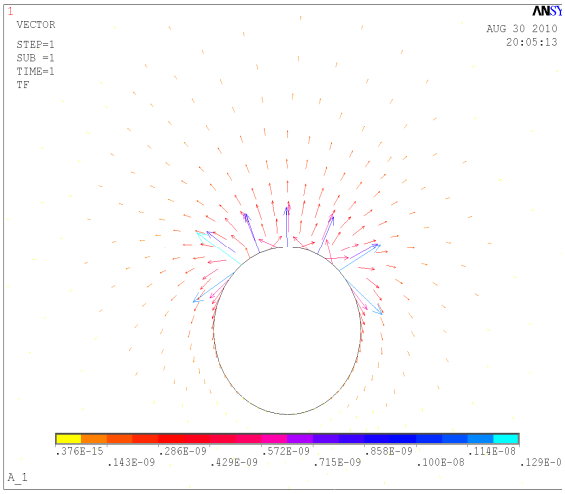

Fig. 3 Vector gas flow

Determination of pressure gradient in the defect area

To calculate the pressure gradient have been defined for the 5 holes, five directions specified, for each of them to determine the pressure variation curve.

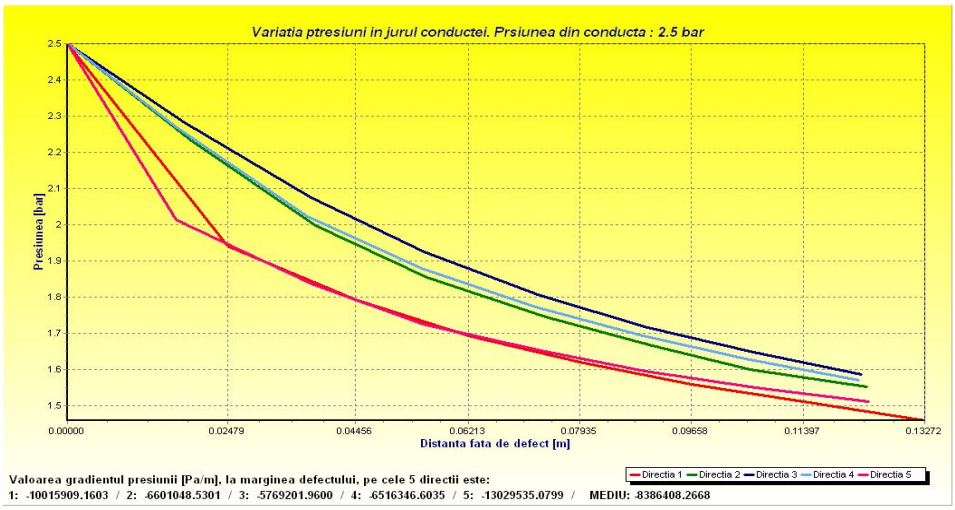

Fig.4. Changes in pressure at the outlet of the pipeline through pores

In a regression using the least squares method, one can obtain a very simple function that approximates the numerically determined variation gradient. Thus, the equation that allows calculating the gradient is: Y is the mean gradient, Pa / m, X - value of gas pressure in the pipe, Pa., and the coefficients have values: a = 1600065.5, b = 1597583.6, c = 5249 , 1419.

The formula is valid for: absolute permeability of the soil k = 10-10 m2 and gas viscosity μ = 1,8.10-6 Pa.s.

Case study

Given the above model, the flow of gas passing through the defect pores composed of the five is a steady flow. Lost through faulty gas flow is estimated based on the pressure in the pipe, the formula

$$Q = -A\frac{k}{\mu}\frac{\partial p}{\partial x}, \tag{2}$$

where A is the section of the defect, k - absolute permeability of the soil, μ - viscosity of gas, and $\frac{\partial p}{\partial x}$ - the value of pressure gradient in the pipe wall defect.

For the case study were considered experimental data following a failure situation occurring in the District Tirgu Jiu: 300 mm diameter pipeline, gas pressure 2.5 bar, fault section 5x3, 14 = 15.7 mm^2.

The calculated value of the corresponding pressure gradient gas pipeline:

$$\left.\frac{\partial p}{\partial x}\right|_{p=2.5} = -1600065.6 + 1597583.6\cdot\left(2.5\cdot 10^5\right)^2 + \frac{5249.1419}{\left(2.5\cdot 10^5\right)} = 10{,}048\cdot 10^6 \text{ Pa/m}$$

Steady flow of gas passing through the damaged section on the basis of the defect:

$$Q = -15{,}7\cdot 10^{-6}\,\frac{10^{-10}}{1.8\cdot 10^{-6}}\,10{,}048\cdot 10^6 = 87{,}64\cdot 10^{-4} \text{ m}^3\text{/s}.$$

while the amount of gas lost during one hour by pipe's defect is

$$Q_h = Q\cdot 3600 = 31{,}55 \text{ m}^3.$$

Measurements have confirmed the loss of about 150 m3 of gas in 3 hours

References

1. Neacşu, S., Trifan, C., Albulescu, M. - *Considerations on the Errors Associated to the Measuring of the Amounts of Natural Gas Delivered to Household Consumers,* Revista de Chimie, vol. 59 (7), pg. 796-801, 2008
2. Albulescu, M., Neacşu, S., Trifan, C., Ionescu, E.M. - *Theoretical Considerations and Experimental Measurements Concerning the Defining of Correction Coefficients in Case of Measuring Natural Gas Volumes for Household Consumers,* Revista de Mase Plastice, vol. 45 (1), 2008, pg. 38-41
3. Trifan, C., Olteanu, D.,Herda, R., Trifan, T.F. –*Modeling Gas Flow trough Pipes Bracks,* Buletinul UPG Ploieşti, Vol LX. No. 4A/2008

Validarea metodei de estimare a pierderilor prin defectele conductelor de distribuţie gaze îngropate

Rezumat

În acest articol se prezintă validarea metodei de calcul estimativ a pierderilor de gaze prin defectele de coroziune a conductelor îngropate. Metoda de calcul a fost publicată în Buletinul ştiinţific al UPG Ploieşti [3]. Modelul matematic al curgerii gazelor prin defectele conductelor îngropate în sol este abordat printr-o metodă numerică cu elemente finite cu ajutorul programului ANSYS versiunea 10.0. În lucrare se prezintă un studiu de caz cu o conductă de gaze corodată în 5 locuri. Valoarea pierderii de gaze înregistrată de societate fiind apropiată de cea rezultată prin calculul estimativ a validat metoda.