Quality Approval System for Wood Products in Korea

S.M. Kang[1], D.Y. Kang[2], W.M. Koo[3], K.M. Kim[4] & J.Y. Park[5]

Abstract

Korean government has started quality approval (QA) system for wood products including preservative treated wood, wood charcoal, and pyroligneous acid in July 1, 2004. The QA system has been now expanding product items to drying lumber, wood pellets and wood composite materials. The QA system is based on the two forest laws such as the Act on the Promotion and Management of Forest Resources and the Act on Promotion of Forestry and Mountain Villages. Labelling of quality is mandatory and is subject to the Act on the Promotion and Management of Forest Resources and The Act on Promotion of Forestry. The law has applied to both domestic and imported wood products including preservative treated wood, plywood and structural lumber. The QA system becomes effective under Article 12 of Act on Promotion of Forestry and Mountain Villages. The QA system, however, has led voluntary participation of companies. The national research institute, Korea Forest Research Institute (KFRI) takes charge of the QA system. We have also conducted investigations and researches for development of the QA system. The main projects include grading of kiln dried wood, treatability of wood species, fixation mechanism of preservative treated wood, leaching of biocides from treated wood on environments, and development analytical methods for wood products. Over all objectives of the QA system are to improve quality of wood products, to enhance distribution system of wood products and to protect customers.

1. Korean Forest Resources

The Korean peninsula is located at the North Western Pacific region. Forest areas cover 65% of the land, estimated 6.39 million ha. The Korean forests are grouped into warm temperate, cool-temperate, and boreal forests. Cool temperate forests consist about 85% of them.

While coniferous forests are composed of 42.3% (2.70 million ha) of the total forest, broadleaved forest and mixed forest make up 25.9% (1.66 million ha) and 29.3% (1.87 million ha), respectively (Forest statistics, 2005). The remaining 2.5% (0.16 million ha) is classified as others such as forest-steppe.

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The total standing wood reserves amount up to 506 million m^3 and the volume per ha is estimated at $79.2m^3$. However, nearly 60% of forest presents forest younger than 40 years. Since most of the forest resources in Korea are still immature to use timber source, Korea has been largely dependent on imported timber, supplying about 94% of the domestic timber consumption.

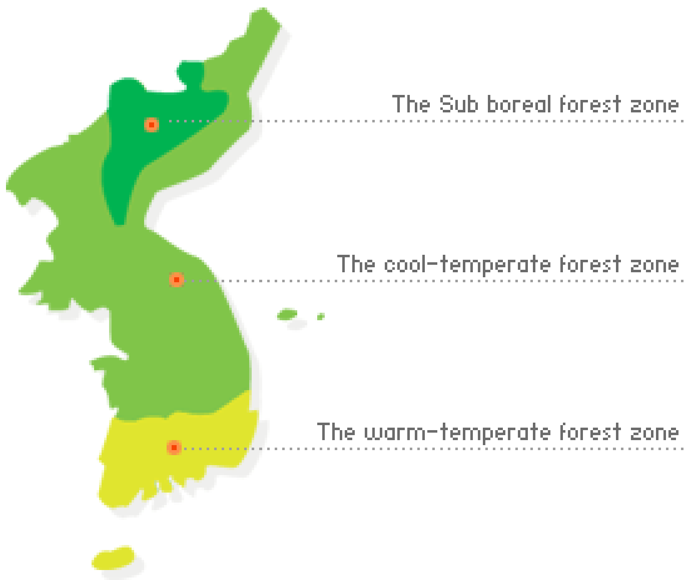

Figure 1. Korean forests classified with temperature zone

2. Korean timber Industry

Domestic timber industry used only 6 % domestic species for the total demands of timber in 2006. Considering economic development and population growth, however, domestic timber demand will continue to increase for the long-term supply and demand.

