

Health Safety of Main Water Pipe Materials Supplied in China Market¹

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Objective To assess the health safety of copper, steel and plastic water pipes by field water quality investigations. **Methods** Four consumers were randomly selected for each type of water pipes. Two consumers of every type of the water pipes had used the water pipes for more than 1 year and the other 2 consumers had used the water pipes for less than 3 months. The terminal volume of tap water in copper and steel water pipes should be not less than 0.1 liter, whereas that in plastic water pipes should be not less than 1 liter. **Results** The mean values of the experimental results in the second field water quality investigation of the copper and steel water pipes met the *Sanitary Standards for Drinking Water Quality*. The items of water sample of the plastic water pipes met the requirements of the *Sanitary Standards for Drinking Water Quality*. **Conclusion** Copper, steel, and plastic pipes can be used as drinking water pipes.

Key words: Copper; Steel; Plastic; Water pipes; Health safety

INTRODUCTION

The life-span of copper water pipes is almost 100 years. Copper water pipes are widely used in developed countries, including United States of America, European Union, and so on. Because the price of copper is higher than that of the other materials and China is a country in short of copper, copper water pipes have been used only recently in China. The copper water pipes traditionally used in developed countries are faced with corrosion problems^[1], such as so-called blue water phenomena^[2]. In China, copper water pipes are used in limited places. However, now the safety problem of drinking water are beginning to be one of the greatest concern in China, and more and more people choose the safe water pipe material, special copper water pipes.

Steel water pipes have many virtues, such as corrosion and impact resistances. Chinese factories have succeeded in developing steel water pipes by adopting advanced techniques. With the help of the Ministry of Science and Technology of China, steel water pipes are gradually accepted by China market.

The life-spans of the PPR, PVC, PAP (aluminum-plastic combination), and ABS water

pipes are over 50 years. The pipes tolerate a wide range of temperature. They are lighter than the copper and steel water pipes.

In order to ensure the safety of drinking water, we carried out a study on health safety of copper, steel, and plastic water pipes.

MATERIALS AND METHODS

Investigation Objects

In Beijing City, four consumers were randomly selected for each type of water pipes, i.e. copper water pipes and plastic water pipes (PPR, PVC, PAP, and ABS). In Chengdu City, four consumers were randomly selected for steel water pipes. Among them, two consumers of every type of the water pipes had used the water pipes for more than 1 year, and the other two consumers had used the water pipes for less than 3 months. The terminal volume of tap water in copper and steel water pipes should be not less than 0.1 liter, and that in the plastic water pipes should be not less than 1 liter.

Items for Water Quality Analysis

Items of water quality analysis for copper and

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steel water pipes included: copper, lead, zinc, chromium, cadmium, nickel, tin, pH, total alkalinity, chloride residue, sulphate, arsenic, chloride, and total hardness.

Items of water analysis for plastic water pipes included: copper, lead, zinc, chromium, cadmium, nickel, tin, pH, total alkalinity, chloride residue, sulphate, arsenic, chloride, and total hardness.

ICP-MS was used for analysis of metals in water. The analysis of the other items followed the "Standard Examination Methods for Drinking Water"^[3]. The results were compared with and assessed by the *Sanitary Standards for Drinking Water in China*^[4].

Sampling Method

For consumers of copper and steel water pipes: two samples were taken after the consumers stopped using water for 8 hours. The first sample was 0.1 litre for metals in stagnant water. The second one was 1 litre for all remaining parameters of running water; the tap water was required to run at least 5 minutes after the first sample was taken.

For plastic water pipe consumers: one sample was taken after the consumers stopped using water for 8 hours. The tap water must run at least 5 minutes. Then, 2 litre of water sample was taken for all parameters.

Water samples were collected three times during

the same week.

Sampling Schedule

Two investigations including examinations were carried out, one in the summer and the other in the autumn of 2003.

RESULTS

Copper Water Pipes

Maximum permissible levels of cadmium and nickel in Sanitary Standards for Drinking Water Quality are 0.005 and 0.02 mg/L, respectively. As shown by the experimental results in Table 1, the levels of cadmium and nickel exceeded the standards, but did not much differ from the maximum permissible values.

Some values of the cadmium met the *Sanitary Standards for Drinking Water Quality* (Table 2).

By comparing the experimental results of water samples collected from the consumers using copper water pipes for less than 3 months with those for more than 1 year, the difference in time of use had no effect on the quality of drinking water (Tables 1 and 2).

