

Some Considerations Why and How to Use Plastic Pipes in Domestic Gas Installations

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Abstract: The article analyses the prospects and opportunities for the use of plastic pipes, fittings, and valves for domestic natural gas, which are produced from cross-linked polyethylene, overlapped welded aluminium, cross-linked polyethylene – for short, called PEXAL-Gas.

Keywords: *natural gas, government regulations, standards, gas pipelines and fittings.*

1. Introduction

The energy sector is one of the main drivers of carbon emissions, which requires the adoption of sustainable practices along the supply chain. Therefore, in order to achieve sustainability and a circular economy throughout the chain, it is imperative to undertake environmentally responsible initiatives to reduce the carbon footprint [1] including some estimation to measure it [2], [3]. The type of heating system and equipment used significantly affects pollutant emissions, and individual heating systems contribute more to NO_2 and CO_2 concentrations in residential areas than district heating systems do [4], [5]. In this regard, replacing any element that leads to low CO_2 emissions is important.

Natural gas remains one of the most commonly used energy sources for household heating today, offering efficiency, reliability, and widespread availability [6]. To date, Bulgaria has built many domestic natural gas installations (DGING). According to Bulgarian regulations [7], [8], the maximum operating

pressure (MOP) is 100 mbar(g). The MOP for domestic gas appliances is 20 mbar(g). That's why these DGING are usually designed with an MOP of 20 mbar(g). So far in Bulgaria, DGING installations have used only copper pipes and fittings, which are the most expensive materials. A promising solution is the PEXAL-GAS system (pipes made of cross-linked polyethylene) [9]. To do this, national standards and rules are needed, or international ones should be adopted. PEXAL-GAS system is approved according to BDS EN 1775 [10] and ISO 17484-1 [11].

The PEX AL GAS system is manufactured in accordance with the European norm BDS EN ISO 21003-2 [12] and the international standard for the production of multilayer system ISO 17484-1 [11]. Its reliability and quality are guaranteed by constant meticulous inspection of the production by various authorized bodies in accordance with BDS EN ISO 21003-1 [13]. The structure of the PEXAL GAS system is illustrated in Fig. 1 [14].

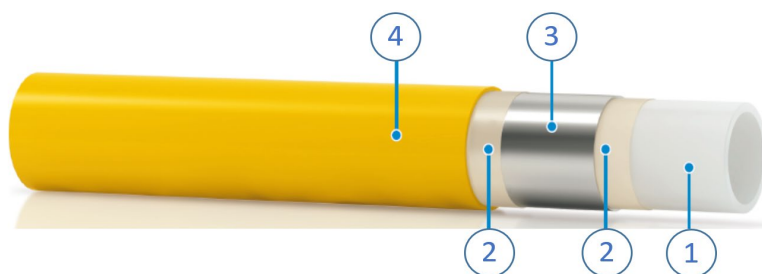


Fig. 1 structure of the PEX AL GAS system: 1 – inner layer made of crosslinked polyethylene high density HDPE, PE-X; 2 – bonding layer; 3 – inner layer made of aluminium alloy; 4 – outer layer – made of crosslinked polyethylene HDPE, PE-X.

The inner layer (1) is made of crosslinked polyethylene high density HDPE, PE-X, characterized by an extremely smooth surface that minimizes pressure losses. The bonding layers (2) is made of strong glue, which provides excellent bonding of the layer of aluminium with the outer and inner layers. The inner layer (3) is made of aluminium alloy, butt welded along the length of the pipe providing a barrier to penetration of oxygen, gas and light, providing the pipe with excellent mechanical strength and flexibility. Also connection between the crosslinked polyethylene and aluminium guarantees excellent flexibility during bending (also manual) and structure permanence in the long term. The outer layer (4) is made of crosslinked polyethylene HDPE, PE-X and acts as mechanical, electrical, and chemical protection for the aluminium layer, protecting it from impact, scratching, and electrochemical effects of water, cement, and other substances present in the soil. Everything described so far is a prerequisite for using the PEXAL-Gas system in domestic gas installations.

2. Consideration in the design of the gas installation with PEXAL GAS system

The designing of the gas installation with PEXAL-Gas system must be coordinate with specific national rules and practice. Multi-layered pipes are delivered generally as a complete system. Generally, pipes, fittings and valves are not compatible with components of another brand. An advantage is that all components are perfectly geared to one another, but for repairing, the lack of compatibility might be problematic in the future. Depending on the construction of the houses/buildings, pipework layout and other local circumstances, it is possible that additional safety devices are required to fulfil the demands of fire safety. Usually, in buildings with more than an apartment, in the common parts of the building in natural ventilated boxes are installed individual domestic gas meters (DGM). In these boxes the pipe's part between DGM and putty is opened. In this case this part must be done by copper pipe (see Fig. 2).