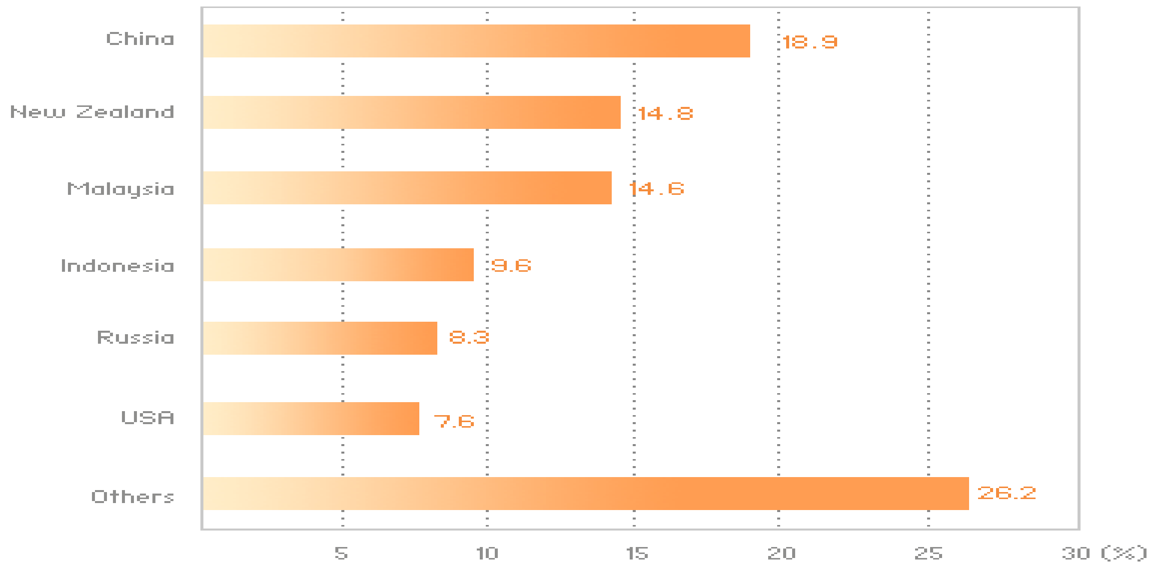

Figure 2. Major timber exporters to Korea (2006)

Major imported goods include timber and commodity timber products such as logs, sawn wood, plywood and particle boards. These items consisted about 80% of the total imports in 2006. After imported logs reached the peak of 8.0 million m^3 in 1991, the amount of logs gradually declined to 4.4 million m^3 in 1998. Recently, it has recovered slowly up to 6.4 million m^3 in 2006. Import of sawn timber started in the early 1980s and increased steadily. Although the amount of importing lumber hit a peak of 1.3 million m^3 in 1993, it went down to 804,000 m^3 in 2006.

During the 1970s, the major exporters included Indonesia, New Zealand, China, the USA and Malaysia. When the new regulations for tropical timber logging were adopted in the mid-1980s, tropical log exporters activated policies to protect their industry and the sawn timber industry developed in the logging countries. Therefore, import sources have been diversified to other countries including Canada, Eastern Europe and Africa. The total value of imports was estimated to US$ 2,881 million in 2006.

The Korean sawn timber industry and plywood industry were developed for export markets since 1977. However, since the major timber supplying countries have restricted log exports to promote their own timber industry, Korean timber industry went through great depression in early 1990s. The number of plywood companies drastically decreased from 72 in 1990 to 5 in 2000. Sawmill also experienced the same situation, resulting in increasing numbers of shutdown (1,000 sawmills in 2000 vs. 1,500 in the mid-1990s).

Recently, Korean timber industries have recovered with new growing power contributing low carbon and green growth society. Compared to 2004, most wood industries expanded their markets (Figure 3). Koreans have demanded more lumber and wood products for indoor and outdoor usages because of need for better life and environmentally friendly materials. In order to tackle climate change, we are expecting growing markets for wooden house, landscape structure and retaining walls reducing carbon dioxide and further storing carbon dioxide. Wood pellets industry has been focused to solve energy crisis and climate change.

