2 Content of Conference

Master of Ceremonies

Since it has come to the scheduled time, I would like to open the Asian-Pacific City Summit 3rd Working Level Conference. I am Nishiyama of the International Planning Section of Fukuoka City Hall, and have been given the task of coordinating the Asian-Pacific City Summit. I sincerely request your kind cooperation. Now, I would like to introduce the Secretary General of the Asian-Pacific City Summit, Hiroshi Murakami, who is the Executive Director of the International Affairs Department of the General Affairs and Planning Bureau of Fukuoka City.

Opening Remarks

Mr. Hiroshi Murakami
Executive Director
International Affairs Department of Fukuoka City

Mr. Hiroshi Murakami (FUKUOKA)

I am Hiroshi Murakami, Executive Director of the International Affairs Department of Fukuoka City. I would like to say a few words upon the opening of the Asian-Pacific City Summit 3rd Working Level Conference.

The Asian-Pacific City Summit is a biannual meeting of city leaders from the Asian-Pacific region held in order to form a cooperative network to address various urban issues resulting from population concentration. Since its first meeting in Fukuoka in 1994, the second conference was held in Guangzhou, China, the 3rd meeting was again here in Fukuoka, and the 4th City Summit is scheduled to be held in Pusan, Korea in May, 2000.

The Working Level Conference complements the Asian-Pacific City Summit attended by city mayors, and is held the year following the City Summit. The Working Level Conference is very significant on the basis that not only heads of cities, but also working level administrators who are actively involved with front line tasks, meet and exchange information and experiences in order to solve urban problems. The theme for the 1995 conference was "Traffic Issues," and in 1997, the conference focused on "Waste Treatment and Disposal." At the previous Working Level Conference on "Waste Treatment and Disposal," we had an opportunity to introduce our landfill management technology called "Fukuoka Method." This led to technical cooperation with participating cities and Tehran, Iran, thanks to the help of United Nations Centre for Human Settlements (Habitat). This is one of the results of the Working Level Conference.

At this conference, we are focused on the theme of the "Supply of Safe, Clean Water to the City," which is a critical issue facing all cities. The conference includes case study presentations from Singapore, Shanghai, Kitakyushu, and Ho Chi Minh City. We will also have a keynote speech by Professor Utsumi of Kyushu University Graduate School and UN report by the Human Settlement Officer of the United Nations Centre for Human Settlements, which is located in this building, as well as an activity report from the volunteer group "Hakata-Yumematsubara no kai."

Additionally, we have guests from the Japan International Cooperation Agency and the United Nations Department of Economic and Social Affairs to make today's conference even more successful. Over the next two days, we have arranged for fieldwork at the Water Quality Control Laboratory and a tour of waterworks related facilities in Fukuoka. I hope you will have a meaningful three-day visit, with active exchanges of opinions and information.

In closing, I hope that the 3rd Working Level Conference will be a fruitful meeting and that through it, the network among each participating city grows with stronger ties. Thank you for your attention.

Master of Ceremonies

Thank you very much. Before we all proceed with the conference, I would like to appoint the chairperson for this conference. We would like to elect Mr. Hiroto Oda to serve as chairperson. He is the Executive Director of the Water Supply Department of the Waterworks Bureau. Mr. Oda, please.

Chairperson

Good morning, ladies and gentlemen. I am Hiroto Oda, and am honored to serve as chairperson of today's conference. We are very pleased with the attendance of representatives who are involved with city water issues, and hope for active opinion exchanges, but in a relaxed manner. I ask for your cooperation.

Now I'll move on to the introduction of the participants. Due to the limited time, I'll ask that you just stand up when your name is called.

• • • Introduction of Participating Cities • • •

Keynote Speech

Prof. Hideo Utsumi
Graduate School of Pharmaceutical Sciences
Kyushu University

Chairperson (Mr. Hiroto Oda)

Now we'll proceed to the keynote speech by Professor Utsumi of the Graduate School of Kyushu University. He will speak about "Tap Water and Our Health." Please refer to your handouts for information about his career. Professor Utsumi, please.

