G.P.-S. (F-L)

TR 101

REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF WATER AFFAIRS

Health Implications of using Bitumen, Coal-tar, Asbestos and Plastic Materials in Water Distribution Systems

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Technical Report No TR 101

HEALTH IMPLICATIONS OF USING BITUMEN, COAL-TAR, ASBESTOS AND PLASTIC MATERIALS IN WATER DISTRIBUTION SYSTEMS

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September, 1979

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ISBN 0 621 05574 3

EXPLANATION OF SOME TERMS USED

HYDROCARBON	=	Chain like carbon compounds, consisting of carbon chains with hydrogen atoms attached to the chains.
PARAFFINIC MOLECULES	=	Long chain hydrocarbons with wax-like properties. Water insoluble.
AROMATIC COMPOUNDS	=	Carbon compounds with ring structure.
PHENOLIC GROUPS	=	Hydroxyl group (OH) attached to carbon ring. Phenolic groups make aromatic compounds water soluble.
CARCINOGEN	=	Cancer causing agent. The carcinogenic organic compounds are mostly aromatic compounds.
VOLATILE ORGANIC COMPOUNDS	=	The smaller aromatic organic molecules present in raw coal tar. Many of these smaller molecules are both toxic and carcinogenic. They tend to be volatile and moderately soluble in water.
TOXIC	=	Causing poisoning.

ABSTRACT

The health aspects of using bitumen, coal-tar, asbestos and plastic piping in water distribu= tion systems were reviewed: The conventional lining material, bitumen, is becoming scarce. Coal-tar is only suitable after the volatile organic compounds are removed. Asbestos-cement is suitable for non-corrosive water. Plastic piping of the unplasticized polyvinylchloride type, with the minimal amount of lead or organo-tin stabilizer is suitable.

INTRODUCTION

The purpose of this report is to consider the possible health implications associated with the use of certain materials for the construction of drinking water piping.

The following are discussed:

(a) Bitumen and coal-tar, used to line iron pipes.

(b) Asbestos-cement.

(c) Plastic pipes.

BITUMEN AND COAL-TAR

Bitumen, derived from natural petroleum, is a complex mixture of hydrocarbons with molecular mass between 400 and 10 000 (Anon, 1962; Jamieson, 1977). Bitumen is insoluble in water both because of the high average molecular mass, and because the oily fraction of bitumen consists of water repellent wax-like paraffinic molecules (Brady, 1979). Consequently bitumen makes a good lining material for water mains. Unfortunately it is becoming scarce and expensive (Jamieson, 1974).

Coal-tar, obtained from the distillation of coal in the absence of air, is a mixture of aromatic organic compounds with molecular mass between 200 and 2 000 (Brady, 1979). The oily fraction of coal-tar has considerable water solubility, due to the presence of phenolic groups. Raw coal-tar, containing water soluble oils, is unsuitable for lining water mains (Burman and Colbourne, 1979). When coal-tar is made, the different distillation fractions are separated according to boiling point (Table 1):

The pitch residue is blended with one or more of the oil or creosote fractions to obtain the coal-tar end product (Jamieson, 1974).

Where coal-tar is used as a road binding agent, the light oils are lost by evaporation within a few days, and all the oils up to the middle creosote fraction are lost within a year (Jamieson, 1974).

To minimize the loss of oils, low-volatile blends must be specifically prepared, by using only tar oils boiling above 350^{o}C for blending with pitch (Jamieson, 1974). Jamieson (1974) has developed a low volatile coal-tar blend containing 1,5% polyvinylchloride.

TABLE 1 : Coal-tar fractions*

Distilling temperature ^{o}C	Tar Fraction	Component
<210	light oil	benzene derivatives.
210 to 230	middle oil	naphthalenes, phenols, cresols.
230 to 315	light creosote	creosote oils.
315 to 355	middle creosote	anthracene, phenanthrene.
355 to 400	heavy creosote	fluoranthrene, chrysene.
residue	pitch	condensed aromatics.

*(adapted from Hoiberg, 1966, p 69).

Coal-tar has been used in the past for lining water mains (Hoiberg, 1966). Only low-volatile content coal-tar blends should be considered for possible use as water pipe lining material, as the soluble organic compounds present in the usual coal-tar blends are both toxic, carcinogenic, and unpleasant to taste (Jamieson, 1978; McKee and Wolf, 1963; WHO, 1973a).

ASBESTOS-CEMENT

Asbestos-cement piping has been long used in America for water mains (Hallenbeck, Chen, Hesse, Pattel-Mandlik and Wolff, 1978). Inhalation of asbestos fibres is a known cause of cancer (WHO, 1973b). The risk involved in drinking water containing asbestos fibres is uncertain (AWWA, 1974; Beaman and File, 1976; Cunningham and Pontefract, 1971; Peterson, 1978; Wagner and Berry, 1969). Asbestos related cancer has a latent period following exposure of as long as 40 years (WHO, 1973b). The Americans have reported that asbestos-cement piping does not release asbestos fibres into the water (Hallenbeck *et al*, 1978); the question is not yet adequately resolved, as accurate fibre counts are few, and can only be done with sophisticated electron microscopes (Beaman and File, 1976; Foley and Missingham, 1976).

Our own department has stated that they have had experience of asbestos-cement pipes only lasting 5 years in practice. In view of the known carcinogenicity of asbestos, it should only be used for piping non-corrosive water which will not attack the cement.

PLASTIC PIPING

The chief plastic that has been widely used overseas for drinking water distribution is unplasticized polyvinylchloride (uPVC). The vinylchloride polymer as such is non toxic, but in its manufacture many chemicals may be added such as stabilizers, fillers, lubricants, anti-oxidizers, pigments, accelerators, etc. The additives can be highly toxic (WHO, 1971).

The World Health Organization report on the health aspects of uPVC in water distribution (WHO, 1973c) makes the following recommendations:

(a) As metallic-additives (stabilizers, lubricants, etc.), are leached from uPVC, the amount of toxic additives used should be kept to the absolute minimum required for production.

(b) Compounds of barium, cadmium and mercury should never be used in uPVC destined for water distribution piping.

(c) No toxic metal compound should be used as a lubricant.

(d) The amount of metal stabilizer added in the manufacture of the uPVC should be the absolute minimum required. In Europe lead is customarily used, while in America organo-tin compounds are used. Tin or lead compounds may be used until less toxic alternative stabilizers become available.

(e) Suspension type uPVC should be used for water piping rather than emulsion type uPVC, as metal stabilizers are more rapidly leached from the latter.

RECOMMENDATION

(a) Coal-tar is not suitable in its usual form for lining water mains as it contains soluble toxic chemical compounds. Specifically prepared low volatile coal-tar, containing the minimum amount of oils boiling below 350^{o}C may be suitable, and is worth trying. Low volatile coal-tar with 1,5% PVC may also be tried. Water from freshly coated coal-tar pipes should be tested for aromatic organic compounds.

(b) Asbestos-cement should only be used for transporting non-corrosive waters which are unli= kely to dissolve the cement. Water from asbestos pipes should be tested for asbestos fibres by electron microscopy at least once a year.

(c) Plastic pipes, of the suspension uPVC type containing the minimum quantity of lead or organo-tin stabilizer may be used for transporting drinking water. If a lubricant is used

in its manufacture, it should contain no toxic metals. The use of compounds of barium, cadmium and mercury is specifically excluded in the manufacture of uPVC for drinking water purposes.

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TR 101