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Reduction of the installation costs for domestic gas appliances

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ABSTRACT

Installation cost is a key factor when considering the future of gas in the domestic sector. As heating demand is decreasing (due to improved house insulation) the appliance and installation need to be competitive, especially because electricity is becoming a more attractive solution.

This paper presents a number of technical solutions for cost reduction (hardware and installation techniques). Moreover, the results of filled-out questionnaires from 12 countries are presented. These results cover aspects such as total gas installation costs, service lines, interior piping, appliances for cooking, boilers, maintenance, general lifetime, etc.

Based on the data collected from IGU's study group and Marcogaz this paper provides an overview of, for instance, the costs for the individual technical installation in a total gas installation and of durability for gas installations in the different countries.

Furthermore, the possibilities for using new technologies for domestic gas installations regarding decreasing an installation costs are discussed. The tests with some of the new components for application in the gas piping system, like flexible corrugated stainless steel and plastic pipes with safety devices, were carried out in DGC's laboratory. The results of the tests are presented, as well as a short summary of the state-of-the-art.

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BACKGROUND

In the EU, new directives, such as the Energy Performance of Buildings in EU, are coming up and most houses and new buildings will very shortly have less energy consumption. Generally, a tightening of the demands for required energy for buildings are expected and the required energy consumption is, therefore, expected to drop by 25-30 % compared to present standards. Furthermore, in the future the heating system will utilize energy more efficiently, and heat buildings with a minimum of energy loss. We have already seen standard houses with “passive” energy consumption and this type of houses will constitute a considerable part in the future.

The use of energy effective gas boilers, improved control of the system, improved insulation of housing and other energy efficient measures will secure an efficient utilization of natural gas. The gas consumption for the individual consumer will drop drastically for central heating and for the heating of water.

In the future, it will no longer be financially attractive or responsible to establish gas service lines to houses with very low consumption, e.g. 300 – 800 m^3 natural gas per year. The costs relating to the establishment of a service line and a traditional central heating system are far too high and the pay-back period is far too long.

Natural gas will, therefore, not be an obvious choice of energy source for new buildings/housing. In some countries, connection to natural gas is compulsory based on political decisions and this compulsory connection is considered to be difficult to maintain, as natural gas is non-commercial and unable to compete with other forms of energy, especially electricity, when installation costs are included.

Gas utilisation in the domestic sector is menaced if we do not maintain competitive prices of gas installations compared to oil, electricity and other forms of energy. There are, basically, three ways to reduce the costs:

- Smart new hardware (pipes, connections).
- Reduce labour via new techniques and material.
- Develop new gas applications to lower the relative cost (comparing with the overall gas consumption)

There are innovative systems for alternative applications (water, industrial gas), including new material for pipes and their associated assembly techniques, available on the market. Several technical studies of new techniques for domestic gas distribution have already been carried out. These new techniques could reduce total installation cost, achieve a high level of safety (at least comparable to conventional pipes) and allow the development of new user-friendly applications.

THE GAS INSTALLATIONS COST AND DURABILITY IN DIFFERENT COUNTRIES

Within the SG 5.2 of WOC 5 a questionnaire was worked out to collect data from different countries and to provide an overview of the total gas installation concerning service lines, pipes inside houses, appliances for cooking, boilers, maintenance, general lifetime, etc. It was sent to all members of SG-5.2 and to a number of key persons and collaborators - among others in IGU and Marcogaz. A total of 12 countries have answered the questionnaire and many data and remarks have been reported /1/.

Various alternatives for gas supply and establishment of heat supply systems have been examined and analysed, plus an overview of the costs for the individual technical installation in a total gas installation.

To obtain a comparative database the following conditions were essential:

- All data is to be based upon approximate average data.

- All prices are inclusive of tax and VAT.
- All data for service line and gas meter must be based on the price the gas company has to pay.
- All other data must be based on the price the costumer has to pay.

A	Austria	
B	Belgium	
CDN	Canada	
CZ	Czech Republic	
DK	Denmark	
GB	Great Britain	
HR	Croatia	
I	Italy	(has not answered all questions)
J	Japan	(has not answered all questions)
PL	Poland	
RUS	Russia	
SK	Slovakia	

Table 1: Countries that have answered the questionnaire

Data from all countries have been treated individually and there is a short conclusion and some findings for every part of the answers. Not all questions were answered by all countries. Furthermore, some answers are not directly comparative to others. The results of the investigations are presented graphically in the report /1/, and the most interesting ones are shown below.

