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Guidance document for BRL K17101 and K17102

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Contents

1 Introduction

This document provides further background and guidance information for using the evaluation guidelines BRL K17101 “Class II and class III polyethylene piping systems with an aluminium barrier layer for the transport of drinking water in polluted soil” and BRL K17102 “Class II and class III polyethylene piping systems with a plastics barrier layer for the transport of drinking water in polluted soil”. On the basis of these BRL’s Kiwa issues quality declarations in the form of Kiwa technical approval with a product certificates.

This is a dynamic document which implies that it can be edited and updated whenever required.

If in doubt about the meaning of the wording in this document, the evaluation guidelines K17101 and K17102 are valid.

2 General

In evaluation guideline (BRL) K17101 as well as K17102 background and guidance information is given in:

- Annex III: Background information about the development of the BRLs;
- Annex IV: Guidance for prevention of contamination
- Annex V: Non steady state conditions (K17101) and Example calculation C_{24h} (K17102)
- Annex VI: Target values and intervention values

In this document further guidance is provided regarding:

- Permeation requirements: points of departure, target values for drinking water norm, permeation classes and motivation for the model sustances chosen (chapter 3);
- Overview of tests to be performed and order of tests (chapter 4);
- Flow chart of the certification process (chapter 5)

3 Permeation requirements

3.1 General

Each consumer in our world today comes into contact and consumes substances (chemicals, metals, organic compounds etc) in low quantities that are applied in all kind of products, like food itself, drinks, packaging materials (via migration of substances) and also via drinking water. The generally accepted following criterion is hereby taken into account for drinking water: the contribution of drinking water to the consumption of a certain substance may not be more than 10% of the maximum allowed daily amount for this substance. The concentration levels in the “Waterworks Decree” in The Netherlands are based upon this criterion and the contribution in drinking water may be fully taken up by permeation.

The permeation requirement for barrier piping systems (pipes and connections) has been set at $C_{24h} \leq 1{,}0$ µg/l. C_{24h} is the concentration of each model substance (toluene, trichloroethylene, p-dichlorobenzene) in the drinking water at a lifetime of the piping system of 50 years and after a standstill time of 24 hours.

This requirement has been set already in BRL K545 in 1995 on the basis of which BRL K17101 has been developed in 2002 (BRL K545 does not exist anymore).

At present, the drinking water norm in The Netherlands for each of the model substances is $\leq 1{,}0$ µg/l.

The three mentioned model substances are considered to be representative for a broad pallet of organic pollutions that may occur in practice.

3.2 “Trigger value” for drinking water norm

In a recent study performed by the “Rijksinstituut voor Volksgezondheid en Milieu” (RIVM), a risk assessment procedure has been developed regarding “permeation of contaminants in groundwater through polyethylene drinking water pipes” (report 2016-2017). One of the major conclusions in this report is that – on the basis of the analysis of on-site measurements (see paragraph 6.1 of the RIVM report) – the intervention values[1)] for groundwater can be used as a safe “trigger value” for considering cases of soil pollution with possible risks for the drinking water quality and to start further investigation.
Further, a step-by-step plan has been developed (see paragraph 6.4 and 6.5 of the RIVM report) for the evaluation of the permeation risk into a polyethylene drinking water piping system. This step-by-step plan consists of a combination of testing groundwater concentrations of pollutants, paying attention to user complaints, the modelling of permeation and, in case of doubt, measurements of drinking water. This is all applicable to polyethylene piping systems without barrier layer(s). In the case of polyethylene piping systems with barrier layer(s) according BRL K17101 and K17102, the situation is different. These piping systems are considered to be permeation tight and in worst case conditions allow only a limited amount of flux of pollutants into the drinking water. So, in the case of very high pollutions far above the intervention values, these piping systems are considered to be safe with no risk for the drinking

[1)] The intervention values for groundwater and soil are provided within the framework of the Law Soil Protection (*Wet Bodembescherming (Wbb)*). The quality of the soil may not be adversely affected with respect to the functional characteristics of the soil for humans, animals and plants. In the Circular Soil Contamination 2012 (*Circulaire Bodemsanering 2012*), the so-called target and intervention values for groundwater and soil are provided. The list of these values for organic compounds is included in annex VI of BRL K17101 and K17102.

water quality. This is shown in table 1: the concentration levels used for the permeation testing are much higher than the intervention values for groundwater that in practice are used as trigger values for further risk assessment as explained above.

