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APPLICATION OF ANAEROBIC THREAD SEALANTS IN NATURAL GAS PIPELINES

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Preliminary notes

Contemporary approaches regarding to infrastructure are more and more directed to new materials development for natural gas and other installations. The most recent development and application of the new materials pertain to sealant materials for sealing of threaded joints in gas pipeline installations and installations for other media. Based on provided analysis, gas leaking on threaded joints in home metering and control units sealed with hemp was affirmed. Considering that in practical work in the case of hemp, sealing threads are made by a thread tool and during threading, the tool lubricates, the influence of impurities on sealing with anaerobic sealant compounds has been tested. Experimental work includes testing of three different anaerobic sealing compounds with three material combinations in threaded pipe joints (steel – brass, brass – brass and brass – aluminium) on three different temperatures (-20 °C, 25 °C and 100 °C).

Keywords: *anaerobic polymeric sealants, gas installations, leakage of natural gas*

Istraživanje primjene anaerobnih brtvenih smjesa u plinovodnim sustavima

Prethodno priopćenje

Trenutačni su pristupi, koji se odnose na infrastrukturu, sve više usmjereni na razvoj novih materijala za izvođenje plinskih i drugih instalacija. Najnovija dostignuća i primjena novih materijala prvenstveno se odnose na smjese za brtvljenje navojnih spojeva plinskih cjevovodnih instalacija, te cjevovoda za druge medije. Provedenim je ispitivanjima potvrđeno propuštanje prirodnog plina na navojnim spojevima kućnih regulacijskih stanica brtvljenih kudjeljom, što je potvrđeno provedenim ispitivanjima. U instalaterskoj praksi navoj na cijevima izrađuje se pomoću nareznica koje se prilikom narezivanja navoja podmazuju. Ispitivanjem se utvrdio utjecaj onečišćenja na brtvljenje spojeva pomoću anaerobnih brtvenih smjesa. Eksperimentalnim radom ispitana su tri različita anaerobna brtvila s kombinacijom tri materijala u navojnom spoju (čelik - mesing, mesing - mesing, mesing - aluminij), pri trima različitim temperaturama (-20 °C, 25 °C i 100 °C).

Ključne riječi: *anaerobne polimerne brtvene smjese, plinske instalacije, propuštanje prirodnog plina*

1
Introduction
Uvod

Application of hemp and non-curing sealing compounds is quite common in developing countries for different installation types, especially in natural gas installations. In spite of careful assembling, industry is faced with leakage problems of such joints after few years of exploitation. Nowadays, most of the countries and especially industrial developed countries devote great care to development and application of sealing materials for sealing of threaded joints in gas pipeline installations and installations for other media.

Main task of thread sealants is to prevent leakage of gases and liquids from pipe joints. All such joints consider being dynamic due to vibrations, changing pressures or changing temperatures, which makes special requests on them. With the growth of natural gas usage, possibilities of risk are also increasing, and for that reason, it is necessary to direct all attention to the tightness of sealed joints in gas installations. For sealing threaded joints in gas pipeline installations, according to regulation EN 751 non-curing sealing compounds, polytetrafluoroethylene (PTFE) tapes and anaerobic polymer sealants can be used.

Non-curing jointing compounds that are made of oil and fillers, mostly combined with hemp, are one of the oldest methods for sealing threaded joints. Jointing is easier because of lubricating threads. However, they can squeeze out under pressure, have poor solvent resistance, and do not work on parallel threads. Solvent-based jointing compounds are also an old method of sealing threaded joints. It provides lubrication and jams in gaps, extrude less easily. Disadvantage is that they shrink during cure as solvent evaporates and fittings must be re-torqued to minimize voids.

One of the solutions is also polytetrafluoroethylene (PTFE) tapes that give a good initial seal; they can resist chemical attack and it is the only organic sealant allowed for gaseous oxygen. At the same time, they also act as a lubricant and resist solvents. Unfortunately, PTFE tapes lubricate also in off direction, facilitating fittings to loosen. Dynamic loads may accelerate creep, causing leakage over time [1].

The most recent development in sealants is polymeric (methacrylate) anaerobic sealants, which cure to insoluble, tough, plastic thread fillers that prevent leakage regardless of the pressure or torque applied. Some of the most important advantages of these anaerobic jointing compounds are that they lubricate during assembling, seal regardless of assembly torque, seal to the burst rating of the pipe, provide controlled disassembly torque years later, do not cure outside joint (easy clean-up) and by that prevent corrosion on threads, give the lowest cost per sealed fitting.

The leaking of the gas from commercial pipelines is not only safety problem; it should also be regarded as direct loss of financial resources for gas distributors. Therefore, it is necessary to determine positions and frequency of the gas leaking as well as to analyze the possible causes of leaking and to give the eventual solutions to improve sealing.

