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APPLICATION OF CONTEMPORARY MATERIALS FOR SEALING PIPE - THREADED JOINTS

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Professional paper

This paper deals with application of contemporary liquid sealants based on methyl - methacrylate, so called anaerobic sealants. Applications include reliable sealing of threaded joints in pipeline installations (cold and hot water pipelines, steam pipelines, gas pipelines, cooling and air-conditioning, pneumatics and hydraulics). Economy of anaerobic sealants application as well as important advantages of this contemporary sealing technique in comparison with traditional one has been considered in particular.

Keywords: *anaerobic sealants, pipe - threaded joint, sealing methods*

Primjena suvremenih materijala za brtvljenje cijevnih navojnih spojeva

Strukovni članak

U radu je razmotrena primjena suvremenih tekućih brtvenih materijala na bazi metil-metakrilata, tzv. anaerobnih brtvila. Primjene obuhvaćaju pouzdano brtvljenje navojnih spojeva u svim vrstama cijevnih instalacija (vodovodi, toplovodi, parovodi, plinovodi, rashladna tehnika i klimatizacija, pneumatika i hidraulika). Posebice je razmotrena gospodarska opravdanost tih brtvenih materijala i značajne prednosti koje ta suvremena tehnika brtvljenja ima u odnosu na klasične postupke.

Ključne riječi: *anaerobni brtveni materijali, cijevni navojni spoj, metode brtvljenja*

1 Introduction
Uvod

One of the most important tasks while drafting, making or maintaining any pipeline installation is to prevent leakage of gases or liquid media by sealing pipe-threaded joints. That implies various communal and industrial pipelines such as cold and hot water pipelines, steam pipelines, gas pipelines as well as technically high demanding pipe systems in cooling and air-conditioning, pneumatics and hydraulics. Pipe-threaded joints are extremely dynamic systems due to vibrations, changing pressures or changing temperatures, which complicate their reliable sealing. Unintentional leakage of media from any element of pipe supply systems is uncontrolled leakage. In such a manner, uncontrolled leakage of natural gas performs a great risk for people and material property. Regarding duration, leakage intensity can cause disaster by producing flammable and explosive compounds in combination with air [1].

Nowadays two types of threaded joints are mainly used in pipe installations, metric (M) and pipefitting (Whitworth form, R). In the case of metric threaded joint, threads (external and internal) are parallel, and fittings must be torqued with the application of sealing material to minimize voids. Pipefitting threaded joint has parallel internal thread and taper external thread. Sealing of such threaded joint is accomplished by screwing external into internal thread with the application of proper sealing material until the joint is tight. Main task of the sealing material is to fill in clearances between threads.

2 Sealing methods and materials
Metode brtvljenja i brtveni materijali

Improperly assembled joints are most often the reason of leakage that can lead to life danger situations, therefore sealing of threaded joints is particularly important.

The ideal sealing method is to achieve a joint with tight thread connection. In doing so, theoretically there is no need for the application of sealing material. It is possible to achieve absolute tightness of the joint with precisely compiled thread. In practice, on the other hand high costs of fitting and problems with fulfilling tolerances usually demand the application of sealing methods with additional various sealing materials.

For sealing threaded joints in pipeline installations, according to regulation EN 751, non-curing sealing compounds, polytetrafluoroethylene (PTFE) tapes and anaerobic sealants [2] can be used.

Non-curing joining compounds are one of the oldest methods for sealing threaded joints. They are various liquid and paste compounds based on oil and grease, mostly with the addition of filler. These sealing compounds lubricate and completely fill in threads. However, this kind of threaded joint can squeeze out and has poor solvent resistance on aggressive media, so that is why it is not a proper method for parallel threads.

Solvent - based joining compounds are also an old method of sealing threaded joints. Sealing effect is accomplished by curing compound due to the evaporation of solvent. These compounds lubricate threads while fitting, fill small clearances and it is not possible to squeeze them out as easy as non-curing compounds. Disadvantage is that they shrink during cure as the solvent evaporates and fittings must be re-torqued to ensure full sealing. Assurance against self-torque is based on the presence of abrasion within threads.

Hemp and polytetrafluoroethylene (PTFE) tapes are categorized as solid sealing materials, where the most common ones are PTFE tapes. PTFE tapes act as lubricant and simplify fitting, give a good initial seal and have good solvent resistance on aggressive media (chemicals). It is the only organic sealant allowed for gaseous oxygen. Unfortunately, PTFE tapes lubricate (low abrasion) also in off direction so the risk of spontaneous torque is very high. Dynamic loads may accelerate creep, causing leakage over time [3].