Analyses of the received answers show that countries have a general problem with far too high installation costs both for service lines and for interior gas installations for individual small housing. It is financially unsustainable not having a reasonable payback time when laying down service lines, as it is financially unsustainable that the high installation costs make it financially unwise for the consumer to invest in new gas installations. Therefore, the following actions shall be undertaken/studied by the gas industry:

- Development of new installation techniques.
- Larger heating plants that supply several houses (within “energy service”).
- Additional sale to existing customers via alternative appliances.
- Research and development in renewables: e.g. solar energy and wind energy in connection with gas installations.

Countries were asked to indicate the price of a 25 m service line in the table below together with the expected lifetime of the service line.

Service line 25 meter to house (cost for the gas company)

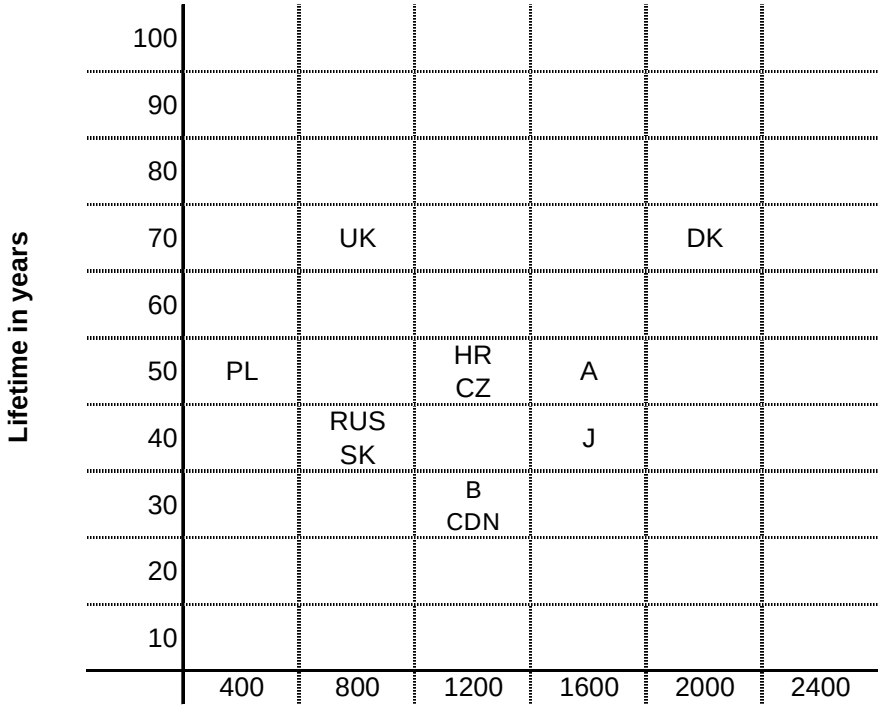

Figure 1: Costs of a 25 m service line

Findings

Most countries have a fixed lower price for customers

- In a few countries the service line is free
- Countries, where service lines typically have a durability of less than 50 years, are still using steel in some cases
- GB has meter 'unbundling'. Energy suppliers are free to use own meters. We are seeing new 'meter operator companies'.
- Almost every country have random control every 5, 7 or 10 years, based on statistical data for gas meters

Countries were asked how much it costs to build up the indoor pipeline including components and connections to the appliances in proportion to expected lifetime of the installation. Answers and some comments are presented in the table below.