2
Leaking analysis
Analiza propuštanja

To set the natural gas consumer in motion, work performer has to make the home metering and control unit (MCU) and to seal all the elements safety. An analysis of the gas leaking in home MCUs has been performed in the distributive region Osijek (locations Višnjevac, Josipovac and city area of Osijek). The installation systems of 3 bar inlet pressure have been analyzed. Each MCU consists of

eight threaded pipe joints (schematically presented in Figure 1), all sealed traditionally with hemp and non-curing jointing compounds.

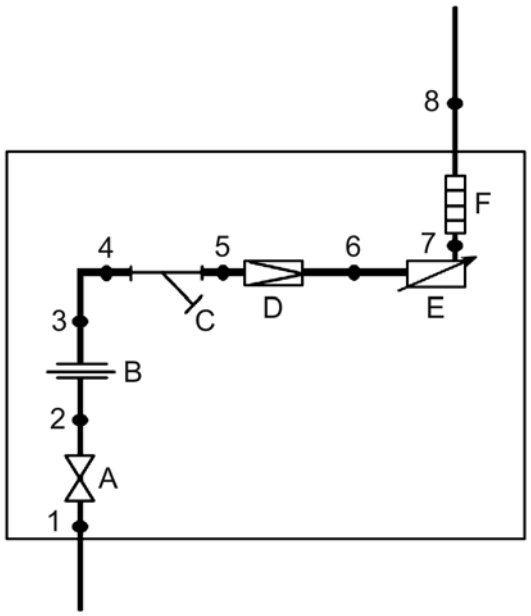

Figure 1 *Schematic overview of MCU (A – The major cock, B – dielectric connector, C – filter, D – regulator of the pressure, E – gasflow-meter and F – flexible gut)*
Slika 1 *Shematski prikaz kućne regulacijske stanice (A – glavna slavina, B – dilektrična spojnica C – filtar, D – regulator tlaka, E – plinomjer i F – fleksibilno crijevo)*

Gas leakage on each considered MCU, has been controlled using a foam-detecting agent [2]. The considered joints have been in operation during the last 5 years.

2.1
Results of leaking analysis
Rezultati analize propuštanja

In the location of Višnjevac a total number of 1366 MCUs (10928 threaded joints) has been analyzed. Total number of leaking joints was 967 or 8,85 %. Figure 2 shows gas leaking frequency on each position of threaded joints in the location of Višnjevac.

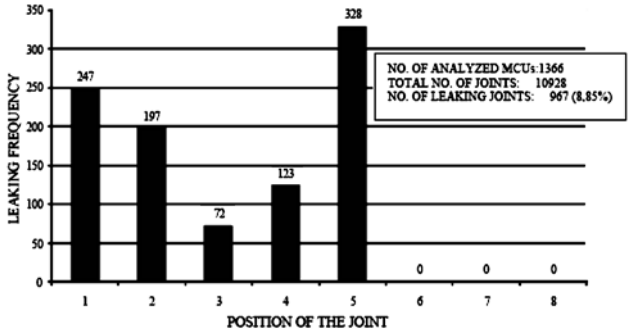

Figure 2 *Gas leaking frequency in the location of Višnjevac*
Slika 2 *Učestalost propuštanja KRS-a u Višnjevcu*

In the location of Josipovac the 718 MCUs (total number of threaded joints is 5744) have been analyzed. Total number of leaking joints is 638 or even 11,11 %. Figure 3 shows gas leaking frequency on each position of threaded joints in the location of Josipovac.

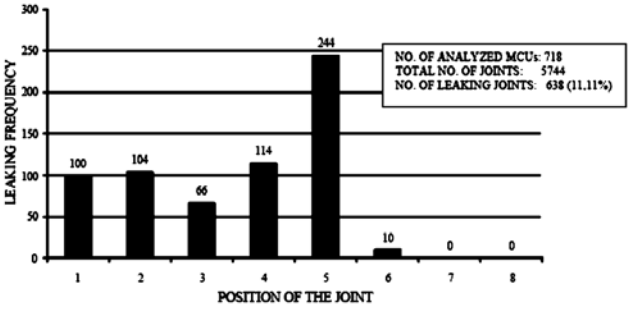

Figure 3 *Gas leaking frequency in the location of Josipovac*
Slika 3 *Učestalost propuštanja KRS-a u Josipovcu*

In the city area of Osijek 87 leaking positions on total number of 1320 analyzed threaded joints were detected (6,59 % of leaking joints). Figure 4 shows gas leaking frequency on each position of threaded joints.