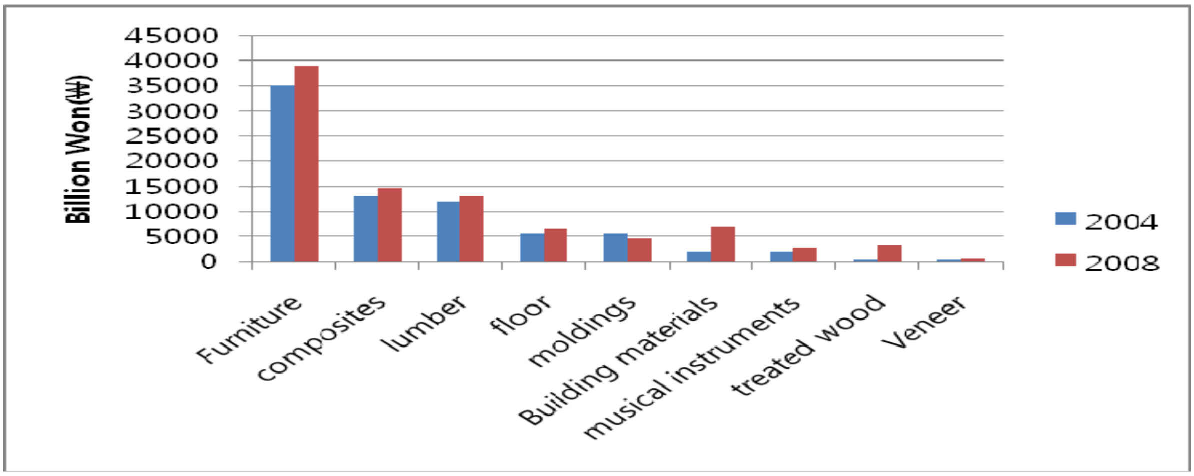

Figure 3. Timber industries in Korea

3. The Quality Control System for Wood Products in Korea

The Korean Government, especially Forest Service, has made efforts to develop timber industry. The concrete objectives are enhancing competitiveness, improving product quality, supporting automation facilities and securing a stable supply of raw materials.

One of the policies was launching the QA system to improve quality of wood products, to enhance distribution system of wood products and to protect customers.

The QA system is based on the two forest laws such as the Act on the Promotion and Management of Forest Resources and the Act on Promotion of Forestry and Mountain Villages. Labelling of quality is mandatory and is subject to the Act on the Promotion and Management of Forest Resources and The Act on Promotion of Forestry. The law has applied to both domestic and imported wood products including preservative treated wood, plywood and structural lumber. The QA system becomes effective under Article 12 of Act on Promotion of Forestry and Mountain Villages. The QA system, however, has led voluntary participation of companies.

Korean government has started QA system for wood products including preservative treated wood, wood charcoal, and pyroligneous acid in July 1, 2004. The QA system has been now expanding product items to drying lumber, wood pellets and wood composite materials.

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4. Main projects for QA system

Korea Forest Research Institute (KFRI) has developed high utilization techniques for forest products. We have also improved forest industries which are new growing power in Korea to contribute low carbon and green growth society. The utilization techniques have facilitated to add values for wood products.

We conducted investigations and researches for development of the QA system. The main projects include kiln dried wood, treatability of wood species, fixation mechanism of preservative treated wood, leaching of biocides from treated wood on environments, and development analytical methods for wood products.

4.1. Kiln dried wood

We analyzed wood characteristic variations and investigated major domestic timbers to identify wood species with explication of variation of microscopic structures of wood. Major dried species in Korea included tropical wood, radiate pine, hem-lock, and larch. They were used for indoor products (31%), building materials (31%) and civil constructions and landscape structures (19%). The remaining 19% was classified into musical instruments, furniture, and wood carvings. While most drying systems applied hot air circulation, some adapted vacuum drying.

4.2. Treatability of wood species

We estimated anatomical characteristics, air permeabilities, and treatabilities for wood species used in Korea to establish regulations for incising requisitions of treated wood. Liquid movements were analyzed in wood with designed permeability measuring equipments (Figure 4). Permeability and treatability were varied with species, and even the same species showed different properties depending on growing regions. Generally, there was less relationship between permeability and treatability. Wood with poor treatability exhibited large biocide gradient in wood and vice versa in wood with good treatability.