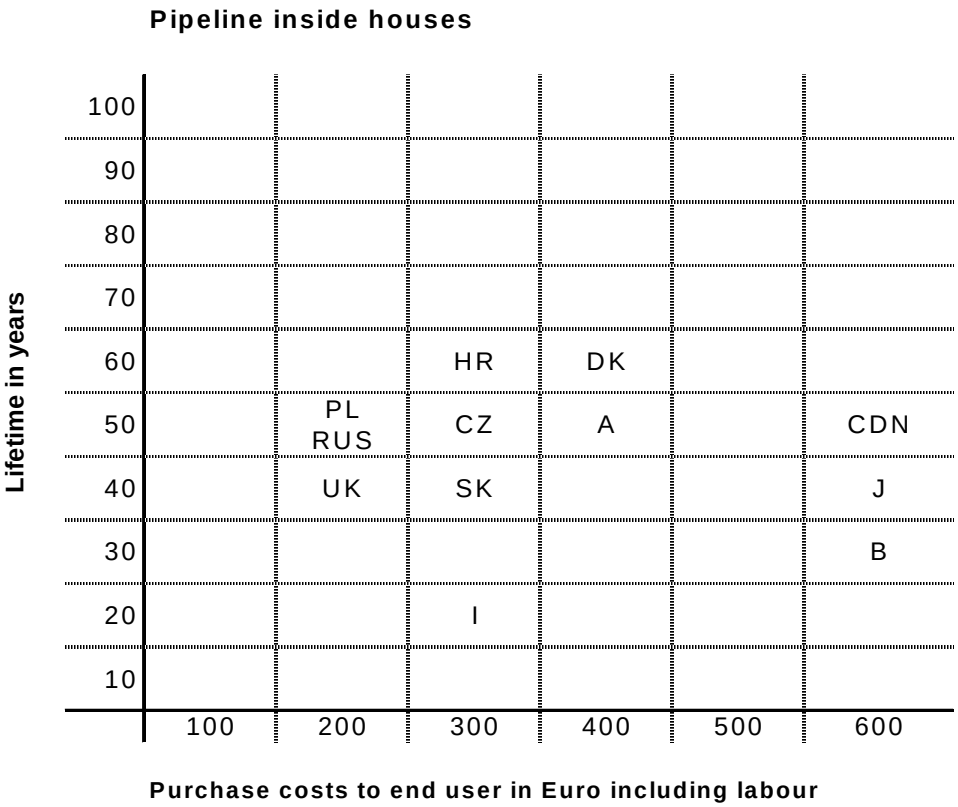

Figure 2: Costs of indoor pipelines

Findings

- Most countries use steel and copper.
- The costs in Belgium, Canada and Japan are rather high.
- Flexible steel pipes are on the way.
- Press fittings are on the way, but the long-term durability is still unknown.

To find out if the installation techniques are time-consuming or the materials used are high-priced, countries were asked how much the labour and material cost represents of the total cost.

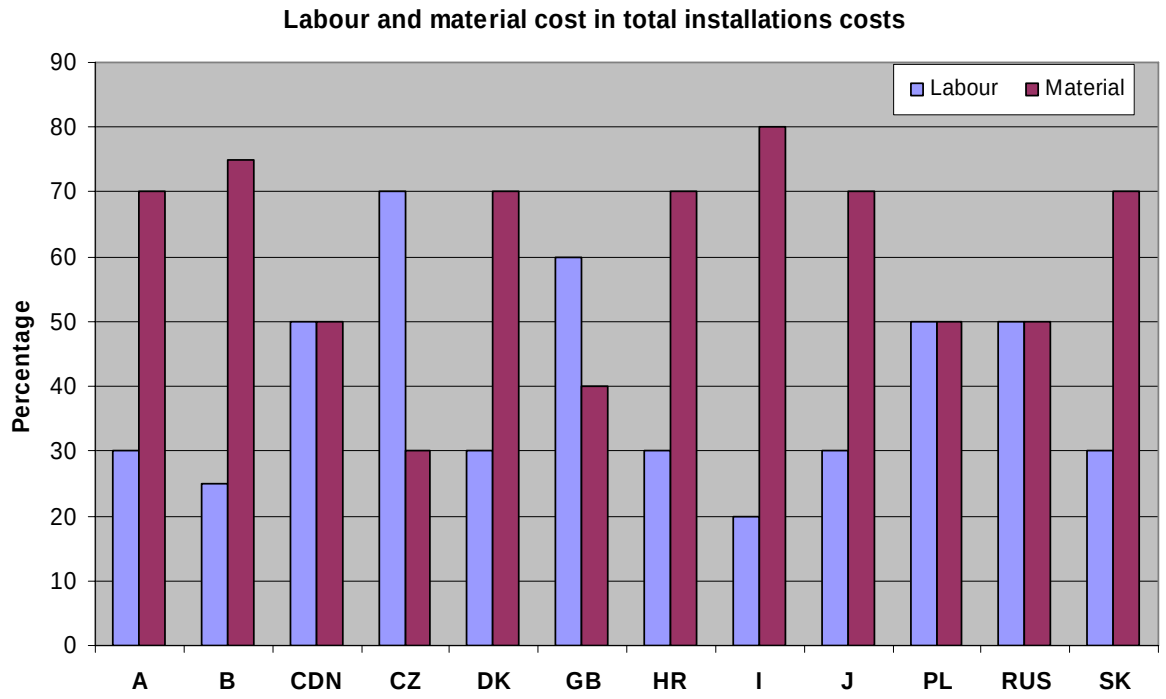

Figure 3: Labour and material cost

Countries were asked about the maintenance cost, including spare parts, in a lifetime of conventional or condensing boilers, respectively.

