

# INTRODUCTION TO FIRE SCIENCE RESEARCH IN KOREA

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Abstract

Overall view of fire science research in Korea is introduced by observing research papers published in the Journal of Korean Institute of Fire Science and Engineering, together with research interests and researches undergoing at universities and research institutes. The role of Korean Institute of Fire Science and Engineering in promoting fire researches in Korea is described. In addition, research projects conducted Korean Institute of Fire Science and Engineering in cooperation with universities and research institutes are introduced.

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## 1. INTRODUCTION

Researches on fire science and technology in Korea that were conducted at various engineering departments of universities and research institutes had been published in various journals of their own professional institutes. It was only after the Korean Institute of Fire Science and Engineering (KIFSE) began to publish its official journal in 1987 that researchers found a common space to publish their research results on fire science and related technologies in Korea. Thus, in order to observe research trends in fire science in Korea, it would be helpful to

survey papers published in the journal of Korean Institute of Fire Science and Engineering, even though it is quite true that all the researches done are not published in the journal alone. In recent years, as with the ever increasing frequency and the size of fire disasters, concern and demand on fire safety are increased, and several universities have opened courses of fire science and fire safety. Consequently, research activities on fire science and fire safety at universities have been greatly enhanced. In this paper, researches on fire science in Korea are surveyed though the papers published in the journal of KIFSE and recent research activities and interests at universities and institutes are introduced.

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## 2. RESEARCHES PUBLISHED IN "JOURNAL OF KOREAN INSTITUTE OF FIRE SCIENCE AND ENGINEERING"

Since its first publication of the journal of KIFSE in 1987 to 1997, the journal has published the total of 84 research papers in various aspects of fire science and technologies carried out in Korea. Research papers published in the journal are classified according to disciplines in Table 1. Many disciplines such as architectural-, electrical-, mechanical-, chemical-, and material engineering, and fire safety administrations and laws are involved as anticipated in considering the complexity of fire phenomena. Architectural engineering field has contributed nearly half of the papers, 39 out of 84 papers. Other engineering fields have contributed the rest, more or less equally. Table 2 shows the

classification papers according to research areas. Papers concerned on the fire safety and fire escapes of high rise buildings are dominant, followed by fire science, fire detectors and fire resistant material.

### 2.1 FIRE SCIENCE

Basic researches in fire science such as physical and chemical phenomena of fire, combustion characteristics, and numerical simulations of fire phenomena in various situations are included in this research area. Numerical studies and analyses of heat and fluid movements in a fired room, laminar diffusion flame with radiation along vertical wall, and combined natural convection-radiation in a partially open square compartment were presented. Simulations of heat and smoke movements in the space based on Field and Zone models, analysis of fires of high rise apartment buildings by Zone model

Table 1. Research Papers in KIFSE Journal(1987-1997).

	87	88	89	90	91	92	93	94	95	96	97	Total
Architectural	2	6	7	3	4	2	1	2	1	5	6	39
Electrical		1					1		1	3	2	8
Mechanical		1				1	1	1	3	2	2	11
Chemical					3	1	2	1		3	1	11
Material					2				1	4		7
Laws			1	1	1	3			1	1		8
Total	2	8	8	4	10	7	5	4	7	18	11	84

Table 2. Research Papers in KIFSE Journal(1987-1997).

	87	88	89	90	91	92	93	94	95	96	97	Total
FS					2	1	2	2	1	5	5	20
IU			1		2	1			1	2	1	5
SE	2	6	5	3	3	2	1	2		3	3	28
MA					2					2	10	
DC		2	1				2		4	5	2	13
LA			1	1	1	3			1	1		8
Total	2	8	8	4	10	7	5	4	7	18	11	84

FS : Fire Science, IU : Industrial and Urban Fire Protection, SE : Structures and Escapes  
MA : Fire Resistant Materials, DC : Detectors, Control and Suppression of Fires, LA : Laws and Administrations

were reported. Experimental determinations of flame extinguishing concentrations of clean fire extinguishing agents and flash points of fuels, minimum ignition energy for electrostatic discharge of gasoline-air mixtures, and combustion rates of alcohol were presented.