As shown by the experimental results of the first and second water samples collected from copper water pipes, the cadmium and nickel levels in stagnant water in copper water pipes were lowered.

TABLE 1

Experiment Results of the First Field Water Quality Sampling for Copper Water Pipes

Items	Maximum Permissible Level	Water Samples of Users Using Copper Water Pipes for More Than One Year			Water Samples of Users Using Copper Water Pipes for Less Than Three Months		
		Sample Size	Range	Mean	Sample Size	Range	Mean
pH	6.5-8.5	6	7.41-7.81	7.59	6	7.28-7.77	7.56
Chlorine Residue (mg/L)	-	6	0.03-0.05	0.03	6	0-0.05	0.03
Total Alkalinity (mg/L)	-	6	137-211	173	6	142-432	286
Total Hardness (mg/L)	450	6	159-292	226	6	175-178	177
Sulphate (mg/L)	250	6	27.7-56.1	39.8	6	30.5-194	108
Chloride (mg/L)	250	6	12.4-35.7	22.8	6	14.2-68.7	40.6
Copper (mg/L)	1.0	6	0.027-0.150	0.068	6	0.013-0.028	0.019
Lead (mg/L)	0.01	6	0.0015-0.0069	0.0030	6	0.00085-0.0098	0.0028
Zinc (mg/L)	1.0	6	0.149-0.255	0.193	6	0.061-0.121	0.088
Chromium (mg/L)	0.05 (Cr VI)	6	0.0110-0.0170	0.0140	6	0.0110-0.0200	0.0140
Cadmium (mg/L)	0.005	6	0.0057-0.0066*	0.0060*	6	0.0054-0.0062*	0.0058*
Nickel (mg/L)	0.02	6	0.0250-0.0350*	0.0290*	6	0.0250-0.0280*	0.0260*
Tin (mg/L)	-	6	0.00082-0.00340	0.00150	6	0.00110-0.00130	0.00120
Arsenic (mg/L)	0.05	6	0.0240-0.0370	0.0320	6	0.0240-0.0300	0.0280

Note. *represent the results that exceed *Sanitary Standards For Drinking Water Quality* issued by Ministry of Health of China.

TABLE 2

Experimental Results of the Second Field Water Quality Sampling for Copper Water Pipes

Items	Water Samples of Users Using Copper Water Pipes for More Than One Year			Water Samples of Users Using Copper Water Pipes for Less Than Three Months		
	Sample Size	Range	Mean	Sample Size	Range	Mean
pH	6	7.39-8.01	7.66	6	7.30-7.79	7.55
Chlorine Residue (mg/L)	6	0.03-0.05	0.05	6	0.03-0.05	0.05
Total Alkalinity (mg/L)	6	142-250	200	6	177-427	298
Total Hardness (mg/L)	6	186-384	281	6	222-573	397
Sulphate (mg/L)	6	28.4-86.8	54.7	6	29.3-180	102
Chloride (mg/L)	6	16.0-61.5	38.6	6	18.3-67.8	42.1
Copper (mg/L)	6	<0.0005-0.821	0.324	6	0.027-0.481	0.221
Lead (mg/L)	6	0.0016-0.0072	0.0036	6	0.0023-0.0095	0.0059
Zinc (mg/L)	6	0.125-0.138	0.133	6	0.182-0.926	0.459
Chromium (mg/L)	6	<0.0002	<0.0002	6	<0.0002	<0.0002
Cadmium (mg/L)	6	0.0030-0.0060*	0.0045	6	0.0018-0.0066*	0.0046
Nickel (mg/L)	6	<0.0005-0.0092	0.0038	6	<0.0005	<0.0005
Tin (mg/L)	6	0.00075-0.00363	0.00146	6	0.00025-0.00114	0.00065
Arsenic (mg/L)	6	<0.00003-0.00318	0.00053	6	<0.00003-0.00346	0.00058

Note. *represent the results that exceed *Sanitary Standards for Drinking Water Quality* issued by Ministry of Health of China.

Steel Water Pipes

Comparison of the nickel levels in the two samples revealed that nickel was dissolved out from the steel water pipes. By comparing the experimental results of water samples, the drinking water quality for the consumers using steel water pipes for less than 3 months was better than that for more than 1

year (Table 3).

But the difference in time of use had no effect on the quality of drinking water (Table 4).

By comparing the experiment results of the first field water quality investigations for steel water pipes with those of the second one, nickel levels met the *Sanitary Standards for Drinking Water Quality*.

