BAM 2356

Objective

Drinking water is the most important kind of food, since it cannot be substituted. As a rule, damage to pipes and other elements of the drinking water supply system leads to uncontrolled loss of large quantities of water. Often the corresponding financial loss is by far exceeded by the substantial damage to buildings and equipment caused by the water.
The loss of waste water does not directly lead to financial losses of the institution operating the system, however, the outflow of waste water can contaminate the surrounding soil and ground water. Therefore, the operation of defective channels is an of-fence against environmental law.
Currently in Germany the frequency of damage in supply and disposal systems differs very much. Waste water piping systems show approx. 40 times more cases of damage than drinking water piping systems.
Thus, the restoration of defective waste water channels must be a primary demand. More than 96 % of channel pipes in Germany consist of mineral material. Current figures show that the majority of these pipes become defective well within their depreciation period of 50 or 100 years.
These facts show that the existing waste water systems do not meet - at least partly - the requirements. The objective of this study was, therefore, to find out to what extent pipes made of polymer materials are apt to withstand on a long-term basis the strain exercised on them in their function as drinking water pipes or channel pipes.
The following types of pipes were considered:

- pipes made of mineral material (concrete, vitrified clay)
- pipes made of metallic material (steel, stainless steel, copper, ductile cast iron)
- pipes made of polymer material (polybutene (PB), polyethylene (PE), cross-linked polyethylene (PE-X), polypropylene (PP), unplasticized polyvinyl chloride (PVC-U), glass-fibre reinforced, unsaturated polyester resins (UP-GF)).

Method

In order to establish the aptitude of the various pipes, at first all demands were described which the products must meet in the different ranges of application. After that the question was raised to what extent the pipes and parts of the various materials are able to do that. This was done based on practical experiences as well as damage analyses and statistics.
The demands on a single pipe are mainly determined by the accompanying surrounding conditions. The most important general factor of influence is the type of liquid which is transported in the pipe and the volumetric rate of flow. Other factors are the media surrounding the pipe (soil etc.) which correspond with the outer wall of the pipe, abrasive solids which are lead through the pipe together with the liquid flow, as well as the temperatures arising.

Requirements

Wherever it was possible in the consideration of the various demands, also the corresponding differences of the mineral, metallic and polymer pipe materials were described. The following criteria were taken into account:

- mechanical strength
- incrustations
- hydraulic properties, wear resistance
- connection and laying
- influence of temperature
- hygiene aspects (only drinking water)
- quality
- exclusion criteria

Technical aspects

As a rule plastic pipes have a good long-term behaviour. This is particularly due to the combination of bending flexibility and freedom of corrosion.
Pipes with flexural rigidity break in overload situations. The break of the pipe is always followed by leakiness. This is the main reason of damage in the German waste water system, which consists of 96 % flexurally rigid mineral material.
In this respect the polymer and ductile metallic pipes show better characteristics. In these materials which are also called flexible the same overload leads only to a deformation of the pipe. The corresponding reduction of the sectional area means only an insignificant decrease of function.

In the long run corrosion leads to destruction of the constructions. The corrosion products locally reduce the sectional area of the pipe and increase the roughness of the walls. In drinking water systems, apart from technical aspects, there must be considered also the hygienic consequences of corrosion. Above all increased concentrations of metallic ions can impair the health of the consumers.
The proneness to corrosion is mostly a disadvantage of metallic pipe materials, but also of concrete. By coating with non-corrosive materials or application of more nobel metals - as ma-terial or galvanic coating - the progress of corrosion may be slowed down.
Polymer materials are practically not affected by corrosion.

Economical aspects

A general statement regarding economical aspects of pipes depending on the materials used cannot be made, since the various ranges of application are too diversified.
Some advantageous properties of pipes made of polymer materials, as a rule, have a favourable economical effect. This is, apart from economical laying - above all in the „no-dig" system - the long and trouble-free serviceable life which is made possible by freedom of corrosion and good hygienical properties.

Ecological aspects

The current ecological studies dealing with drinking water and waste water systems have brought mixed results. As regards ecological significance there is no reason to prefer a single kind of material.

Discussion of results

Studies on economical aspects and serviceable life of pipes together with technical, ecological, hygienic and toxicological aspects show that the various plastics piping systems have good performance characteristics.
The presented practical examples of pipelines made of various plastics, all of them far more than 20, some of them more than 50 years in operation, show that even the polymer piping material of the „first generation" had a considerable serviceable life.

When comparing the current demands with the current performance of the different materials, it turns out that plastic pipes are optimal for application in many areas of the drinking and waste water systems, though they do not achieve maximum figures in some disciplines. The substantial factor for the good serviceable life of plastic pipes is the combination of freedom of corrosion and bending flexibility.

A disadvantage of the plastic pipes is their inflammability and their properties' dependance on temperature. These restrictions, however, hardly have a disadvantageous effect on the practical application of plastic pipes, as the temperature limitations are known and the single polymer pipes are applied only in ranges they are suited for.
Only the demand for application of non-inflammable pipes can lead to a general exclusion of plastic pipes.