DISTRICT HEATING SYSTEMS

Guidance Notes

BRITISH PLASTICS FEDERATION PIPES GROUP

Introduction

District heating systems are a relatively new concept for the UK market. They offer the benefit of significantly reducing carbon emissions by using low carbon and renewable sources of heat.

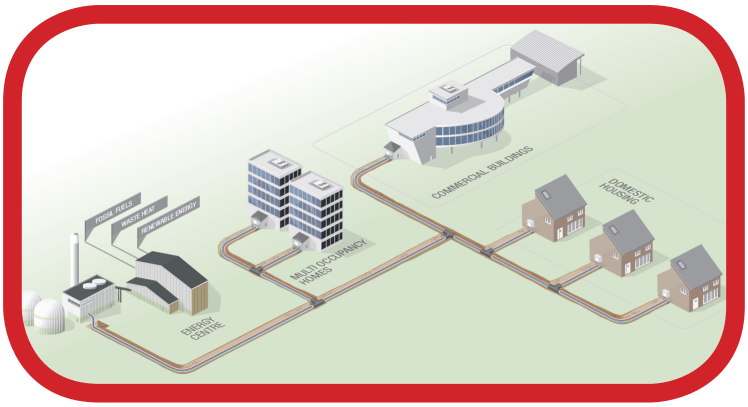
This guide introduces these systems and sets out best practice in design, installation, commissioning and operation of district heating systems with plastic piping. It is intended for use by clients, design consultants, specifiers and installers.

The term polymer pipes is used in most design guides for district heating systems. It is therefore used here, meaning the same as plastic pipes.

Overview

DISTRICT HEATING SYSTEM

District heating is the concept of having one or more central heat sources instead of individual boilers. The heat is transported from the central heat source through a network of underground pre-insulated pipes to each building. Each building typically uses a heat interface unit (HIU) which will provide space heating and hot water to the building from the district heating network. The heat used is then metered to each building and consumers are billed for their energy use. District heating technology can be used with all heat sources including conventional gas / oil, gas CHP (combined heat and power), heat pumps, biomass, anaerobic digestion, recovered energy from waste (EfW) and industrial processes.



Advantages

District heating systems can significantly reduce carbon emissions by using low carbon or renewable sources of heat. Some renewable heat options are not feasible for individual properties but work well in a district heating system. Where a CHP heat source is used, both heat and electricity are generated which can be used on site or exported.

Maintenance of central heat sources (typically located away from the building to be heated) offers financial benefits compared to servicing of individual boilers in every home. Being external to the building to be heated means that it is possible to change the heat source e.g. from gas CHP to heat pumps with minimal disruption to the home owner. The pipes will last significantly longer than the heat source.

UK MARKET

Other European countries are far more advanced in the use of these systems than the UK. Currently about 2% of the UK heat demand is met by district heating systems covering around 53000 homes (2017) (1) with less than half of those systems using renewable energy sources. This is however, rising annually due to significant government investment in heat networks.

The Heat Network Delivery Unit (HNDU)' https://www.gov.uk/guidance/heat-networks-delivery-support) was set up by the UK government to support local authorities in feasibility studies and heat mapping to identify areas where heat networks could be planned. So far, over 220 projects in England and Wales have been supported. The Heat Network Investment Project (HNIP) offered by the Department for Business, Energy and Industrial Strategy (BEIS) is now offering capital funding (soft loans and grants) to public sector projects, helping to further stimulate the market.

UK DESIGN CODES

Current guidance for UK applications is provided by:

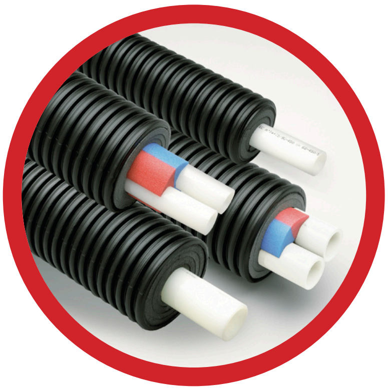
- CP1: Heat Networks: Code of Practice for the UK (CIBSE / ADE, 2015)
- A Technical Guide to District Heating (BRE, 2014).

These were developed for UK designers seeking to increase their knowledge of district heating. They set out minimum requirements and best practice providing a basis for all stages of a district heating project: starting at feasibility and progressing through design, installation and commissioning. CP1 is now being used by clients in tender packages to ensure a well-designed scheme.

DISTRIBUTION PIPEWORK

The distribution pipework between the heat source and the building to be supplied with heat is laid below ground. It therefore needs to withstand external soil and traffic loadings and internal water pressure including fluctuations in the same way as a water distribution pipe; and additionally, be capable of constant operation at elevated temperatures whilst minimising heat loss during transmission. It is important that proven systems are selected for these applications which operate at high temperatures and pressures.