TABLE 3

Experimental Results of the First Field Water Quality Sampling for Steel Water Pipes

Items	Water Samples of Users Using Steel Water Pipes for More Than One Year			Water Samples of Users Using Steel Water Pipes for Less Than Three Months		
	Sample Size	Range	Mean	Sample Size	Range	Mean
pH	6	7.53-7.65	7.59	6	7.67-7.73	7.69
Chlorine Residue (mg/L)	6	0	0	6	0.05-0.10	0.08
Total Alkalinity (mg/L)	6	270-275	272	6	90.7-98.1	94.0
Total Hardness (mg/L)	6	301-310	306	6	102-106	104
Sulphate (mg/L)	6	42.9-45.7	44.2	6	11.8-12.8	12.4
Chloride (mg/L)	6	13.8-14.0	14.0	6	6.4-7.1	6.8
Copper (mg/L)	6	0.0065-0.029	0.014	6	0.016-0.145	0.099
Lead (mg/L)	6	0.00042-0.0017	0.0011	6	0.0074-0.0089	0.0081
Zinc (mg/L)	6	0.086-0.153	0.108	6	0.033-0.368	0.177
Chromium (mg/L)	6	0.0014-0.0078	0.0046	6	<0.0002-0.0028	0.0012
Cadmium (mg/L)	6	0.0020-0.0036	0.0031	6	0.00022-0.0014	0.0008
Nickel (mg/L)	6	0.0290-0.0450*	0.0340*	6	0.0140-0.0180	0.0150
Nickel (mg/L) [#]	6	0.0080-0.0130	0.0100	6	0.0069-0.0087	0.0078
Tin (mg/L)	6	0.00046-0.00091	0.00057	6	0.00003-0.00042	0.00027
Arsenic (mg/L)	6	0.0180-0.0280	0.0240	6	0.0052-0.0110	0.0078

Note. [#]represent the experimental results of the second sample by the sampling method. *represent the results that exceed *Sanitary Standards for Drinking Water Quality* issued by Ministry of Health of China.

TABLE 4

Experimental Results of the Second Field Water Quality Sampling for Steel Water Pipes

Items	Water Samples of Users Using Steel Water Pipes for More Than One Year			Water Samples of Users Using Steel Water Pipes for Less Than Three Months		
	Sample Size	Range	Mean	Sample Size	Range	Mean
pH	6	7.47-7.59	7.54	6	7.62-7.76	7.69
Chlorine Residue (mg/L)	6	0	0	6	0.05	0.05
Total Alkalinity (mg/L)	6	265-275	273	6	108-118	115
Total Hardness (mg/L)	6	182-236	211	6	131-139	135
Sulphate (mg/L)	6	48.9-56.8	52.8	6	18.4-22.6	20.7
Chloride (mg/L)	6	14.1-16.0	15.0	6	4.6-7.1	5.3
Copper (mg/L)	6	<0.0005-0.0184	0.0037	6	<0.0005-0.132	0.032
Lead (mg/L)	6	0.00057-0.0019	0.0010	6	0.0018-0.0044	0.0031
Zinc (mg/L)	6	0.080-0.667	0.253	6	0.066-0.584	0.183
Chromium (mg/L)	6	<0.0002	<0.0002	6	<0.0002	<0.0002
Cadmium (mg/L)	6	0.0031-0.0042	0.0038	6	0.00091-0.0014	0.0012
Nickel (mg/L)	6	<0.0005-0.0029	0.00067	6	<0.0005-0.0088	0.0019
Tin (mg/L)	6	0.00020-0.00039	0.00029	6	0.00025-0.00137	0.00065
Arsenic (mg/L)	6	<0.00003	<0.00003	6	<0.00003	<0.00003

Plastic Water Pipes

By comparing the experimental results of water samples of the consumers using PPR, PVC, PAP, and ABS water pipes for less than 3 months with those

for more than 1 year, and the experimental results of the first and second field water quality investigations for PPR, PVC, PAP and ABS water pipes, the difference in time periods of use had no effect on the quality of drinking water (Tables 5-12).