Due to low abrasion of threads, it is necessary to give high initial seal that can cause high stress and thread cracking. Application of PTFE tapes in hydraulic systems is often restricted because small tape particles can separate and by that block the system bores causing expensive repairs.

The most effective contemporary sealing method for

metallic threaded joints from technical and economical point of view is the application of liquid polymer sealants based on methyl – methacrylate, so called anaerobic sealants.

3
Anaerobic sealants
Anaerobni brtveni materijali

The most recent development in sealants are polymeric (methacrylate) anaerobic sealants. Those materials of various consistencies (from liquid, low viscose to high density, paste) cure to insoluble, tough, plastic thread fillers that prevent leakage regardless of the pressure or torque applied. Those sealants are called anaerobic because they cure only without presence of oxygen.

The most important advantages of anaerobic sealants in comparison with conventional ones are:

- Prompt and easy assembling of joints: lubricate during assembling, sealing of external or internal thread is clean and quick directly from package or dosage device, seal regardless of assembly torque;
- Easy to clean remains of sealing: anaerobic sealants cure only inside of threaded joint;
- Easy and reliable disassembling of joints: no corrosion on threaded joint, controlled unscrewing torque depending on applied material type (low, medium or high toughness);
- Reliable sealing regardless of assembly torque: seal to the burst rating of the pipe;
- Exquisite chemical resistance on most of industrial media (acid, alkali, lubricant, etc.);
- Medically and ecologically acceptable: when cured anaerobic sealants are completely neutral and by that have a permission for appliance in food industry and water supply;
- DVGW (Deutscher Verein des Gas- und Wasserfaches) authorization: for safe application in gas installations,
- Good temperature persistence: depend on material type, from – 55 to +230 °C in permanent exploitation.

Disadvantages of anaerobic sealants refer to their restricted usage in the presence of oxygen and strong oxidize media or in case when working temperatures reach above 230 °C. These sealants are not usually applied for sealing threads with diameter greater than M 80 R3").

When acting with active metals liquid anaerobic sealants react as accelerant of polymerization (Tab. 1) [4].

Table 1 *Overview of various materials accelerant characteristics while curing* [4]
Tablica 1 *Pregled katalitičkih svojstava raznih materijala u procesu očvršćivanja* [4]

ACTIVE MATERIALS	PASSIVE MATERIALS
steel	highly alloyed steel
brass	aluminum
bronze	nickel
other copper alloys	zinc
	tin
	silver
	gold
	oxidized joints
	chrome – plated areas
	anode areas
	polymers
	ceramics

Passive materials in general have poor or do not have accelerant function therefore different chemical substances, so-called activators must be applied on one or both assembling areas to accelerate and ensure complete curing of sealing compounds. The most important characteristics of liquid anaerobic sealants are:

- have increased tangentially toughness
- have good temperature persistence
- fast curing
- easy to dose
- do not require special handling of assembling areas
- gum and seal joint at the same time
- have exceptional persistence on various media
- have good endurance due to vibrations
- have good endurance due to permanent dynamic stress.

Anaerobic sealants have specific course of curing significantly conditioned with threads material type, sealing compound thickness, curing temperature and applied activators. According to the mentioned factors qualitative courses of curing (achieving declarative toughness of sealing compound) are shown in Fig. 1 to 4.

Fig. 1 shows the course of curing threaded joint conditioned with the threads material type.

Fig. 2 shows course of curing threaded joint conditioned with sealing compound thickness (clearances in threads that sealing compound must fill in completely).

Fig. 3 shows course of curing threaded joint conditioned with curing temperature.

Fig. 4 shows course of curing threaded joint conditioned with applied activators.