Prof. Hideo Utsumi (KYUSHU UNIVERSITY)

Thank you for your kind introduction. I am Hideo Utsumi of the Graduate School of Pharmaceutical Sciences of Kyushu University. It is a great honor for me to speak to you on the occasion of the Asian-Pacific City Summit 3rd Working Level Conference.

Along with today's theme, "Supplying Safe, Clean Water to the City," I will speak about tap water and our health, and what we can do to secure safer tap water.

First, let me give you an outline of the requirements for tap water. Firstly, we must have quality and quantity; that is, it is necessary to secure an adequate quantity of water and make it safe for use. Recently, the smell and taste of water have also become important considerations. Various questions are raised about such matters these days. Residents are asking whether an adequate quantity and reliable quality of water are secured, or whether the water is safe enough to drink. Whether the taste is satisfactory or not is also an issue.

How should we seek answers to these questions? Today I would like to discuss not only raw water, but also how to develop new technology or how to establish a new methodology to improve tap water safety and to satisfy residents. Another point I want to address concerns information disclosure or education. Indeed, the tap water we produce every day with great care is very safe. However, due to inadequate information disclosure or education, citizens tend to have doubt about tap water.

Before discussing the main focus of today's topic, let me talk a little bit about the history of tap water in Japan. The first water quality test of tap water, or rather I should say drinking water, was conducted in 1874. There was a laboratory called National Institute of Health Science, presently the National Institute for Drug and Food, that conducted tests of medicine and food. At this institute, graduates from the pharmaceutical department analyzed the quality of city water supplied from the Tama River in Tokyo for the first time.

The first Japanese waterworks were constructed about 110 years ago, in 1887. Before that, most water was distributed through wooden pipes to residents. Or, as you may know, water was sold by venders shouldering wooden buckets just like gold fish venders. The first waterworks were built in Yokohama. After a long period of national seclusion, Japan was forced to open its doors to foreign countries and built ports in 6 cities. Due to significant population increases in those cities, their water quality deteriorated. In those days, 4% of the residents died of cholera in Yokohama City. People died one after another in a short a time. The people of Yokohama called the disease "corori" in Japanese, which roughly means, "drop dead." They were very afraid of waterborne infections. This is why the first waterworks were built in Yokohama 113 years ago. Later, other treatment plants were constructed in Hakodate, Moji and other port cities.

Then in 1908, a water quality standard was formed by the Society of Pharmaceutical Sciences of Japan, to which I belong. The standard already included ammonia issues, along with potassium permanganate and hardness, which are included in the current standard. An effort was made to ensure the sufficient safety of drinking water. The first guideline for tap water was drawn up by the City Water Testing Council in 1916.

Around this year, they also tried to set up guidelines for drinking water. So some people may cite an earlier year. In this way, we have endeavored to ensure safe water, because we are well aware of the great significance of tap water.

Next, let me tell you what we considered to be safe tap water back then. Traditionally, he common problem in the world for waterworks or to secure drinking water has been controlling waterborne infections. I mentioned cholera, but waterborne infections were considered a problem of drinking water or tap water even in those days. That means that pathogenic bacteria in water have a great impact on citizens. It was first shown in the United Kingdom or Germany that slow filtration could remove pathogenic bacteria from drinking water. Therefore slow filtration was predominantly used for disinfecting water. In Japan, chlorination was also introduced after World War II.

Then what attention was paid to toxic substances? In those days, raw water was considered to contain no toxic substances. Under the water quality standard, however, we discussed various elements, including hardness, to obtain safer and cleaner water. Yokohama City, where the first waterworks were constructed, tried to bring water through iron pipes from a far away river, named the Doshi River, at the foot of Mt. Fuji.

Now, let me touch on chlorination. I said that after World War II, Japan introduced chlorination. Unfortunately, chlorination tends to have a bad reputation in places. Residents think that chlorination generates various toxic substances, thus it is better for drinking water not to contain chlorine. I guess you've also heard such an opinion. I would like to tell you that chlorine is a very effective disinfectant. Consider the mechanism of the immune system in the body. Based on various knowledge, it is well known that white blood cells phagocytize pathogenic bacteria when they enter our body. But that is not enough to kill the bacteria. They are still alive in white blood cells. Enzyme-deficient patients, who hereditarily do not have certain enzymes, are not able to complete this process; thus infection continues to affect their bodies slowly but steadily. When white blood cells, particularly neutrophil in our body, phagocytize bacteria, O_2, a super oxide called active oxygen, is created. Another enzyme generates hydrogen peroxide or a hydroxyl radical. Hydrogen peroxide generates chloride with the effect of the other enzymes. Then chloride reacts with an amino acid in our body, creating chloramine. Chloramine completely inactivates bacteria. The lack of even one of these enzymes doesn't allow for complete disinfection, thus infection continues for a long time. We have learned this process recently.