TABLE 5

Experimental Results of the First Field Water Quality Sampling for PPR Water Pipes

Items	Water Samples of Users Using PPR Water Pipes for More Than One Year			Water Samples of Users Using PPR Water Pipes for Less Than Three Months		
	Sample Size	Range	Mean	Sample Size	Range	Mean
pH	6	7.49-7.89	7.66	6	7.59-7.75	7.67
Chlorine Residue (mg/L)	6	0.01-0.07	0.04	6	0.05-0.7	0.48
Total Alkalinity (mg/L)	6	177-253	225	6	253-257	255
Total Hardness (mg/L)	6	253-287	270	6	286-287	286
Sulphate (mg/L)	6	27.1-85.1	57.0	6	73.5-83.5	76.8
Chloride (mg/L)	6	14.9-44.7	28.2	6	34.1-46.6	40.7
Copper (mg/L)	6	0.079-0.965	0.332	6	0.133-0.733	0.297
Lead (mg/L)	6	0.0031-0.0098	0.0066	6	0.0046-0.0048	0.0047
Zinc (mg/L)	6	0.396-0.893	0.709	6	0.278-0.739	0.407
Chromium (mg/L)	6	0.0024-0.0089	0.0065	6	0.00018-0.0064	0.0059
Tin (mg/L)	6	0.00048-0.00100	0.00079	6	0.00047-0.00310	0.00154
Arsenic (mg/L)	6	0.0130-0.0250	0.0198	6	0.0110-0.0340	0.0220

TABLE 6

Experimental Results of the Second Field Water Quality Sampling for PPR Water Pipes

Items	Water Samples of Users Using PPR Water Pipes for More Than One Year			Water Samples of Users Using PPR Water Pipes for Less Than Three Months		
	Sample Size	Range	Mean	Sample Size	Range	Mean
pH	6	7.56-7.87	7.68	6	7.58-7.79	7.67
Chlorine Residue (mg/L)	6	0.03-0.10	0.06	6	0.05-0.07	0.05
Total Alkalinity (mg/L)	6	196-255	229	6	245-265	251
Total Hardness (mg/L)	6	214-297	258	6	269-297	282
Sulphate (mg/L)	6	25.4-85.1	55.8	6	89.3-103	99.9
Chloride (mg/L)	6	14.4-39.2	26.9	6	41.2-47.8	45.6
Copper (mg/L)	6	<0.0005-0.0238	0.0069	6	<0.0005-0.0136	0.0050
Lead (mg/L)	6	0.0020-0.0090	0.0045	6	0.00088-0.0071	0.0029
Zinc (mg/L)	6	0.343-0.780	0.555	6	0.045-0.161	0.076
Chromium (mg/L)	6	<0.0002-0.0039	0.0026	6	0.0026-0.0052	0.0040
Tin (mg/L)	6	0.00049-0.00163	0.00087	6	0.00051-0.00073	0.00057
Arsenic (mg/L)	6	<0.00003-0.0208	0.0176	6	<0.00003-0.0223	0.0108

TABLE 7

Experiment Results of the First Field Water Quality Sampling for PVC Water Pipes

Items	Water Samples of Users Using PVC Water Pipes for More Than One Year			Water Samples of Users Using PVC Water Pipes for Less Than Three Months		
	Sample Size	Range	Mean	Sample Size	Range	Mean
pH	6	7.90-8.24	8.14	6	7.50-8.26	7.84
Chlorine Residue (mg/L)	6	0.01-0.03	0.02	6	0.03-0.10	0.05
Total Alkalinity (mg/L)	6	141-221	177	6	139-213	174
Total Hardness (mg/L)	6	167-187	172	6	170-245	207
Sulphate (mg/L)	6	34.3-37.0	35.5	6	31.0-37.8	33.7
Chloride (mg/L)	6	9.66-19.1	13.9	6	16.4-19.2	17.2
Copper (mg/L)	6	0.0013-0.0073	0.0031	6	<0.0005-0.0060	0.0025
Lead (mg/L)	6	0.0010-0.0031	0.0016	6	0.0010-0.0022	0.0017
Zinc (mg/L)	6	0.024-0.127	0.072	6	0.024-0.051	0.034
Chromium (mg/L)	6	<0.0002	<0.0002	6	<0.0002	<0.0002
Cadmium (mg/L)	6	0.00029-0.00062	0.00050	6	0.00053-0.0011	0.00071
Nickel (mg/L)	6	0.0058-0.0100	0.0080	6	0.0010-0.0100	0.0073
Tin (mg/L)	6	<0.00003	<0.00003	6	<0.00003	<0.00003
Arsenic (mg/L)	6	<0.00003	<0.00003	6	<0.00003	<0.00003

TABLE 8

Experimental Results of the Second Field Water Quality Sampling for PVC Water Pipes