Polymer piping systems are routinely used for central heating applications in the UK and in district heating systems in the more developed markets in Europe.

Pipes and fittings for use in a district heating system should be specified to BS EN 15632. Cross-linked polyethylene (PE-X) is most commonly used, but polybutylene (PB) is also covered by the standard.

BS EN 15632 District heating pipes. Pre-insulated flexible pipe systems.

This specification details the pipe and insulation material properties and the methods of test required to demonstrate fitness for purpose of the product for its intended use and intended operational lifetime. BS EN 15632 has been prepared in three parts:

- BS EN 15632 – 1: Classification, general requirements and test methods
- BS EN 15632 – 2: Bonded plastic service pipes – requirements and test methods
- BS EN 15632 – 3: Non-bonded system with plastic service pipes; requirements and test methods

Reinforced thermoplastic service (RTS) pipes for district heating systems have been developed to utilise the properties of individual materials. These innovative products are not currently covered by the scope of BS EN 15632, but are designed to meet, or in some cases exceed the performance requirements of the standard. Other polymers such as fibre-reinforced polypropylene (PP-R) may also be used but are not currently included in the scope of the standard.

Reference is made to the manufacturer [add link].

The British Plastics Federation (BPF) Pipes Group and its members strongly advise that compliance with the product standards listed in this guide is verified by a third-party (UKAS accredited or equivalent).

Designing with Polymer Pipes

BENEFITS

Polymer pipes for district heating systems offer a wide range of benefits over traditional materials used for underground pipework (principally steel) resulting in installations which are simple, quick and cost effective with good long-term performance.

These include:

- Supplied in coils (typically over 300m in length) which minimises the number of joints needed compared to 12m straight lengths on any network and permits specialist techniques such as ploughing in, pulling through and horizontal direction drilling.
- Flexibility allowing the pipe to be routed around other services and obstacles without needing to install additional joints and capable of withstanding ground movement in service.
- Lightweight offering the possibility of installation without mechanical handling equipment.
- Easy to join using standard site equipment and techniques.
- Expansion bends, used to accommodate significant expansion and contraction due to temperature changes, are not required for polymer pipes.
- Corrosion resistant and smooth-bore extending lifetime and minimising deposit and biofilm build up inside the pipes.
- Leak detection systems, typically used in district heating systems to monitor and minimise loss of heat due to corrosion of the inner pipe, are not required for polymer pipes.
- Trenches are narrower as no additional space is required for welding around the pipes.

OPERATING LIMITS AND LIFE SPAN

The flow temperatures recommended in CP1 are 80°C for existing buildings and 70°C for new buildings. Polymer pipes for district heating networks are typically rated at 6 bar but there are 10 bar and 16 bar systems available.

BS EN 15632 (all parts) requires pipes to have a minimum life span of 30 years at 80°C operating temperature.

Polymer piping for central heating systems inside buildings has been in use for many decades and is well understood. The thermal ageing of polymers under temperature and pressure is determined during the initial type testing using verified industry standard testing regimes and can be validated again in audit tests. Tests are carried out by independent test labs, which are themselves audited annually. The actual life span can be significantly longer for polymer piping systems dependent on the exact duty profile of the district heating network and the polymer used. Pipe manufacturers should be consulted early in the design stage to maximise the benefits.

PIPE SIZING

After calculating the network heat loads and therefore the required flow rates through the pipes, pipe sizing follows established methods using a correctly selected coefficient of friction. The pressure loss (or headloss) per metre of pipe is determined using the Colebrook-White or Darcy-Weisbach equations.

THERMAL EXPANSION

In a trench, the expansion and contraction of a pipe due to the large difference between ambient temperature and operating temperature, is taken up by the properties of the polymer and is normally assisted by ensuring the pipework in the trench is not laid in a straight line.

Polymer pipe systems manufactured to BS EN 15632-2 are bonded throughout and do not require any provisions for thermal expansion such as expansion bellows, expansion loops or similar. Inside buildings, it is good practice for pipes to be anchored at both ends to reduce the chance of any damage on the system from connecting components.

Pipework manufactured to BS EN 15632-3 are non-bonded systems and must be sufficiently anchored at each end.

PLANNING THE ROUTE AND TRENCH

One of the key benefits of polymer pipes is their flexibility, which allows them to be adapted to almost any type of routing conditions on site. Existing lines can be crossed over or under and obstacles routed around; taking account of manufacturer's minimum bending radius for the pipe.

Choice of bedding and backfill materials, design of cover depth to accommodate traffic loadings and compaction requirements all follow the same principles as polymer pipes for water supply systems. Manufacturers provide detailed guidance on this aspect.

Installing Polymer Pipes

GENERAL

Best practice is similar whether installing polymer pipes for water supply systems or district heating systems. A reminder of the key points is provided here.