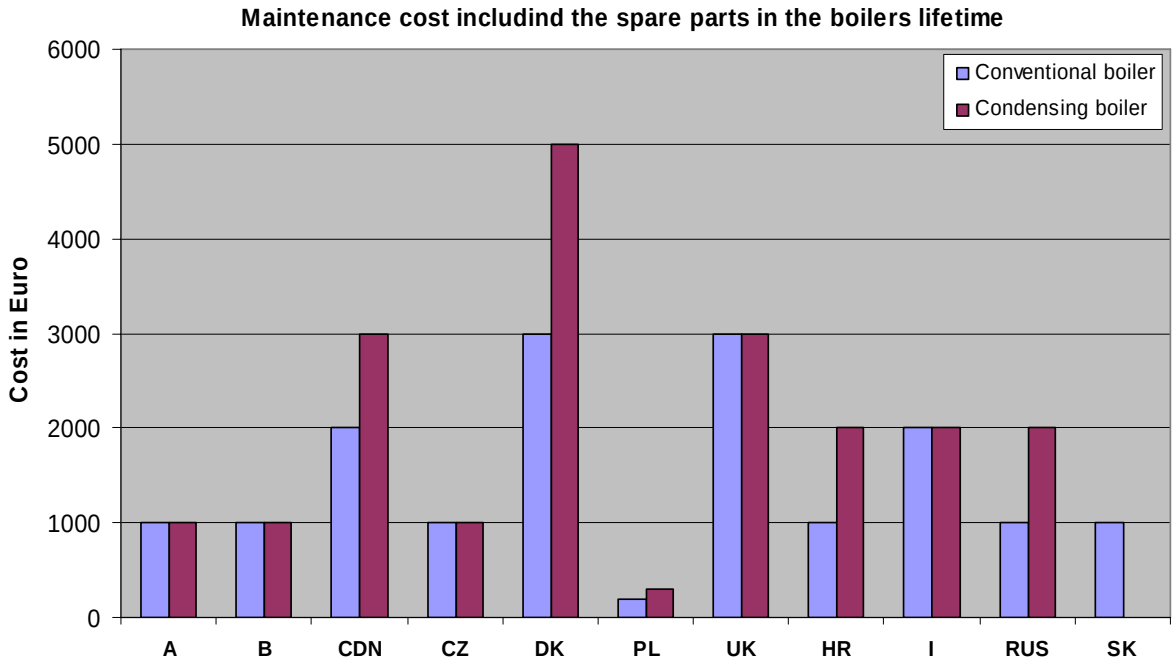

Figure 4: Maintenance costs

Findings

- Most countries have no legal obligation for systematic maintenance.
- A few countries have different rules for inspection depending on the area in the country.
- Most countries expect more inspection through the European Energy Performance of Buildings directive.
- Some countries have different prices for maintenance, typically higher prices for well-known troublesome boilers.
- SK has no experience with condensing boilers.
- Countries with the highest maintenance costs typically also have statutory systematic inspection.

Below, a performance index is sought described, where interaction between durability of an installation is held up against the corresponding total investment for the total activities.The performance index shows the connection between durability and investment as an average consideration for the individual countries.

It is difficult to say exactly what is best, but a long average durability for the total installation and a low investment is considered to be good, and the below performance index can be looked upon as a simple benchmark, where PL is considered to be the best. PL has a durability of more than 150 years, and only 3.000 Euro must be invested in this period. Another example is DK with a durability of more than 210 years, but in this period an investment of 15.000 Euro is necessary. It is not a weighted average, but a simple benchmark that shows an overview.