Items	Water Samples of Users Using PVC Water Pipes for More Than One Year			Water Samples of Users Using PVC Water Pipes for Less Than Three Months		
	Sample Size	Range	Mean	Sample Size	Range	Mean
pH	6	7.87-8.28	8.14	6	7.49-8.24	7.92
Chlorine Residue (mg/L)	6	0.02-0.05	0.03	6	0.04-0.10	0.06
Total Alkalinity (mg/L)	6	152-216	183	6	147-154	150
Total Hardness (mg/L)	6	178-234	202	6	178-210	194
Sulphate (mg/L)	6	29.4-37.6	32.9	6	27.9-36.1	31.7
Chloride (mg/L)	6	8.64-20.9	14.6	6	15.0-21.4	17.9
Copper (mg/L)	6	<0.0005-0.0389	0.0100	6	<0.0005	<0.0005
Lead (mg/L)	6	0.0013-0.0085	0.0039	6	0.00085-0.0068	0.0027
Zinc (mg/L)	6	0.072-0.283	0.167	6	0.063-0.427	0.224
Chromium (mg/L)	6	0.00037-0.0130	0.0067	6	<0.0002-0.00069	0.00020
Cadmium (mg/L)	6	0.0017-0.0042	0.0032	6	0.0023-0.0034	0.0029
Nickel (mg/L)	6	<0.0005	<0.0005	6	<0.0005	<0.0005
Tin (mg/L)	6	0.00083-0.00657	0.00248	6	0.00087-0.00148	0.00118
Arsenic (mg/L)	6	<0.00003-0.0152	0.0074	6	<0.00003-0.0100	0.0026

TABLE 9

Experimental Results of the First Field Water Quality Sampling for PAP Water Pipes

Items	Water Samples of Users Using PVC Water Pipes for More Than One Year			Water Samples of Users Using PVC Water Pipes for Less Than Three Months		
	Sample Size	Range	Mean	Sample Size	Range	Mean
pH	6	7.47-7.94	7.67	6	7.29-7.82	7.48
Chlorine Residue (mg/L)	6	0.03	0.03	6	0.01-0.05	0.04
Total Alkalinity (mg/L)	6	191-210	201	6	196-211	203
Total Hardness (mg/L)	6	238-264	253	6	244-306	259
Sulphate (mg/L)	6	33.6-39.9	36.1	6	30.5-61.1	39.2
Chloride (mg/L)	6	19.4-25.5	21.4	6	15.8-42.1	23.4
Copper (mg/L)	6	0.085-0.534	0.199	6	0.039-0.102	0.063
Lead (mg/L)	6	0.00034-0.00084	0.00050	6	0.00085-0.0015	0.0011
Zinc (mg/L)	6	0.025-0.030	0.027	6	0.029-0.174	0.082
Chromium (mg/L)	6	0.0210-0.0360	0.0290	6	0.0160-0.0320	0.0230
Cadmium (mg/L)	6	0.0018-0.0041	0.0027	6	0.0013-0.0037	0.0025
Tin (mg/L)	6	0.00082-0.00100	0.00090	6	0.00074-0.00160	0.00100
Arsenic (mg/L)	6	0.0310-0.0380	0.0340	6	0.0350-0.0400	0.0370

TABLE 10

Experimental Results of the Second Field Water Quality Sampling for PAP Water Pipes

Items	Water Samples of Users Using PVC Water Pipes for More Than One Year			Water Samples of Users Using PVC Water Pipes for Less Than Three Months		
	Sample Size	Range	Mean	Sample Size	Range	Mean
pH	6	7.51-7.89	7.70	6	7.29-7.79	7.47
Chlorine Residue (mg/L)	6	0.05	0.05	6	0.02-0.05	0.04
Total Alkalinity (mg/L)	6	216-245	227	6	196-216	203
Total Hardness (mg/L)	6	254-337	279	6	246-265	253
Sulphate (mg/L)	6	80.9-89.6	84.2	6	30.4-84.5	55.7
Chloride (mg/L)	6	56.0-68.7	60.7	6	17.9-61.8	37.9
Copper (mg/L)	6	<0.0005-0.1005	0.0210	6	0.0058-0.0198	0.0118
Lead (mg/L)	6	0.0012-0.0078	0.0034	6	0.0029-0.0056	0.0039
Zinc (mg/L)	6	0.042-0.552	0.162	6	0.079-0.761	0.366
Chromium (mg/L)	6	0.0043-0.0288	0.0117	6	0.0029-0.0067	0.0043
Cadmium (mg/L)	6	<0.00001	<0.00001	6	<0.00001	<0.00001
Tin (mg/L)	6	0.00059-0.00234	0.00099	6	0.00043-0.00060	0.00052
Arsenic (mg/L)	6	0.0070-0.0190	0.0150	6	0.0060-0.0150	0.0092