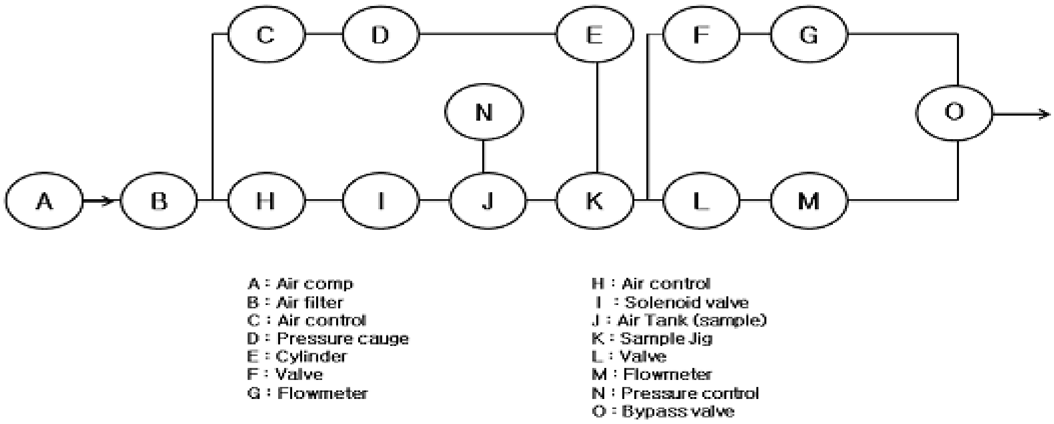

Figure 4. Schematics of equipment for measuring gas permeability in wood

4.3. Fixation mechanism of preservative treated wood

After the Korea Ministry of Environment banned CCA on October 8, 2007, domestic preservative treating industry has mainly used copper amine preservatives including Ammonical Copper Quartz (ACQ), Copper Azole (CUAZ) and Copper Boron bis-(N-cyclohexyl-diazeniumdioxy)-copper (CB-HDO). The biocides, however, require fixation periods after preservative treatment to ensure that their components are water insoluble, leaching into environment very slowly. The rates of copper fixation in copper amine preservative treated wood were investigated with different fixation conditions (20 ℃ with drying and 50 ℃ without drying) and post-steaming. We also measured the degree of leaching for other biocide components (azoles, quartz, and cu-HDO). Treatments conditioned at 20 ℃ with drying required 50 days or more to fix biocide components in wood. While copper was stabilized in a single day at 50 ℃ without drying (Figure 5), the steam treatment finished fixation process less than 30 min (Figure 6). The steaming treatment did not increase amount of cuprous oxide, reduction product of cupric oxide. Little amount of other biocide components were quantified in samples held in the condition at 20 ℃ with drying except benzyl-dimethyl-dodecyl-ammoniumchloride (DBAC).

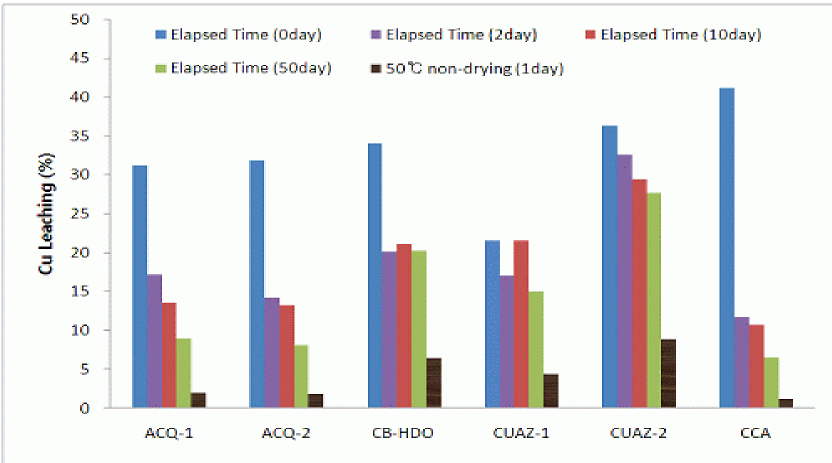

Figure 5. Cu leaching (%) from different preservatives treated radiate pine sapwood at 20 ℃ with drying, compared to 50 ℃ without drying conditions.