Table 1: Target and intervention value versus concentration level for class II and III for toluene and tri-chlorine-ethene

		PE piping systems without barrier layer	PE piping systems with barrier layer	
Substance / CAS nr	Target value (µg/l)	Intervention value (µg/l)	Concentration level in groundwater (µg/l) Class II	Solubility in groundwater (µg/l) Class III
Toluene / 108-88-3	7	1000	309.000	515.000
Tri-chlorine-ethene / 79-01-6	24	500	660.000	1.100.000

For more guidance regarding the application of piping systems in polluted soils, reference is made to the "Practice code drinking water" as published by KWR in July 2017. In this document trigger values are provided for several pipe materials (PE, PVC) and e.g. concrete, cement and GRP piping systems are discussed as well.

3.3 Permeation classes

BRL K17101 and K17102 specify product requirements for permeation classes II and III. For class 0 and I it is assumed that pipes without barrier layer(s) can be used as the concentration of pollutants in the soil are not higher than the intervention values. For that reason no requirements for class 0 and I are included in BRL K17101 and K17102. The following definitions for the permeation classes do apply (see also table 1 of BRL K17101 and K17102):

- Class 0: for clean soil (concentration of pollutants not higher than the target values)
- Class I: for soil with low level of concentrations of pollutants (concentration of pollutants not higher than the intervention values)
- Class II: for polluted soil (concentration of pollutants higher than the intervention values)
- Class III: severely polluted soil (in case of e.g. calamities)

For class II piping systems, the permeation tests are carried out with 60% saturated solutions of the model liquids. For class III piping systems 100% satured solutions are used.

3.4 Motivation for the model substances chosen

Although it is not possible to take into account all possible organic contaminations within the framework of the evaluation of the permeation behaviour of plastics piping systems, the three model substances used in BRL K17101 and K17102 are considered to be representative for a broad pallet of organic pollutions that may occur in practice.

The mixture of the selected substances and water is defined as the so-called model liquid. Each of the selected substances must fulfil a number of criteria. The substance shall:

- be representative for the soil pollution, which means that the substance must appear frequently as a soil polluting substance;
- be interactive with a diversity of plastics (the for the time being common piping materials and in connection with possible future developments also other);
- have a molecular structure as small as possible because of the velocity of the diffusion process through the pipe wall;
- be detectable by a mass spectrometer because of obtaining certainty about the final conclusions drawn from the test results and because of being demonstrable at a relatively low concentration level;
- have a reasonable maximum solubility in water at the temperature interval between room temperature and 60 °C, also because of the practicability of the test.

The selection of the limited number of three model substances for the benefit of test methods at laboratory scale has been done as objectively as possible on the basis of the above-mentioned criteria. Initially a summary was made with several groups of organic compounds that frequently incidence as soil contaminations (criterion 1). This summary (substances are adopted from the Soil pollution law (Wet Bodemverontreiniging)) contained the following groups of organic compounds:
- monocyclic aromatic hydrocarbons;
- polycyclic aromatic hydrocarbons (PAK´s);
- aliphatic chlorinated hydrocarbons;
- aromatic chlorinated hydrocarbons;
- pesticides;
- other substances.

PAKs, pesticides and other substances: these three groups of organic compounds are left aside at the selection of model substances.
With the exception of naphthalene, the solubility of PAKs in water is very low. Also the vapour tension of these groups of organic compounds is very low (both criterion 5). Because of these characteristics PAKs are, with the exception of naphthalene, not usable as model substance for testing at laboratory scale.
Further, because of the molecular structure of PAKs (criterion 3), the diffusion transport through the pipe wall will be too small to obtain measurable concentrations in drinking water.
The same arguments apply for pesticides.

The group ‘other substances’ contains the substances cyclo-hexanon, phthalates (sum), mineral oil, pyridine, styrene, THF and tetra-hydro-thiophene. These substances are not regarded as representative for soil contaminations and therefore within this framework not considered.

Choice of the model substances and circumstances:
The results of the above mentioned investigations were mutually compared for the monocyclic aromats, the chlorinated aliphats and the chlorinated aromats. This yielded in the following substances: water- or (vapour phase): toluene (water phase), tri-chlorine-ethene (vapour phase) and p-di-chlorine-benzene (vapour phase). Of the latter mentioned substance it should be mentioned that the triple and higher chlorinated benzenes do score worse as regards of the activity. Because of the reasons mentioned at ‘‘PAKs’ and pesticides’, these substances are not chosen for the model substance.
On the basis of these considerations the substances toluene, tri-chlorine-ethene and p-di-chlorine-benzene are chosen as model substances for the purpose of testing at laboratory scale. The first mentioned two substances are tested in the water phase (for tri-chlorine-ethene the vapour phase is the worst-case situation, but for practical reasons the water phase has been chosen, especially because the difference is relatively small).

The formulated preconditions for the selected substances are included in table 1.