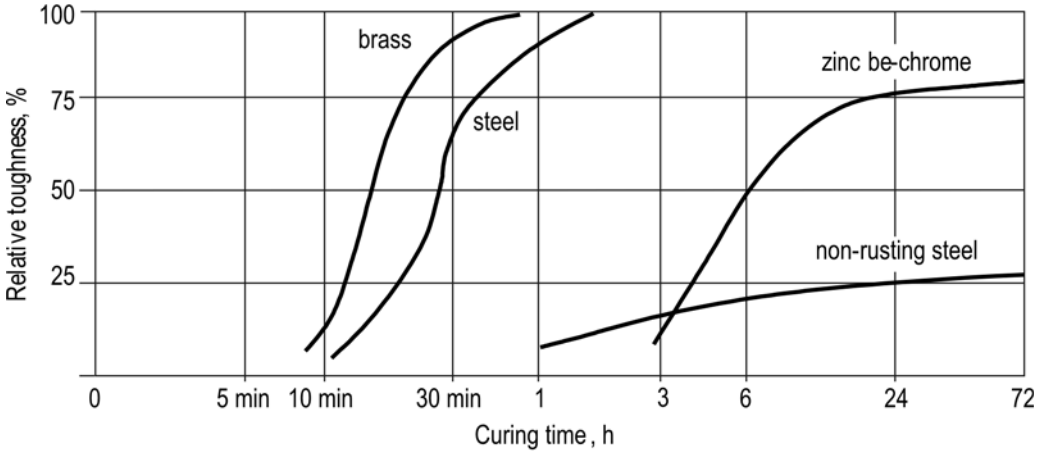

Figure 1 *Dependence on threads material type* [4]
Slika 1 *Ovisnost o materijalu navoja* [4]

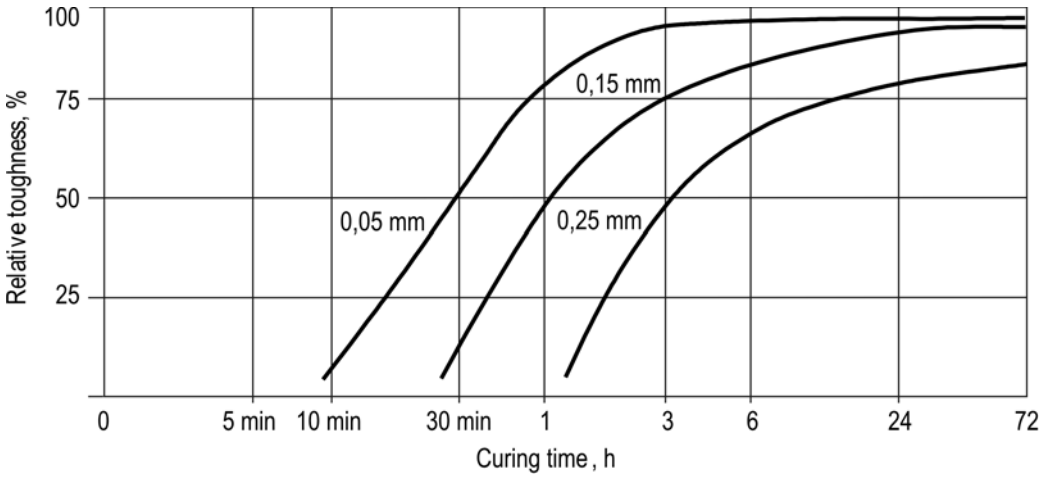

Figure 2 *Dependence on sealing compound thickness* [4]
Slika 2 *Ovisnost o debljini sloja brtvene smjese* [4]

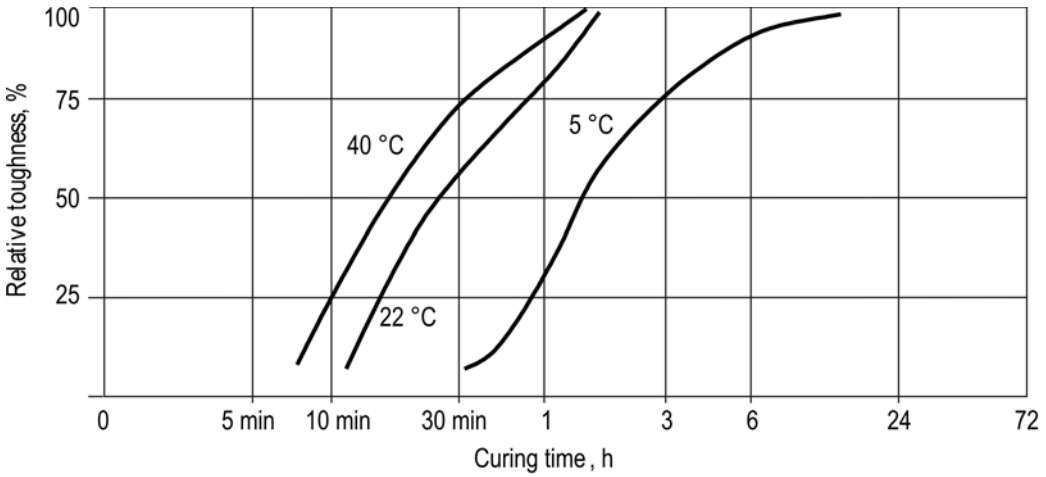

Figure 3 *Dependence on curing temperature* [4]
Slika 3 *Ovisnost o temperaturi pri skrućivanju* [4]