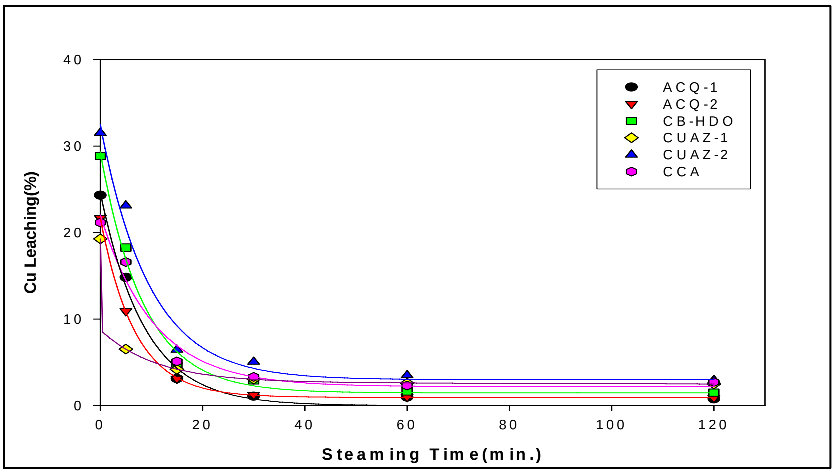

Figure 6. Effect of post steaming treatment on copper fixation in different copper amine preservatives treated radiate pine sapwood.

4.4. Leaching of biocides from treated wood on environments

Chromated copper arsenate (CCA) had been the most widely used wood preservative in Korea. In spite of the ban on CCA in 2007, about 1 million m^3 of CCA treated wood has been still in service in Korea. The toxicity of chromium and arsenic in this preservative has raised environmental concerns for the metal leaching from CCA-treated wood. The total concentrations and their speciations of copper, chromium and arsenic in soil surrounding CCA-treated wood was investigated at several test sites in Seoul, Korea to determine the horizontal and vertical distributions and accumulation of the metals. The physicochemical

properties of the tested soils were investigated to understand the effect of soil properties on the CCA mobility.
The result indicated that the mobility of metal components was very limited to the surface area adjacent to CCA-treated wood (Figure 7). Arsenate and trivalent chromium existed mainly in the environment and the treated wood. Although soil contamination due to the presence of CCA-treated wood might be minimal, the metal components would be persistent and accumulated in the soil, resulting in high chemical concentration in service area of treated wood.

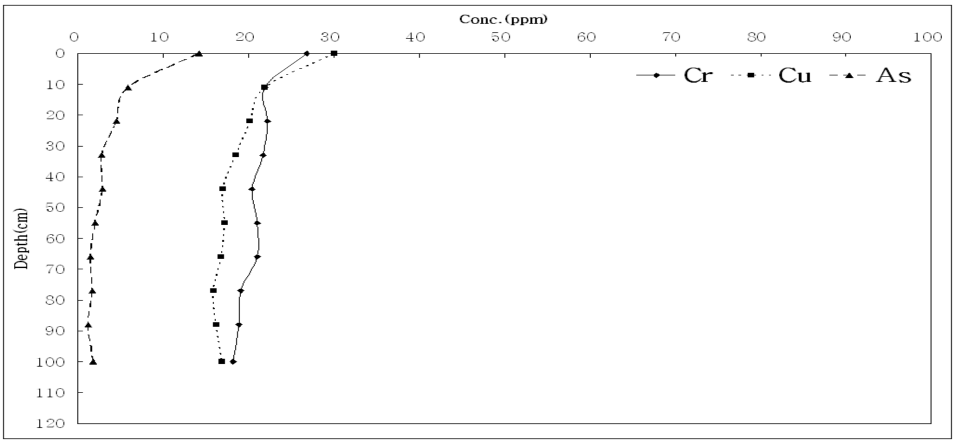

Figure 7. Copper, chromium and arsenic levels in soils at selected depths from the CCA treated wood in Hongreung arboretum.

4.5. Development of analytical methods

ACQ might be expected over 80% of market share in Korea. ACQ contains two active ingredients, copper and quartz (quaternary ammonium compounds) with varying their composition ratios depending on types (AWPA, 2005). Many types of quartz have been widely used as disinfectants, biocides and detergents to control microbial growths in variety of applications (Laopaiboon et al, 2002). Among many quaternary ammonium compounds, wood preservatives employed Didecyldimethylammoniumchloride (DDAC) and Benzyl-dimethyl-dodecyl-ammoniumchloride (DBAC) for their formulations.