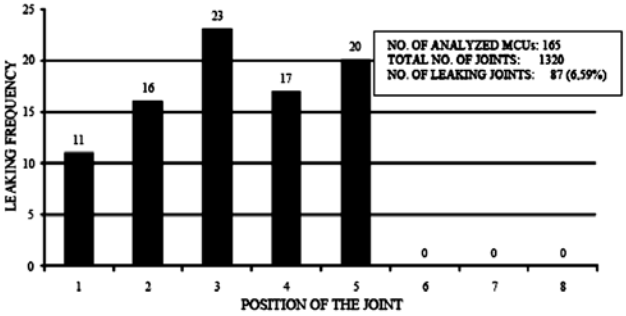

Figure 4 *Gas leaking frequency in the city of Osijek*
Slika 4 *Učestalost propuštanja KRS-a u Osijeku*

2.2
Discussion of the leaking analysis results
Rasprava o rezultatima analize propuštanja

The analysis has shown an unacceptably high number of threaded joints, in which gas leakage has been detected. There are many factors influencing the reliability. It might be the thread length, uncorrected cutting tool, sealing material or man work. However, the analysis has shown that one of the most important factors is the applied sealing method. According to available references [3] and corresponding standards and producer's recommendations as well as based on own experience [4], a significant improvement could be the application of anaerobic-curing jointing compounds instead of traditional sealing method using hemp and non-curing compounds.

The experiences in application of anaerobic jointing sealants for natural and commercial gas installations in Europe vary from country to country. Their application standardizes DIN EN 751-1 (DIN 30 661), BS 6956-7 and some company-internal standards (e.g. Italgas, Gaz de France etc.).

In Croatia, there are no large-scale applications of anaerobic sealants in commercial gas installation pipe works. However, the analysis has shown an excessive leakage in some parts of the analyzed commercial gas installation, traditionally sealed with non-curing sealants in combination with hemp.

Therefore, the authors have conducted experimental investigations in which anaerobic sealants have been applied in some positions of the commercial gas pipelines

and compared them with the same positions on pipe work sealed traditionally.

3
Experimental investigations
Eksperimentalna istraživanja

According to available literature, our experience and preliminary investigations performed [5, 6] there are three main factors influencing the sealing performances of the threaded pipe joints. They are sealing compound, working temperatures and fitting material combination.

3.1
Design and course of the experiment
Plan i tijek pokusa

In the investigations an experimental design, which includes 3 factors at 3 levels in 5 runs [5] giving a total of 135 experimental runs, has been applied. Summarized, all factors and level values are shown in Table 1.

Table 1 *Influencing factors and their levels*
Tablica 1 *Utjecajni faktori i njihove razine*

Factors		Levels	
A	Sealing compound	S1	Loctite 577
		S2	Loctite 511
		S3	Loxeal 58-11
B	Working temperature	T1	- 20 °C
		T2	25 °C
		T3	100°C
C	Fitting material combination	M1	Steel-Brass
		M2	Brass-Brass
		M3	Brass-Aluminum

All experimental procedures have been conducted according to DIN 2999 on R¾" pipe fittings with parallel internal threads and taper external threads of Withworth form. Sealing performances (output variables) at each run have been qualitatively measured using a foaming leak control agent after exposure to an internal pressure of 3 bar during 24 hours. Additionally, the unscrewing torque was measured at the end of each experimental run. Figure 5 shows the experimental setup.

3.2
Results and discussion
Rezultati i rasprava

In only one experimental run at S1/M1/T2, a moderate leakage from the joint was noticed. Afterward checking has shown an inadequate degreasing of fitting threads, which inhibited compound wetting ability to the surface of the fitting threads. However, assuming proper fitting degreasing, all sealing compounds considered give very reliable sealed joints.

As expected, higher working temperatures decrease unscrewing torque, but with no influence on sealing performances. This correlation was observed at all combination of factors. Figure 6 shows this correlation for steel - brass joints (M1), Figure 7 shows correlation for brass - brass joints (M2), and Figure 8 shows correlation for steel - aluminium joints (M3), all assembled by using various sealants (S1, S2 and S3).

Figure 5 *Experimental setup*
Slika 5 *Eksperimentalni postav*

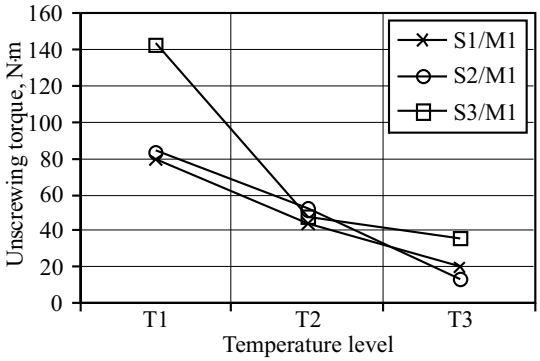

Figure 6 *The influence of temperature and sealant on unscrewing torque at steel-brass joints (M1)*
Slika 6 *Utjecaj temperature i brtvene smjese na moment odvrtanja kod spojeva čelik-mjed (M1)*