Therefore, if some people say that chlorination or disinfection is unnecessary, they should be told to think about what happens in the body.

Well, then what happened after drawing up the guideline? In 1972, chloroform was detected in tap water in Rotterdam, the Netherlands. Around that year, a survey of carcinogenicity was conducted in the United States. The report said residents living along the lower reaches of the Mississippi, who drank chlorinated water, were twice as likely to develop cancer as residents who drank unchlorinated water from its upper reaches. Ever since then, the presence of toxic compounds in water has been a topic of debate. One of the toxic compounds is a carcinogen named chloroform or trihalomethane. It drew attention from 1972 to 1974. Later, it turned out that chloroform or trihalomethane was a by-product of disinfection. Besides this, various by-products were found. Thus, the concept of disinfectant by-products appeared.

Furthermore, trichloroethylene was first detected in well water in Silicon Valley. Later, tetrachloroethylene was also found in other places. Although they are not confirmed carcinogens, people suspected their carcinogenicity in those days. The fact that such substances were in tap water drawn from underground water led Japan to conduct surveys in many places. As a result, water in many cities was found to be highly contaminated. Actually contaminated well water was also found in Fukuoka. Most notorious is a case in Taishi-cho, Hyogo Prefecture. There, an electric appliances maker discharged trichloroethylene into a nearby river, resulting in highly contaminated well water along its downstream. I was involved in one of these surveys myself. In those days, trichloroethylene was called "trichlene," which sounds like a Japanese word meaning irremovable. Therefore, we joked that it must be difficult to remove. However, aeration easily removed it, and this was quite a topic of conversation among us.

In this way, Japan dealt with the problem through notifications from the director-general or director of the Ministry of Health and Welfare. In 1993, the potential existence of carcinogens, disinfectant by-products in water, combined with other problems, brought about a drastic change. Up to then, guidelines were made on the assumption that raw water did not contain toxic chemicals. Realizing that raw water was greatly contaminated, we needed to take some countermeasures. This recognition resulted in the formation of this guideline. The guideline lists 48 chemicals as items subject to the water quality standard or monitoring as of 1993. Along with this move, raw water conservation was aimed at as an environmental standard.

Moreover, contamination from agricultural chemicals came up. Thus, 6 chemicals, including nitrite nitrogen, which are underlined in your handouts, were added to the list. Now the water quality standard includes 54 items.

In Japan, like other countries, tap water is under severe criticism from residents. However, great endeavors made by people involved in this issue have significantly contributed to improved water safety.

The last 2 pages of the handouts are excerpts from 2 papers, both of which are from the most prestigious magazine in the world, Science. In 1987, a special issue of Science was published featuring risk assessment. Mr. Wilson and Mr. Crouch of the US Environment Protection Agency (EPA), as well as Mr. Bruce Ames, a scholar renowned in the world for his study of carcinogens, compare the carcinogenic hazard of tap water with those of other risks.

First, let me introduce Mr. Ames' study. In a 1987 issue of Science, Ames shows the possibilities of developing cancer in our lifetime. He calculated carcinogenic hazards, HERP, by multiplying each carcinogenic potency by the amount of such substances contained in the tap water and food we take in daily. At the top of the handout, you can see the carcinogenic hazard of tap water. Its relative carcinogenic hazard is 0.001. The figure for one of the most contaminated water wells in Silicon Valley is 0.004. When you inhale trihalomethane at a swimming pool, I mean a heated pool, where the warmed air contains a more significant amount of trihalomethane, the HERP is 0.008.