The strongly increasing domestic applications for wood preservatives require developing their accurate and reproducible analytical methods. Although a long historical titration method has been successfully applied to quantify quaternary ammonium compounds (QACs), the method cannot tell DBAC from DDAC in the analytes. We developed the HPLC method to detect DDAC using ion pairing reagents (Kang *et al.*, 2007). One possible limitation is that the sensitivity for DDAC is pretty low. Since DDAC has no chromophore, UV detector cannot readily measure the chemical. Mass Spectrometer (MS) detection provides several advantages over the previously described method for DDAC analysis such as improved sensitivity and specificity (Ford *et al.,* 2002).

MS was able to analyze selected molecules exclusively using for selected ion monitoring (SIM), resulting in more sensitive and specific analysis values

(Figure. 8). Although UV method analyzed DDAC using ion pairing reagents to confer a chromophore character, the rate of ion paring for producing derivatives can be varied, which could lead lower analysis values (Figure 9). The results by titration suffered from their high variabilities because the method was subjective depending on analyst skills. Tested DDAC was composed of 95% C_{10} and other homologues. Both HPLC methods only measured C_{10}, resulting in lower values than titration.

HPLC-UV and MS provided similar results for treating wood samples. HPLC-UV has, however, a potential problem such as the interference by wood extractives or other components on the same retention time for the target analyte. MS method can successfully eliminate this problem with the specificity.

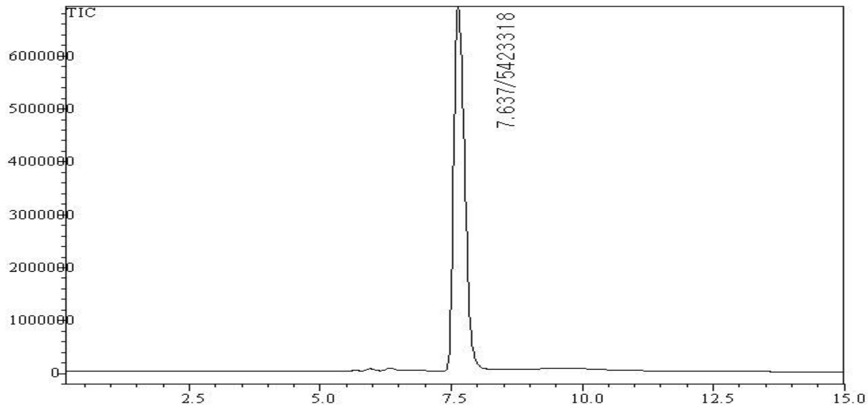

Figure 8. HPLC-MS chromatograms of the DDAC

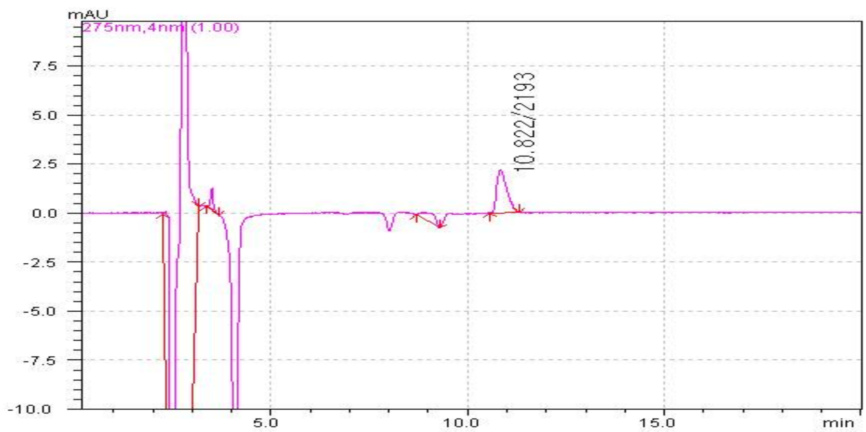

Figure 9. HPLC-UV chromatograms of the DDAC

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