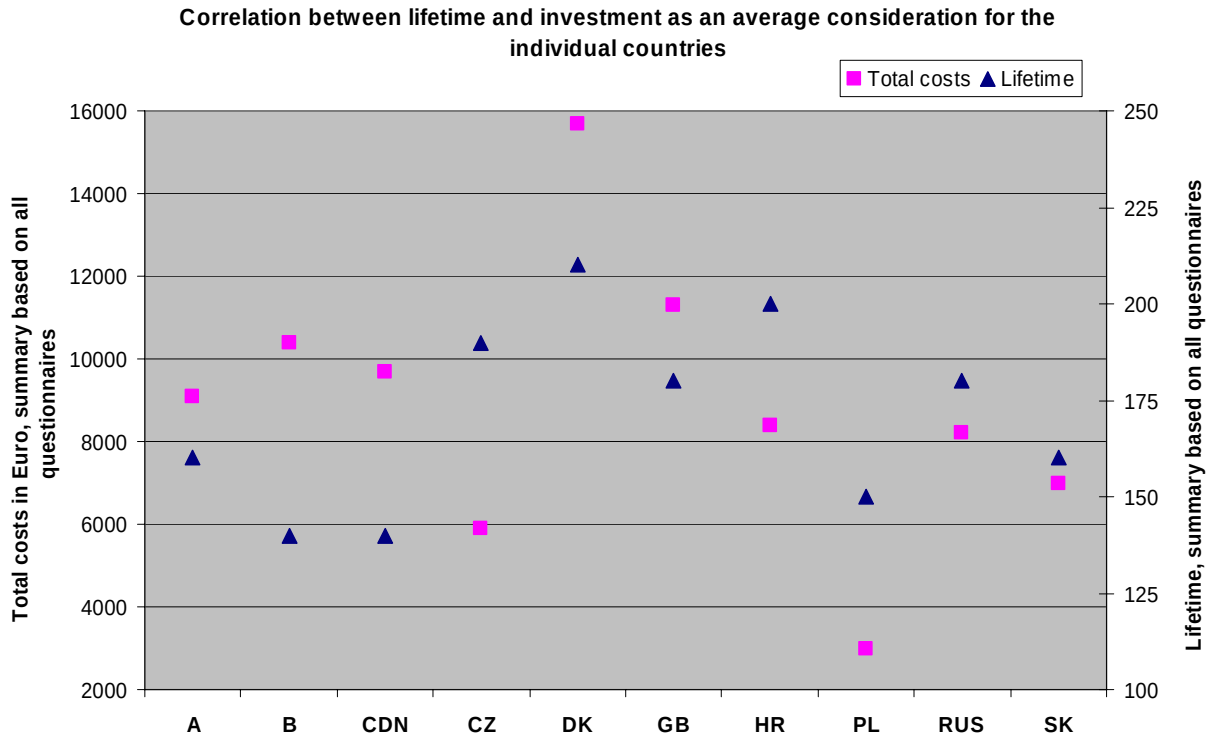

Figure 5: Correlation between lifetime and investment

NEW INSTALLATION TECHNIQUES TO SUPPORT LOW-COST GAS INSTALLATIONS

The possibilities for using the new technologies for the domestic gas installation were examined.

Steel and copper are the most frequently used materials for indoor gas distribution piping. During the last few years, the new technologies for reducing installation costs have been developed. Two new trends were identified, these being

- Replacing copper piping with flexible corrugated stainless steel tubing (CSST) and with flexible plastic tubing like multi-layer tubing PEX-Al-PEX
- Tubing made of cross-linked polyethylene with integrated barrier layer to limit gas diffusion (PEX-EVOH).

These new innovative techniques for domestic gas installations were tested in DGC's laboratory to assess the economical advantages of practical use and to investigate the safety and application qualities of the components.

Generally, the system with flexible piping for interior gas installations has more advantages than the traditional copper tube system:

- High degree of flexibility. The advantages of flexible piping will increase proportionally to the requirements to necessary number of elbows of the particular installation.
- Quicker and easier installation.
- Resistant to corrosion.
- Easy-to-learn joining techniques.
- No fire risk at joints.
- Uniform installation techniques for gas, water, central heating, floor heating, etc.
- Lower total installation costs. Time consumption and thus labour costs can be markedly reduced with the new systems.
- Lightweight materials.

Flexible corrugated stainless steel tubes (CSST)

Tests of flexible stainless steel tubes in DGC's laboratory have demonstrated that this product is fully equal to and in some cases even better than traditional copper piping. The various analyses carried out be fitters, manufacturers and DGC showed that CSST is more economically advantageous than steel and copper /2/.