## 2.2 INDUSTRIAL AND URBAN FIRE PROTECTION

This area covers studies on the fire safety of industrial facilities and evaluation and prevention of urban fire disasters. As for the fire safety of industrial facilities, papers on fire protection planning of nuclear power plants and on expert systems for the practical use of freight and storage containers were presented. For the prevention of urban disasters, studies on the fire protection facilities of high rise buildings and on the measures on fires due to earthquakes were reported. Land utilization and urban fire disasters were studied based on the risk analysis and evaluation.

## 2.3 ANALYSIS OF FIRES IN STRUCTURES AND PLANNING OF ESCAPES

Temperatures distribution, thermal contraction and expansion of thermally protected steel columns, and temperature distribution in the concrete members of reinforced concrete buildings, and fire resisting properties of steel fiber reinforced concrete structure were studied. Studies on the smoke venting plans and smoke proof measures of high rise buildings are presented. Design and evaluation methods of the fire safety of high rise buildings and atrium spaces, and evacuation system of high rise buildings and fire escape facilities of underground spaces were studied.

## 2.4 FIRE RESISTANT MATERIALS

Physical and chemical characteristics of interior and exterior materials of construction of the building, such as flame retardation and fire resistance, were studied. Papers on changes in physical properties of inorganic insulation materials, safety evaluation of fire helmets, and selection of interior materials and its effects on fire safety were included.

## 2.5 DETECTION, CONTROL AND SUPPRESSION OF FIRES

Performance characteristics of thermal detectors, design methods of fire detectors using Fuzzy measure and its characteristic performances, response characteristics of sprinklers and performances of water mists were studied. Papers on performances of automatic fire extinguishing systems, water curtains, and fire-extinguishing agents were presented.

## 2.6 LAWS AND ADMINISTRATIONS

Studies for the improvements in fire protection laws and administrations are included in this area. Studies on the introduction of the expert system to the analysis of the fire protection laws, on the improvements in the fire protection facility standards, and fire administrations were presented. Improvements of self regulated fire safety policies and promotions for fire assessment systems were studied.

## 3. RESEARCH ACTIVITIES IN FIRE SCIENCE

### 3.1 UNIVERSITIES

Researches at universities have been conducted mostly in the engineering departments such as architectural-, mechanical-,

electrical-, and chemical engineering, and material science. In recent years fire safety related departments and research centers have been established and researches in fire

science and technologies at these departments have been much promoted. Some research activities at universities are introduced in Table 3.

Table 3. Research Activities at Universities.

University and Department	Research Activities
Seoul National Polytechnic University Department of Safety Engineering	Development of Software for Fire Hazard Assessment in the buildings, Development of Model for Fire Hazard Assessments in the buildings, A study on Fire Spread between Office Room and Atrium in the atrium buildings, A Development of Assessment Model for Maintenance and Management in the Sprinkler system, A Development of Assessment Model for Maintenance of Type R Fire alarm System in the Building, A Study on the Non-Flammability and Extinguishing Time by using NAF S-III of Cast Mold Transformer, Development of S/W on Fire Protection & Maintenance for Public Structure(Fisma 1.0)
Chungbuk National University Department of Safety Engineering	
Dongguk University(Kyungju) Department of Industrial Safety	
Hoseo University Department of Industrial Safety	Particle size effect on combustion behavior of cellulose insulation, Combustion characteristics of vehicle upholstery, Study on the pressure during the rupture by gas explosion, Study on the forest fire spreading algorithm with calculated wind distribution, Thermal and Smoke measurements of vehicle fires, Analysis of fire evacuation behavior in primary school environment, Development of foaming agents using SLES & DH-109EX, development of a UV flame detector for the automatic fire suppression system for engine compartment fires, Development of the FM-200 gas-filled AFFF fire extinguisher for automatic fire suppression system in the engine compartment of automobiles
University of Inhcon Department of Industrial Safety	Combustion rates of methyl- and ethyl-alcohol, Combustion Characteristics of alcohol soaked in sands, Combustion characteristics of organic solvents soaked in polymer materials, Measurement of mixture gases of three components
Inje University Department of Health and Safety Engineering	Consequence Analysis for Southern Seoul Oil Storage Facilities, Fire Hazard Analysis for Samsung Electronics Plants, Development of Computerized Fire Protection Management Program, Design Review of Incheon International Airport, Emergency Planning Guideline for Incheon International Airport, Wild land Fire Study, Conditions for crown fire, Heat release rate from fuel bed, Estimation of fire propagation

Table 3. Continuance.