Now let me compare these figures with other figures. The fourth from the bottom is phenobarbital, which is a sleeping pill. The HERP of taking it once is 16. You also see figures for beer and wine. I like drinking, and probably you will enjoy drinking at the reception today. The HERPs for beer and wine are 2.8 and 4.7, respectively. That is 1000times more hazardous than drinking tap water. In other words, tap water is 1/1000 less hazardous than beer or wine.

In a similar way, in the United States, EPA researchers conducted an astonishing calculation of annual death probabilities. Around the middle of the material, you can see the risk for drinking water. The risks calculated by chloroform content and trichloroethylene are 6×10^{-7} and 2×10^{-9}, respectively. Compared with them, the risk of smoking is 10^{-3}, which is also about 1000 times riskier than, for instance, trihalomethane in drinking water. This means that smokers already run 1000 times as high a risk of dying of cancer as from drinking tap water. In other words, all of you present here have made a great effort to supply highly clean tap water. The safety of tap water is significantly high. This deserves to be recognized through information disclosure. It is necessary to inform residents that you are supplying this high quality water.

On the other hand, in terms of tap water safety, some problems occurred in Japan later. One is related to waterborne infections. Now, it is fairly well known that tap water contains lots of viruses. Especially, many of these viruses adhere to suspensions in the water. In Fukuoka, there have been cases of hepatitis A infections. Although it did not make a big sensation because it was not fatal, cases of infections causing slight gastroenteritis have been reported. Furthermore, in 1996, 8,800 residents in Ogose, Saitama Prefecture, whose population was approximately 20,000, were infected with cryptosporidium and suffered from gastroenteritis. This case drew much attention in Japan. People wondered what caused this mass digestive problem and talked a lot about it. Examination revealed that the cause was cryptosporidium. Further investigation showed that it caused quite a few cases of digestive trouble. This is also a problem not only in the Unites States but in Europe, too. I will talk about this later, but the problem is that cryptosporidium forms spores called oocyst. Many disinfectants, including chlorine, do not work on the spores or are not so effective. It turned out that even after chlorination, cryptosporidium survives and remains infectious.

Also last year or the year before that, it was discovered that water contains Endocrine Disrupting Chemicals (EDCs). This became a serious problem in Japan. Having allocated $5 billion for research last year or this year, the government is actively promoting it. This year, EDCs are a pressing problem in South Korea. I was invited there by the FDA of South Korea and talked about this same topic in June. Probably in the near future, EDCs will become a big issue even in Asian countries currently unaware of the problem.

EDCs brought about a very similar situation in the waterworks world when carcinogens were found. Chemical carcinogens came into light 25 or 26 years ago; and the first paper about them was published in 1972. Several years later, the United States actually amended its Safe Drinking Water Act. This led to very energetic research. The result was that there was no safe threshold for chemical carcinogenicity. In response to this, the academic world merged to seek a VSD by using a new formula. Consequently, a very strict standard concerning carcinogens was set.

Approximately 20 years later, the problem of EDCs led the United States to amend the Safe Drinking Water Act. This issue is also seriously discussed in Japan. But these substances have some problems. Let's take a look at them.

For those of you who may not know much about them, I'll define EDCs first. According to WHO and OECD workshops, EDCs are external substances that have a bad effect on a living body. They affect the reproductive functions of living things or can affect their fetuses, changing their endocrine systems. Specifically, they cause changes in sexuality and reproductive malfunctions. What is of the greatest concern is that they are a potential threat to the continuation of species, including human beings. The most serious problem in the field of waterworks is that raw water contains, or is likely to contain, many EDCs. In 1998, the Ministry of Construction measured 9 types of EDCs in river water. The data itself has some problems, but I won't go into that here. The ministry collected water at 256 places and checked it to see if it contained EDCs. In Kyushu, they checked water at several places along the Chikugo River. The results showed that a female hormone itself was found in more than half of the places tested. Phthalic acid esters, bis-phenol-A contained in plastics, and nonylphenols, which is a metabolite of a surface-active agent, were found in about 34%, 23.8% and 12.5%, respectively, in the river water around us. These chemicals seep into raw water.