The test work carried out by DGC's laboratory is described below:

The work comprised laboratory analyses of the application and safety potential of the system in Danish gas installations. The aim was to document whether CSST is suitable for use in gas installations and whether the authorities should approve the type of tubing with fittings.

The laboratory tests included construction of a copper tube installation and a comparable flexible steel pipe installation; both constructed by an installer with several years of experience in copper tube installations. The execution of the two constructions was video filmed to facilitate the analysis of the differences between the use of copper tubing and flexible steel piping.

Furthermore, the test work included leakage tests.

Findings

- Material costs for the new CSST system are difficult to estimate, since the price will probably quickly adapt to the market price of corresponding copper tubes. However, with the known prices the product is competitive - even taking into account a fair profit in several sales stages in Denmark.

- Installation time and thus labour costs can be markedly reduced with the new system. The laboratory test showed more than a 50 % reduction in installation time. The advantage of flexible piping will increase proportionally to the requirements of necessary elbows of the particular installation, whereas the total length is less important.
- The new system is easy to handle. As opposed to copper tubes the Japanese product is easy to use in narrow spaces. It can be bent by hand and many times without breaking. On the other hand, it is difficult to make a visible pipe layout that is completely straight. In these instances, it is possible to use cable boxes.
- It is important to note that the new type of tube must be shortened by means of a copper tubing cutter and according to the manufacturer's directions.
- As regards safety the new system is as good as copper tubes and in some areas even better. The new system passed the 150 mbar leakage test; the temperature resistance is better; the number of necessary elbows can be markedly reduced, thus diminishing the risk of leaky joints. However, the system is yet quite new and requires the operator to use the correct tools and the correct procedures when joining the pipes.
- According to the manufacturer of the new system, it has a built-in leakage function to ensure that gas leakages from tubes running in cavities will be drained to the nearest joint and ventilated into the open air. Laboratory tests with nails and screws, respectively, have demonstrated that leakages caused by large nails and screws were registered at the joints, but at the same time gas was leaking out at the nails and screws. In other words, the safety level will be improved compared to that of copper tubes, but the risk of undetected gas leakages in cavities has in no way been eliminated.

On the whole, the laboratory tests verified that the Japanese system with flexible stainless steel pipes is suitable for approval and use in Danish gas installations and, therefore, should be implemented in the Danish Gas Regulations. However, for pipes in cavities the system is only suited for approval if it is led in protection tubes.

Based on the above evaluations the product was approved for use in Denmark and is being used by installers for gas installations. Feedback from the gas industry indicates that in the case of new buildings the economical advantages of using CSST are limited, whereas in the case of existing buildings the savings will be considerable.

Flexible plastic pipes plus safety devices

In order to investigate the safety aspects and application possibilities of gas installations with plastic pipes, a number of tests were carried in DGC's laboratory /3,4/. Two installation concepts with flexible plastic tubing were tested in the laboratory:

- Multi-layer pipe (PEX-Al-PEX) with press fitting connection technology
- PEX-EVOH pipe (with integrated barrier layer to limit gas diffusion) with the unique expanding fitting technology.

When creating an indoor gas system the safety aspects are of greatest importance. Therefore, safety devices are important when using plastic piping, since they are not mechanically strong and - importantly - not fire proof. The temperature resistance of gas installations is imperative in connection with fire. To increase the safety level of gas installations, particularly when using plastic piping, several safety components have been developed:

- Excess flow valve.
- Thermally activated shut-off device.
- Gas safety manifold with integrated excess flow valve and thermally activated shut-off device.
- Gas convenience outlet with integrated excess flow valve and thermally activated shut-off.

Some of the results of the tests carried out in the laboratory can be described and summarised as follows:

1. The leakage test showed that the press fitting technology and expanding fitting technology resulted in absolutely tight connections.

2. The function test of the horizontally and vertically placed excess flow valve that the variety of the closing rate. The wide range of the closing rate can be explained by the sensitivity of the excess flow valve to fluctuations in pressure and flow.

3. The function test of the thermally activated shut-off device showed that it worked as intended. The measured pressure drops for the excess flow valve and the thermally activated shut-off device were, however, a little higher than the values the producer had mentioned.

4, In interior gas installations with plastic pipes the excess flow valve and gas safety manifold will probably not cause noise problems.