University and Department	Research Activities
Chung Ang University Department of Mechanical Engineering	Smoke Movement by a Fire in an Enclosure, Analysis of a Fire in an Apartment Building Using a Zone Model, Upward Flame spread on practical wall materials, Analysis of fire characteristics in apartment building through full scale experiment and zone model simulation
City Univeristy of Seoul	
Urban Disasters Research Center	

### 3.2 RESEARCH INSTITUTES

Research activities on fire science and technology at a few representative research institutes are shown in Table 4. Korea Institute of Science and Technology(KIST) has been involved in the development of Halon alternatives fire extinguishers since 1990 in a series of projects associated with the process development of ozone saving chemicals. They have been testing various chemicals for their adaptability for Halon alternatives and conducting experimental synthesis of new fire extinguishers. Korea Institute of Machinery and Materials has been active recently in researches in smoke spread in the corridor and in pool fires and also in the performance studies of water mist and water sprays in extinguishing fires. Fire Insurers Laboratory of Korea(FILK) is very well

equipped with various facilities for fire researches with many experienced researchers and technicians. Although its main work is to provide test service for product development and performance evaluation in compliance with various standards, and to provide certification service for superior products related to safety including fire protection system, FILK has also been conducting researches to improve building materials and fire protection systems. Recently FILK has started to pay a greater attention in fire researches.

### 3.3 KOREAN INSTITUTE OF FIRE SCIENCE AND ENGINEERING

Korean Institute of Fire Science and Engineering(KIFSE) has been conducting research projects in association with universities and research institutes. Table 5

Table 4. Research Activities at Research Institutes.

Institute	Research Activities
Korea Institute of Science and Technology	Synthesis and Process development of Halon replacements, CF <sub>3</sub> Br, HFC-227ea
Korea Institute of Machinery and Materials	Interaction between Pool Fires and Water Sprays, Corridor Smoke Spread, Sprinklers, Water Mists
Fire Insurers Laboratory of Korea	Test and Research on Fire Extinguishers, Fire retardant, Alarm Systems, Detectors, Sprinklers, Fire Resistant Materials, Interior Materials
Korea Fire Equipment Inspection Corporation	Testing and Research on Fire Extinguishers, Fire Retardant, Fire Hoses and Fittings, Detectors, Guide Lamps

Table 5. Researches conducted by Korean Institute of Fire Science and Engineering.

Projects	Periods
Performance of water curtain system of Lotte World Building	Jun, 1998–Sept. 1988
Measures for the fire protection of the petrochemical complex	Nov. 1990–Jan. 1991
Measures for the fire protection of POSCO management information center	Feb. 1991–May. 1991
Improvement of the fire protection plan of the community housing	Dec. 1992–Jun. 1993
Standards of the fire protection of the nuclear power plant	Jul. 1992–Dec. 1994
Consequence analysis for southern Seoul Oil Storage Facilities	Oct. 1992–Dec. 1992
Development of the standards of the fire protection systems of the electric power plant	Dec. 1995–Dec. 1999
Review of the design of the fire protection system and evacuation plan of Incheon International Airport	Apr. 1996–Dec. 1997
Design of the fire protection system of High Speed Train Station of East Taegu	Aug. 1996–Oct. 1997

lists some researches that have been conducted by KIFSE. Since its establishment in 1987, KIFSE has been promoting researches in fire science and engineering by holding annual conferences and seminars regularly and also publishing its journal quarterly and by distributing "fire news" leaflet bimonthly that introduces new trends in research and development to members of the institute. In 1997, KIFSE held its first international symposium on fire science and technology in Seoul to commemorate its 10<sup>th</sup> anniversary successfully, attracting great concerns from the government and the industry. This event will certainly serve a momentum to further enhance fire researches in Korea.

#### 4. CONCLUSIONS

Research activities on fire science and technology in Korea are observed by surveying research papers published in KIFSE journals from 1987 to 1997, and current research interests at several universities and research institutes are introduced. Researches in fire science and technology have been carried out in architectural, electrical, mechan-

ical and chemical engineering departments of universities. However, recently researches at departments such as safety engineering and industrial safety have become active in a wide range of fire science and technology. The major concern in the research has been on the fire safety of high rise buildings, and this trend is expected to continue as the construction of high rise commercial and apartment buildings and underground facility increases. Also, as the size of the fire safety equipment industry, estimated to be 300 billion Korean won in revenue at present, continues to grow, researches on the development of fire safety equipment will be enlarged.

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