Table 1 – selected model substances and preconditions

Substance	**Represen-tative for practice**	**Interactive with material**	**Group**	**Dimen-sions**	**Gas strip GCMS-detectable**	**Detection limit (µg/l)**	**Solubility in water (mg/l) at 20 °C**
Toluene	Yes	Yes	aromats	small	Yes	0,05	515
Tri-chlorine-ethene	Yes	Yes	chlorinated aliphats	small	Yes	0,05	1.100
p-di-chlorine-benzene	Yes	Yes	chlorinated aromats	small	Yes	0,05	49

3.5 Permeation test results

The concentration C_{24h} (see 3.1) is calculated:

- for barrier pipes on the basis of immersion test results;
  - To be verified via bottle tests on 32 mm[1)] test samples;
- for joints on the basis of bottle tests on 32 mm[1)] test samples.

[1)] Remark: 32mm is the nominal diameter of the inner pipe and the complete barrier pipe is marked on the basis of the nominal dimensions of the inner pipe (DN x e).

For both situations (pipes and joints) the concentration C_{24h} can be calculated for each diameter of the range to be certified.

The basic principles for the calculations are given in BRL K17101 and K17102.

If smaller diameters do not fulfill the permeation requirements, it can be the case that bigger dimensions are able to fulfill the requirements and this shall be proven by calculations. In table 3, an imaginary example is given of the calculated permeation flux C_{24h} for barrier pipes according BRL K17101. In this example the barrier pipes do fulfill the requirements from diameter 40 mm and above. The same principle can be applicable and applied to joints.

Table 3 – calculated concentration, C_{24h}, based on an imaginary test result for an imaginary type test group complying to the requirement i.e. C_{24h} = 1 µg/l.

d_n (mm)	Width of the tape (mm)	Seam length, X (m)	Maximum thickness of the adhesive layer (µm)	Path length to be travelled by the model substance, l_b (mm)	C_{24h} (µg/l)
20	50	1,26	0,05	17,0	2,0
25	50	1,57	0,05	17,0	1,6
32	50	2,01	0,05	17,0	1,3
40	50	2,51	0,05	17,0	1,0
50	50	3,14	0,05	17,0	0,8
63	50	3,96	0,05	17,0	0,6

4 Tests to be performed, including permeation and leaktightness aspect

4.1 Overview

In chapter 5 and 6 the flow charts (overviews) for the tests to be performed according K17101 and K17102 are given.
The applicable tests are as follows categorized:

- Permeation and leak tightness tests (par. 4.2)
- Hygienic tests (par. 4.3)
- Mechanical tests (par. 4.4)

4.2 Permeation and leaktightness tests

Three test phases are distinguished within the aspect ‘permeation and leakthightness’:

I) Permeation aspect for the barrier pipes
II) Permeation aspect for the joints
III) Leaktightness aspect for barrier pipes and joints

I) and II) Permeation aspect
In these phases permeation calculations on the basis of immersion test results are made. The diffusion and solubility coefficient of the barrier layer material(s) are determined according to K17101 and K17102. The applicant must specify all details of the construction of the barrier pipe and joint, specially the barrier layer. On the basis of the diffusion and solubility coefficient and the known construction of the barrier pipe and joint, the expected concentration C_{24h} after 50 years can be calculated for the barrier pipe as well as for the joints. If immersion tests are not possible or available, also bottle test results can be used. A limited bottle test is always carried out as a construction verification test.

III) Leaktightness
The leak tightness of the pipes and joints is checked via helium tests for BRL K17101 and via bottle tests for BRL K17102.

4.3 Hygienic tests

According to Dutch law (Drinking Water Decree) all products coming into contact with drinking water must be hygienically checked, tested and certified. In this respect chemical substances are meant that could leach out of the pipe material and not the chemical substances permeating through the pipeline. The Kiwa HA-approval (formerly called ‘Kiwa ATA’) is part of the product certificate(s) to be issued for the pipes and fittings.
The following steps are distinguished within the full procedure that may lead to granting of the HA-approval:

- Information supply and application;
- Collection of data, specially of the receipts of the materials involved;
- Acceptance criteria and limit values;
- Laboratory tests: migration tests and analysis and taste, smell and colour testing;
- Draw-up of HA certification agreement.

Further information can be obtained from Kiwa’s HA department.

The application procedure can easily take up to six months or more, depending on how quick receipt information from suppliers of raw materials can be provided.

4.4 Mechanical tests

Mechanical requirements are imposed on:

- Barrier pipes;
- Possible fittings, like:
  - Metal fittings;
  - Electrofusion fittings;
  - Socket fusion fittings, etc.
- Joints (the combination of pipes and fittings)

As indicated in the flow charts in chapter 2 and 3 most of the requirements are based on BRL K17105 for PE piping systems with requirements based on EN 12201.

5 Flow chart certification process

With regard to the certification process, the following flow chart is applicable for the tests to be performed.