Some of the conclusions based on the analyses of the test results can be mentioned here:

Safety devices

The results of the tests showed that without doubt safety devices will increase the safety level in existing gas installations. However, there are still some limitations in their application. The thermally activated shut-off device, for example, will react relatively fast to the temperature rise in the pipe if there is a gas/air flow, but without the flow the heat will be distributed very slowly in the pipe. Therefore, the thermally activated shut-off device must be installed upstream and very close to the components that are not resistant to high temperatures. The excess flow valve will not react to small leaks if the flow rate is not close to the predefined closing rate. It is, therefore, very important to choose the appropriate excess flow valve and to closely follow the producer's guidelines.

Plastic pipes

It is difficult to immediately estimate if the safety level is satisfactory. There are advantages as well as disadvantages about indoor gas installations with plastic pipes:

1. The safety level of indoor gas installations with plastic pipes will be lower because the plastic pipes are vulnerable to various mechanical loads. Plastic pipes cannot be used in indoor gas installations without safety devices, which - as mentioned above - will result in a limited safety level and also will cause a pressure drop in the installation.

2. On the other hand, the safety level of indoor gas installations with plastic pipes will be higher, due to fewer joints compared with copper pipe installations.

As far as we know the indoor gas system with the flexible plastic pipes and safety devices are approved and used in the Netherlands and Norway. In Germany, the flexible pipe system is being field tested and is expected to be approved by DVGW soon.

In order to increase the use of gas appliances in the market, the consumer needs to be able to use these products easily and safely. One German company has developed a special gas convenience outlet, which - just like an electrical socket - immediately connects the appliance to the gas supply. A thermally activated shut-off device is integrated into the gas convenience outlet and is designed to stop the gas flow when an ambient temperature of 95°C is reached. The integrated excess flow valve automatically shuts off the gas flow when a defined flow rate is exceeded. When the plug is removed, a safety interlock automatically closes the socket, protecting it from foreign objects and tampering.

A child safety lock provides additional safety and is integrated into the cover of the gas outlet. The gas convenience outlet is already approved and successfully used in Denmark. The gas convenience outlet was not tested in the laboratory, since no relevant test procedures could be found that could clarify or verify the safety regulation properties of the plug. But the gas convenience outlet was approved on the basis of DGC's technical assessment and analyses of safety aspects.

Press fittings

Copper and steel gas installations with press fittings have become more and more popular. In Denmark it is allowed to use press fittings in gas installations up to 100 mbar. In comparison with the usual indoor gas system with soldering of copper pipes the installation with press fittings is quicker, cleaner and easier and is preferred by many fitters. Experience with installations with press fittings has shown that it is important to closely follow the manufacturers' directions in order to avoid mistakes. The most frequent source of error in installations with press fittings is the use of press tools with the wrong press curves and/or wrong dimensions.

CONCLUSIONS

Investigations made by an IGU study group demonstrated that countries included in the investigation have a general problem with far too high installation costs both for service lines and for interior gas installations for individual small housing. Sharpening of the demands for required energy for buildings will mean that the natural gas consumption will decrease. In turn, this will make it uneconomical to lead gas lines to a low-energy house with a very low gas consumption. Payback time will be too long, compared to other energy forms and to the expected lifetime of the appliances.

Some of the possibilities for remedying this situation were mentioned:

- Development of new installation techniques
- Larger heating stations that supply many houses
- Additional sale to existing customers via alternative appliances

Development of new innovative techniques for connection to natural gas lines will help reduce the installation costs and also make it attractive for consumers to use natural gas appliances. Innovative systems for the domestic gas application including new material for pipes and their associated joining techniques are already available, but the long-time durability of the new materials is still unknown.

REFERENCES

1. Report by IGU study group 5.2 concerning domestic use "Can customer afford to use natural gas?", 2005

2 Flexible stainless steel pipes for gas installations. Documentation of properties. (Fleksible rustfri stålrør til gasinstallationer. Dokumentation af egenskaber), DGC, 2001 (in Danish).

3. Demonstration of indoor installations with plastic pipes and safety devices. Phase 1, Test plan. (Demonstration af indendørs plastrørinstallationer med sikkerhedsanordninger. Fase 1, Forsøgsplan, DGC, 2003 (in Danish).

4. Demonstration of indoor installations with plastic pipes and safety devices. Phase 2, Test results. (Demonstration af indendørs plastrørinstallationer med sikkerhedsanordninger. Fase 2, Forsøgsresultater, DGC, 2004 (in Danish).

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