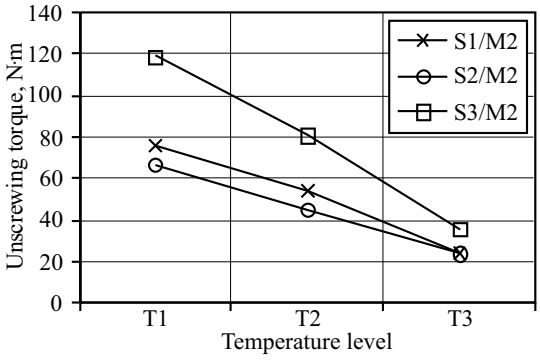

Figure 7 *The influence of temperature and sealant on unscrewing torque at brass-brass joints (M2)*
Slika 7 *Utjecaj temperature i brtvene smjese na moment odvijanja kod spojeva mjed-mjed (M2)*

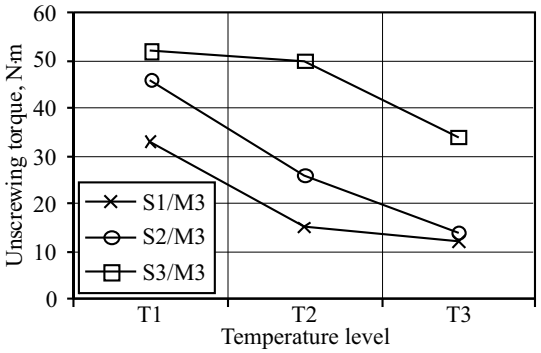

Figure 8 *The influence of temperature and sealant on unscrewing torque at steel-aluminium joints (M3)*
Slika 8 *Utjecaj temperature i brtvene smjese na moment odvijanja kod spojeva čelik-aluminij (M3)*

Furthermore, as an illustration, Figure 9 shows influence of various fitting materials (M1, M2 and M3) on unscrewing torque of threaded joints assembled by using various sealants (S1, S2 and S3) at constant temperature level of – 20 °C (T1).

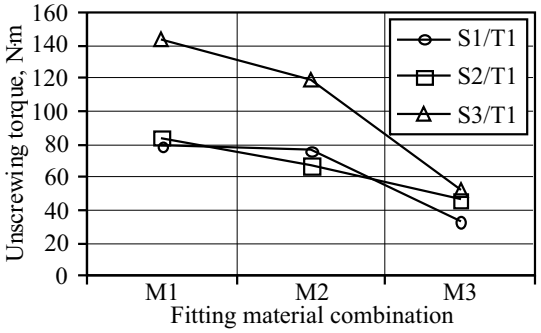

Figure 9 *The influence of fitting material and sealant on unscrewing torque*
Slika 9 *Utjecaj materijala spoja i brtvene smjese na moment odvijanja*

It is very clear that disassembling characteristics of the joints strongly depend on fitting materials used. Fittings made of steel - aluminium combination (M3) give the lowest values of unscrewing torque at every sealant and temperature applied. This is because aluminium is a passive material, which inhibits full cure of anaerobic sealant.

4
Conclusion
Zaključak

An investigation of gas leaks in home metering and control units (MCU) has been performed in the distributive region Osijek. The analysis has shown an unacceptably high number of threaded joints (all sealed traditionally with hemp and non-curing sealants) in which gas leakage has been detected. Further analysis has shown that one of the most important factors influencing leaking possibility is the applied sealing method. Therefore, an experimental investigation of sealing characteristics of some commercially available anaerobic sealants was conducted aiming to improve traditional sealing method using hemp and non-curing compounds.

The results obtained in experimental investigation affirmed the possibility of applications of all three tested anaerobic sealants at any combination of considered fitting materials and temperatures aiming to give safely sealed joints. All of the three tested sealing compounds are adequate to be used for threaded joints R ¾" at p = 3 bar in tested temperature range from –20 to 100 °C. However, the differences in unscrewing torque value have been noticed. The highest values of unscrewing torque at all of the tested temperatures have been detected at threaded joints involving steel – brass combination of fitting materials (M1), and the smallest values at brass – aluminium combination (M3). From the practical point of view a possible limitation for application is a relatively high unscrewing torque, which is achieved by using some compounds and/or large fitting diameters. In this case disassembling the joints using standard manual tools could possibly be problematic.

In further research we will apply anaerobic compounds in the sealing of chosen home metering and control units (MCU) in the distributive region Osijek aiming to research their long-term behavior.

5
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