TABLE 11

Experimental Results of the First Field Water Quality Sampling for ABS Water Pipes

Items	Water Samples of Users Using PVC Water Pipes for More Than One Year			Water Samples of Users Using PVC Water Pipes for Less Than Three Months		
	Sample Size	Range	Mean	Sample Size	Range	Mean
pH	6	7.83-7.99	7.90	6	7.78-8.05	7.90
Chlorine Residue (mg/L)	6	0.05	0.05	6	0.05	0.05
Total Alkalinity (mg/L)	6	43.6-48.1	45.2	6	45.1-49.5	46.7
Total Hardness (mg/L)	6	156-163	161	6	152-163	160
Sulphate (mg/L)	6	43.8-47.8	45.8	6	41.9-48.1	46.0
Chloride (mg/L)	6	16.3-20.6	18.3	6	15.8-20.5	17.7
Copper (mg/L)	6	<0.0005-0.0028	0.0015	6	<0.0005-0.0040	0.0015
Lead (mg/L)	6	0.00064-0.0038	0.0015	6	0.00064-0.0019	0.0023
Zinc (mg/L)	6	<0.00006-0.071	0.039	6	<0.00006-0.399	0.125
Chromium (mg/L)	6	<0.0002-0.0038	0.0017	6	<0.0002-0.013	0.0044
Cadmium (mg/L)	6	<0.00001-0.0012	0.0008	6	<0.00001-0.0010	0.0004
Nickel (mg/L)	6	<0.0005-0.0054	0.0034	6	<0.0005-0.0055	0.0035
Tin (mg/L)	6	<0.00003	<0.00003	6	<0.00003	<0.00003
Arsenic (mg/L)	6	<0.00003	<0.00003	6	<0.00003	<0.00003

TABLE 12

Experimental Results of the Second Field Water Quality Sampling for ABS Water Pipes

Items	Water Samples of Users Using PVC Water Pipes for More Than One Year			Water Samples of Users Using PVC Water Pipes for Less Than Three Months		
	Sample Size	Range	Mean	Sample Size	Range	Mean
pH	6	8.40-8.48	8.45	6	8.29-8.50	8.45
Chlorine Residue (mg/L)	6	0.04-0.05	0.05	6	0.04-0.05	0.05
Total Alkalinity (mg/L)	6	186-223	213	6	206-230	222
Total Hardness (mg/L)	6	163-182	169	6	159-190	176
Sulphate (mg/L)	6	41.6-52.6	47.0	6	36.5-48.8	42.7
Chloride (mg/L)	6	15.4-19.6	17.0	6	13.2-18.1	15.5
Copper (mg/L)	6	<0.0005-0.0108	0.0018	6	<0.0005-0.0236	0.0073
Lead (mg/L)	6	0.0011-0.0071	0.0033	6	0.0012-0.0099	0.0040
Zinc (mg/L)	6	0.057-0.112	0.081	6	0.088-0.334	0.152
Chromium (mg/L)	6	0.00070-0.0025	0.0018	6	0.0030-0.0049	0.0035
Cadmium (mg/L)	6	0.0024-0.0039	0.0030	6	0.0030-0.0037	0.0033
Nickel (mg/L)	6	<0.0005	<0.0005	6	<0.0005	<0.0005
Tin (mg/L)	6	0.00032-0.00039	0.00036	6	0.00021-0.00036	0.00029
Arsenic (mg/L)	6	<0.00003-0.0083	0.0014	6	<0.00003	<0.00003

DISCUSSION

With the elapse of time, the cadmium and nickel levels in stagnant water in copper water pipes were lowered. Nickel level met the *Sanitary Standards for Drinking Water Quality*. The inner wall of copper and steel water pipes forms a film, which controls the release of the metal ions to drinking water. The copper and steel water pipes meet the requirements of drinking water standards of China.

CONCLUSION

Copper, steel, PPR, PVC, PAP and ABS water pipes meet the requirements of the *Sanitary Standards for Drinking Water Quality* issued by the Ministry of Health of China.

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