Though I'm not going to show you the data today, most raw water contains EDCs when measured by a certain method. In some places in Japan, treated wastewater is returned to rivers to be used again as raw water. A typical example is Osaka, where EDCs were found in treated wastewater. Moreover, our data shows that EDCs were found in treated water processed at on-site sewage water treatment facilities such as a septic tank for combined treatment, which is a private treatment system. This indicates the existence of substances suspected of having an endocrine disrupting effect in raw water.

Now we are facing new health-related problems with tap water represented by waterborne infections and toxic chemicals. Spore forming microorganisms and viruses adhering to colloidal organisms in water cannot be easily sterilized by conventional methods. We also have problems with by-products, non-intentional products including dioxin, and substances such as nonylphenols that are generated through the biosynthesis of rivers and lakes. On top of that, we have EDCs. Now we know that all of these substances seep into raw water. What measures will we be forced to take in the future?

I said that tap water is very safe as far as it is measured based on the water quality standard. I also told you to assert with confidence the quality of water if smokers raise a question about it. Yet raw water still contains unknown substances. Actually we do not know how many chemicals are contained in water. We have made an analysis of only 10-20% of the organisms in water. Therefore, a new methodology is required.

We know that chlorination cannot completely remove viruses and cryptosporidium. Thus, in Japan we are now actively trying to develop and introduce a new method or process. It is an advanced oxidation processing system called AOP. This process is an attempt to sterilize substances which could not be fully disinfected by conventional methods, by using UV, ozone or other advanced oxidation processing systems.

I will detail toxic chemicals later, but it is estimated that there are 60,000 chemicals around us. Besides those, we have various by-products. In spite of such an enormous number, only 54 of them have water quality standards. The rest are neglected; their toxicity unknown. To secure the safety of raw water as well as tap water, new technology for the rest of the chemicals should be introduced.

Let me briefly introduce the method we are working on as a possible new methodology.

First I would like to tell you how many chemicals exist in the world. As those who studied chemistry in science, engineering or pharmaceutical departments well know, the most important and most-used database in chemistry is the Chemical Abstract. This abstract lists all of the chemicals that have been created or cited in papers all over the world. Once a chemical is created, it is listed in this database. In figuring the number of chemicals existing in the world, it is quite objective and reliable data.

In 1990, the 10-millionth chemical was registered in the Chemical Abstract. As of 1998 or early 1999, it lists 18 million chemicals, which means that 8 million chemicals were generated in the past 9 years. At this stage, the number is probably close to around 20 million. This many chemicals have come into being in this world; and the number has dramatically grown since World War II. Most of them are stocked at laboratories, including the Department of Pharmaceutical Sciences to which I belong. Actually, the 10-millionth chemical was created by a professor in my department. For this, he wasbestowed a highly honorable award from the organization responsible for the Chemical Abstract.

Japan has a law concerning the creation and use of chemical substances, with which we can estimate the number of chemicals manufactured and used on a daily basis. According to the aforementioned law, at least 60,000 chemicals are created and used every day, although some people estimate that number to be 100,000. The United States is trying to draw up a new methodology and measures to deal with EDCs. The EPA estimated that there are 87,000 chemicals. Roughly, there are 60,000 to 100,000 chemicals in this world, and about 10,000 to 20,000 of them accumulate on earth.

The theme of the last conference was "Waste Treatment and Disposal." Now much attention is being paid to the significant amount of chemicals accumulated at industrial waste disposal sites. Eventually these chemicals come into contact with raw water. Here again, the world problem for waterworks facilities is quantity and quality, as I mentioned when I first began speaking. Fukuoka City, particularly, has a limited amount of water. As you see when you look out of the window of your hotel, there are mountains very nearby. That means a river's watercourse is very short and, consequently, the water quantity is very small. The water you drank this morning came from the river over the mountain, from which we draw our water. That, alone, cannot meet our demands. Therefore, we are exploring various water resources. We are discussing using water treated at sewage plants as one option. This water is not utilized as tap water, but is used as flush water. Also desalination of seawater is actually in operation. The plant may be included in your study tour. A budget has been allocated to construct a desalination facility in the Genkai Sea. You can see the site from the air.

Considering these situations, it is clear that the quality of raw water has become an important issue. Moreover, the quality of river and lake water is rapidly deteriorating. How to control the quality and quantity of raw water, and how to maintain a high quality are crucial issues. How to monitor the quality is also a point to consider.