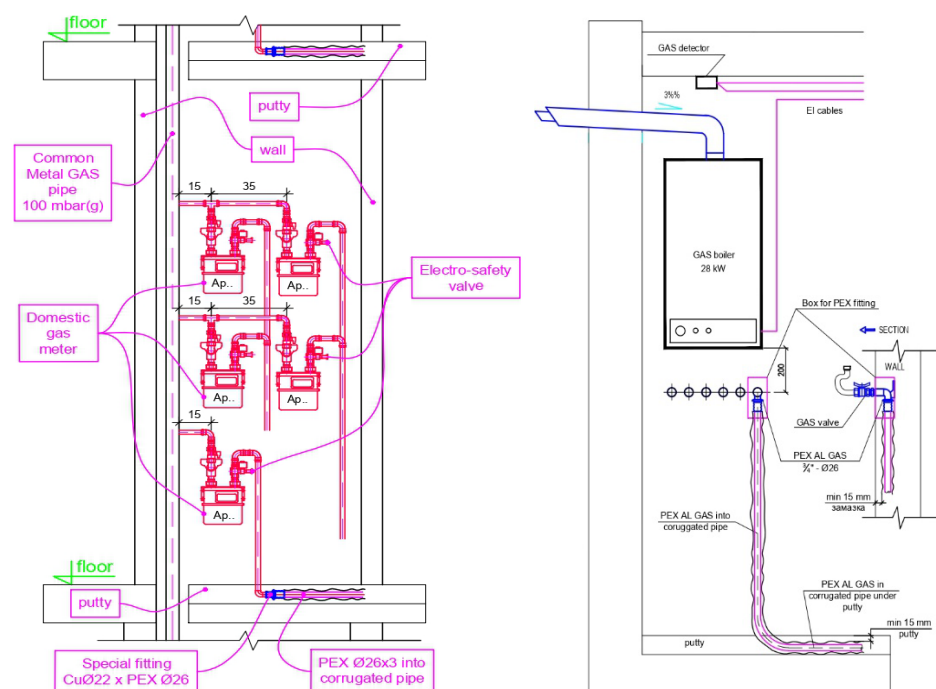


Fig. 2. Designing of gas installation by (a)copper and (b) PEXAL GAS pipes with operating pressure 20 mbar(g)

To protect the PEXAL GAS system, the protective corrugated pipe is used. It protects against UV rays and is made from a combustible material that slows combustion and provides crush protection. In order to ensure compatibility with other systems, PEXAL fittings are useful components to connect with other piping

systems. Special transition fittings and accessories allow existing copper and crosslinked polyethylene pipes to connect easily to multilayer pipes. To calculate the proper diameter for each pipe, use the standard algorithm, which is not the subject of this material.

2.1. PEXAL GAS press fittings

PEXAL GAS press fittings are produced with brass alloy body and stainlesssteel sleeve are fixed with a technopolymer yellow ring. They are termed “multipress” as they can be used with the various pressing profiles most widely used in the market. The Press PEXAL Gas fittings guarantee immediate leakage in the event of incorrect pressing, therefore, in the event of poor pressing, the error can be immediately identified, guaranteeing an easy and safe installation [15].



Fig. 3. Types of PEXAL GAS fittings

The stainless steel sleeves have four holes on the end that allow the plumber to verify that the pipe has been fully inserted. A special seal in teflon [16] on the end of the fitting prevents contact between the brass and aluminium of the pipe, thus avoiding galvanic corrosion.

After measuring the length, cut the pipe with a tool that won't damage its round shape, cut it at an angle, or chip it. After cutting the pipe to the desired length, the end needs to be calibrated and a 'chamfer' made. For this, a calibrator with a built-in scraper for cutting the 'chamfer' is used. The calibrator is turned in one direction until it reaches the stopper, and then all material shavings are cleaned off, if there are any. Calibrating the pipe and making the chamfer is really important because doing it correctly ensures a quality cold-press connection. After calibrating, the inside of the pipe should be smooth, because any bump, scratch, or metal shaving can compromise the seal of the press connection.

The silicone lubricant recommended by the system manufacturer makes installation easier and protects the rubber seals from damage or shifting out of their seats. Next, the fitting is installed on the pipe, and it should slide on effortlessly. Checking that the pipe is visible through the inspection holes in the fitting's press sleeve is a guarantee that the fitting is installed correctly.

The position of the crimping machine so that the selected crimping jaw is perpendicular to the fitting, and the guide ring is in the jaw's guide groove. Now, the pressing cycle can start until the process is complete. The end of the pressing is marked by a specific “click” sound.

After finishing the process, it is visually checked whether the pipe is visible in the control openings of the fitting. If it is visible, the process is complete. The overall strength and tightness test of the installation is done according to a different procedure. If the visual check shows that the press connection was not done correctly, the fitting needs to be removed, following the described sequence of operations.

The pressing system has various pressing tools with the corresponding pressing jaws. Pressing is carried out using the system's pressing tools and jaws, or with other pressing tools and jaws recommended by the system's manufacturer. The tool systems have pressing automation and uniform pressing force, ensuring high-quality connections. Before the pressing process is complete, it is not possible to open the pressing dies or remove the fitting. This always ensures a fully completed press and a properly pressed connection.

2.2. Fixing of the pipes

Gas pipelines should not be attached to other pipelines or used to carry out other pipelines. Gas pipelines should be secured to the building structure with non-combustible fasteners – like metal clamps – and regular dowels, which can be plastic. The pressed fittings of the PEXAL GAS system are non-disassemblable, durable, and act as strong connecting elements.