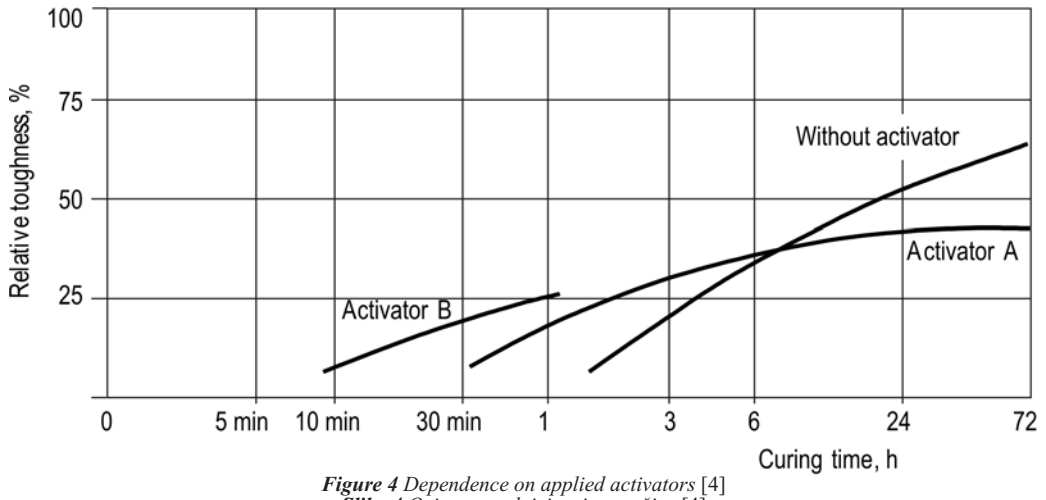

Figure 4 *Dependence on applied activators* [4]
Slika 4 *Ovisnost o aktiviranju površine* [4]

Anaerobic sealants are half packed because of their specific curing. In this way sufficient presence of oxygen prevents curing in package. Liquid anaerobic sealants can last at least one year at temperatures of storage from -5 °C to 28 °C [4]. Lower or higher temperatures of storage can affect product quality.

4
Economics of anaerobic sealants application
Gospodarstvenost primjene anaerobnih brtvenih materijala

The analysis shows that the application of anaerobic sealants is the cheapest way of sealing considering costs and required work (Tab. 2) [4].

Table 2 *Necessary amount of anaerobic sealants for reliable sealing of threaded joint* [4]
Tablica 2 *Potrebne količine anaerobne brtvene smjese za pouzdano brtvljenje navojnog spoja* [4]

Pipe – threaded joint	Necessary amount of sealant, ml	
	Automatically put on	Manually put on
R 1/8" (3 mm)	25	40
R 1/4" (6 mm)	45	60
R 3/8" (10 mm)	60	90
R 1/2" (13 mm)	90	130
R 3/4" (19 mm)	190	250
R 1" (25 mm)	350	450

Direct (material) costs of anaerobic sealants application are slightly higher than for ones of conventional application (hemp, PTFE tapes). Average anaerobic sealant amount for one pipe – threaded joint (size R1") is about 0,45 l (put on manually) or 0,35 l (put on automatically) what is according to current prices on Croatian market about 0,90 or 0,70 kn. However, real savings of anaerobic sealants application are within indirect costs, such as assembling time (that is a few times less), no additional expenses for re-torque, joint controls or badly sealed threaded joints. Considering these elements, even the simplest economic calculation gives significant advantage to anaerobic sealants application, the fact confirmed in industries all over the western world and lately also in Croatia.

5 Conclusion
Zaključak

Development of contemporary liquid anaerobic sealants enabled, among other, their significant application while making and maintaining various industrial and communal pipe installations. In this group of sealants the most important ones are anaerobic polymer sealants based on methyl - methacrylate. The arguments for increasingly frequent anaerobic sealants application are their outstanding technical characteristics in comparison with conventional sealants as well as economical adequacy of their application.

6 Reference
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