Let's look at this from a different angle. One of the leading figures in the field of tap water in Japan is Mr. Magara, who worked at the Institute of Public Health and is currently teaching at Hokkaido University. He has written a book about what methodology would be developed for health-related risks from tap water. As for waterborne infections, it is impossible to check all bacteria and viruses now, as well as in the future. The only way is to use alternative indexes, such as E. coli, the general bacteria number or residual chlorine. The same concept can be applied to chemicals. Though the number increased from 48 to 54, only 54 chemicals have standards. There is no reliable standard for the rest of 60,000 to 100,000 chemicals. Given this situation, you can expect fewer measures for non-intentional products and variations created in our environment. No measures are taken against them. Among these unregulated chemicals, disinfectant by-products are controlled in Japan through the concept of Trihalomethane Forming Potential and TOX (Total Organic Halogene). However, other concepts have to be introduced in the future. One of them is bioassay.

What is bioassay? Due to limited time, I will not explain it in detail. In a conventional chemical analysis, a chemical reagent is used to start a chemical reaction, which is utilized to measure the mass of a substance. In this way, we measure the amount of toxic substances in tap water or raw water and control them. We are trying to form a new concept using bioassay instead of a chemical analysis. Bioassay uses living materials for measuring the amount of toxic substances based on their reaction. Through this, we are striving to reduce the amount of and lessen the risk impact of chemicals in raw water and tap water.

Based on this idea, we have been working on projects with an annual budget of ¥100 million from 1997 until now. This project is supported by the Fundamental Research Fund for the Environmental Future of the Environmental Agency. We are studying various bioassays to find out which are effective and to clarify which combination of methods is usable for the evaluation of raw water or the environment. We are trying to make a new methodology by horizontally lining up 255 chemicals, including 28 EDCs, to make a comprehensive comparison of bioassays.

For example, we are now trying to develop a methodology to study the effect of chemicals, such as dioxin, which cause liver cancer or liver disorders. An assay of a certain metabolic enzyme of a toxic substance, investigation of its effect on liver cell phagocytosis, inherited toxicity or other influences is carried out for it. As for EDCs, we are also trying to create new testing methods. As a result, we found that phthalic acid esters in a dioxin detection system respond at a low concentration level and are easy to understand. In terms of immune toxicity, it has significant toxicity. Also, looking at liver disorders or the impact on Daphnia, we can begin to understand which combination would bring us more accurate evaluations of chemicals.

In other words, we can say that testing raw water with bioassay using toxicity or the hazardous impact as a new index mean is the integration of a new concept.

I'll now show you how to introduce this in the management of the environment and raw water. First, we test to find out the toxicity in raw water using this evaluation method. If the toxicity is low, it can be used as tap water after conventional treatment. On the contrary, if it is hazardous, we must decide on a target chemical, or introduce a treatment method to reduce the toxicity. We see if it is volatile or ionic according to the treatment process, then analyze it again with bioassay. If it is volatile, aeration can easily diminish toxicity. Then you must verify the results at a pilot plant before integrating the new method into the water treatment process. Thus, we establish a methodology to secure safer water. If we can set up such a system, it would be quite beneficial.

As you see, we are developing a new concept. Unfortunately, we do not have any English version, but you can see the details on our homepage. If you are interested, please access our web site.

In closing, let me show you one other slide. Those who are involved in research will stay overnight in Fukuoka to have a study meeting. This is the scene of our discussion. We have committed ourselves to secure safe tap water, and our efforts have resulted in great improvements. We should inform people of this fact. On the other hand, we recognize that tap water contains dubious substances and a new methodology is necessary to reduce them. Efforts in this area should also be made known to the public. To secure safe tap water, we need more information. Tap water is indispensable, not only to the healthy, but to the sick, elderly and other people. I hope all of us present here will join forces and be able to supply safer and more satisfying tap water. Thank you for your kind attention.

(Applause)

Presentation

Mr. Wong Kee Wei
Superintending Engineer
Public Utilities Board, Singapore

Chairperson (Mr. Hiroto Oda)

We would like to move on to the next case study presentation. The first presentation is from Singapore. Mr. Wong Kee Wei of Singapore, please.