TRANSPORT, HANDLING AND STORAGE

Careful storage and handling will ensure pipe insulation and pipes remain free from damage.

- Cover up pipe ends to avoid any contamination prior to installation.
- Protect pipes from sharp objects during transportation and storage.
- Unload pipe carefully.
- Do not drag pipes across rough surfaces.
- Where possible, store all components under cover. Pipes can be stored outside if necessary.

One of the major benefits of flexible district heating pipeline materials is that the pipe can be supplied in long lengths as a pipe coil. These can be several hundred metres in length with a total weight of several hundred kilograms per coil.

Transport, lifting and handling must be done safely.

- Make relevant method statements and Operation Health and Safety information available on site.
- Use mechanical handling for lifting and moving coils (with fork protection or lifting belts/straps of at least 50mm width and sufficient handling capacity).
- Store coils only in a horizontal position and ensure they are not squashed (visually inspect the external surface before use).

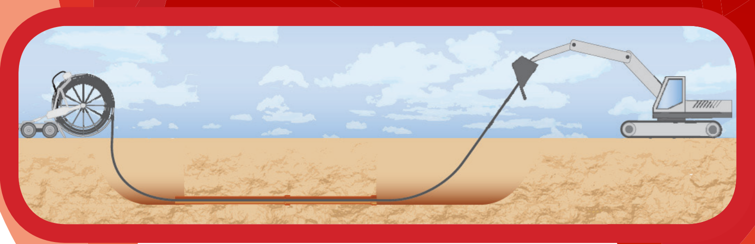
For safety reasons, it is recommended that the pipe be dispensed from a coil dispensing unit, taking care to secure the trailing pipe to ensure that it cannot become detached causing it to whiplash. Smaller diameter pipes can be dispensed directly from their delivery packaging where the packaging bands are progressively cut as the coil is dispensed.

Installation

Pipes may be installed in a traditional open trench or using 'no-dig' techniques.

Open trench – this is the most common technique. Narrow trenching can be used if the installer can work safely to make any joints. Damage to the jacket pipe from poor handling can be repaired using a suitable repair set available from the manufacturer.

Ploughing in – a form of narrow trenching, which ploughs a trench of the exact size for the pipe and feeds the pipe directly from a coil into the trench. The process is fast, but only works in soft-dig areas with mainly stone-free soil.



Pull-through – allows new pipe to be winched through suitable buried pipelines that are now redundant. This reduces time and cost of installation and minimises disruption to the public.

Horizontal Directional Drilling (HDD) – the pipe is pulled behind a drilling machine, making this technique ideal for complex crossings such as buildings, motorway, railway tracks and waterways. Disruption is minimal. Non-bonded pipes cannot be used with this technique.

JOINTING AND INSULATING

Polymer pipes for district heating systems are typically jointed by either a permanent mechanical compression sleeve or a compression ring fitting. Welded systems are also available from some polymer district heating pipe manufacturers.

The mechanical jointing methods are much faster than welding, use simple installation equipment and require less space in the trench permitting narrow trenching to be used. They are more forgiving of slight pipe misalignment and the flexible nature of the pipe means there is no need for on-site fabricated adaptors to circumnavigate obstacles in the ground. As with all jointing, good practice and working strictly in accordance with manufacturer's guidance will offer a watertight system which can be verified by pressure testing.

For efficient and long lasting network performance, all below ground joints require insulation to reduce heat loss. The mechanical jointing methods used with polymer pipes are provided with simple to use insulation sets.

Commissioning and Operating

Commissioning any district heating system is a key element in delivering an efficient and reliable network which performs as intended. Guidance is provided in CP1 and the BRE guide.

- Leaktightness of the system is verified by pressure testing. Polymer pipe manufacturers can provide guidance on the correct pressure test regime.

Operating the system in line with the specified operating parameters will safeguard the reliability and the life span of the network. Guidance is provided in CP1 and the BRE guide.

- Regular checks should be carried out to ensure the system is running at a stable pressure and temperature to maximise the life of the system.
- Water quality and composition – as with any heating system, the quality and composition of water has a major impact on the district heating system. A robust and adequate monitoring regime needs to cover parameters such as pH, conductivity, alkalinity, hardness, oxygen and general appearance of the water. Water quality should be adjusted as required.
- Additives – required for corrosion protection of some metallic components in heating systems, the chemical compatibility of the chosen additives should be confirmed with the polymer pipe manufacturer to avoid any detrimental effect on the pipe.

REFERENCES

- https://www.theade.co.uk/resources/publications/district-heating-installation-map
- CIBSE CP1 : Heat Networks: Code of Practice www.cibse.org.uk/cp1
- BRE Technical Guide to district heating
- BS EN 15632 (all parts)