2.3. Installing of the pipes

PEXAL-GAS does not have a fire rating and must be openly mounted in ventilated channels (see Fig. 4a). In the plaster/putty cavity, a corrugated pipe is required that leads to protective boxes. In this way, if there are any gas leaks, the gas is safely vented at both ends of the gas installation (in box with gasmeters, which is ventilated, and under the gas appliance it is monitored by gas detector) – see Fig. 4b.

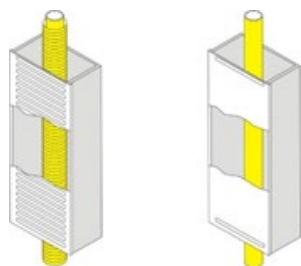


Fig. 4. (a) installation into ventilation channels



(b) Real done domestic gas installation – the corrugated pipe is black

When it is necessary to connect and another gas appliance, must be done press tee into the ventilation box and this box is built into the putty under the sink, as shown in Fig. 5.

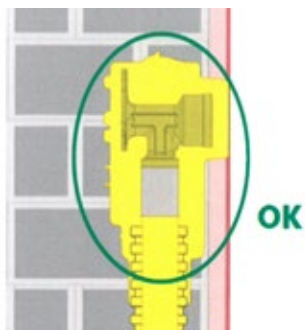


Fig. 5. Point for connection of the gas boiler

2.4. Strength and tightness test

After the installation of DGING, executed with a PEXAL GAS system, brass plugs are installed on all terminals and the mechanical strength of the pipeline is carefully checked. Gas appliances, regulating and safety fittings shall not be included in the test. The strength and tightness test is carried out with air or inert gas in accordance with the requirements of the ordinance on the structure and safe operation of transmission and distribution pipelines, facilities, installations and appliances for natural gas. The strength test pressure is recommended to be 5 bar/minimum 15 min. The tightness test pressure is equal to the operating pressure of the gas installation – minimum 15 min.

4. Comparison between Copper and PEXAL pipes

To highlight the advantages of the discussed system, the characteristics of copper pipes and the PEXAL pipes are compared in Table 1 [17], [18].

Table 1. Comparison between Copper and PEXAL pipes.

Parameter	Copper pipes	PEXAL pipes
Corrosion	Yes – depends from covers	No
Working pressure	up to 5 bar	up to 5 bar
Service life (years)	Depends from corrosion	up to 50 years
Weight (kg/m)	0.60	0.25
Installation	A burner for high-pressure gas is needed O ₂ +C ₃ H ₈	Just with jaw tools
Special Personal certification	Needed	Don't needed
Worker's teaching	Special	Usual
Special additives	Cu-P-Ag brazing filler metal	No

The PEXAL-Gas system costs less than copper pipes and has lower installation costs. It resists corrosion, construction materials, and most chemical compounds, allowing use in a wide range of applications. The exceptional smoothness of the inner surface of the pipe minimizes pressure losses. This system has a service life of at least 50 years, which is guaranteed by product standards. The elasticity of the crosslinked polyethylene means vibrations are absorbed, which therefore guarantees excellent sound absorption. The range of fittings, accessories, and related tools is particularly wide and allows all requirements to be satisfied. The layer of butt-welded aluminium acts as an absolute barrier to the passage of oxygen, gas, and light. Its thermal expansion is about 8 times lower than that of plastic pipes and similar to that of metal pipes. The pipes are extremely light as compared with metal pipes, the weight is 1/3 in comparison with the weight of a copper pipe and is 1/10 of the weight of a steel pipe. It is also an ideal solution in earthquake-prone areas thanks to excellent mechanical properties such as flexibility and vibration-damping capacity. The PEXAL-Gas system is produced with materials that are completely recyclable which can be recovered at the end of their service life. The production processes employed are energy efficient and of reduced impact.

The tools used to build the PEXAL-Gas S system are standard, making it easy to install and operate. Reduced to zero errors or non-compliance with technology by the executive staff. They require working pressure up to 500 mbar; maximum working pressure: 5 bar; application: natural gas; operating pressure for gas installations: up to 500 mbar; temperature range of the fluid: - 60°C to + 100°C; softening temperature: +130°C; roughness: 0,007 mm; temperature expansion: 0.026 mm/mK; temperature conductivity: 0.42 ÷ 0.52 W/mK.

5. Conclusion

Unlike standard plastic PEX pipes, the PEXAL multilayer pipe bends easily and retains its shape. Due to the ultra-smooth composite surface of the inner layer, scale accumulation is prevented and friction is minimized. It withstands high temperatures and high mechanical pressure. Therefore, the use of the PEXAL-Gas system will provide the following opportunities for domestic gasification in Bulgaria: ensure greater reliability and security of the built and commissioned gas building systems; will decrease the price of building gas installations, which will provide a larger range of the population with the opportunity to use ecological fuel, natural gas; and provide a significant reduction in carbon emissions generated by households. In addition, high-quality fittings and PEX meet strict safety and quality standards set by regulatory authorities, ensuring a safe, legal gas system.

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