THE CORRELATION BETWEEN INDOOR RADON CONCENTRATION FOR DIFFERENT TYPES OF RESIDENTIAL BUILDING AND ITS AGES

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DEDICATION

I dedicated this thesis to my mother, my late father, and my husband, who encourage me to explore knowledge in this field. Then, I am also would like to dedicate to all my sons and family members, who always remind me to always be positive whenever facing the difficulties.

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ABSTRACT

Radon is a naturally occurring gas originated from the geology material. Most of the building materials like bricks, concrete blocks, aggregates, sand, and soil produce radon gas and it will exhale into the residential building. The high contamination of indoor radon gas in the residential building is very harmful to human health because the radon gas can be the main contributor to the lung cancer disease. Therefore, this study was conducted to investigate the indoor radon concentration in residential building as well as its relationship with building material and age of the building. This study also identifies the correlation between indoor radon concentration and its building elevation. The Radon Eye detector has been used to measure the indoor radon concentration. Based on the finding results, the indoor radon concentration of concrete type residence is higher than the wooden type residence as 283 Bq/m^3 of indoor radon was recorded at Hotel in Putrajaya which this residence is made by concrete material while the lowest indoor radon concentration of 14.13 Bq/m^3 was recorded at wooden residence located at Felda Sg Koyan 3, Pahang. However, few mitigations can be taken to reduce the indoor radon gas included to provide good ventilation system in the residence.

ABSTRAK

Radon ada adalah sejenis gas yang semulajadi berasal daripada bahan geologi. Kebanyakan daripada bahan binaan seperti bata, blok konkrit, batu baur, pasir dan juga tanah boleh menghasilkan gas radon dan ianya akan merebak ke dalam bangunan perumahan. Kepekatan radon gas yang tinggi adalah berbahaya terhadap kesihatan manusia kerana gas radon boleh menjadi punca utama kepada penyakit kanser paru-paru. Oleh yang demikian, kajian ini telah dijalnkan bagi mengkaji tentang kepekatan gas radon di dalam bangunan beserta kaitannya dengan bahan binaan dan umur bangunan. Kajian ini juga dijalankan bagi mengenalpasti kaitan kepekatan gas radon dalam bangunan dengan ketinggian bangunan tersebut. Kajian ini telah menggunakan pengesan Radon Eye. Berdasarkan keputusan kajian, ianya menunjukkan kepekatan radon di dalam bangunan perumahan yang diperbuat daripada konkrit adalah lebih tinggi jika dibandingkan dengan bangunan perumahan yang diperbuat daripada kayu. Ini adalah kerana sebanyak 283 Bq/m^3 kepekatan radon telah dikesan di dalam sebuah hotel di Putrajaya yang mana ianya diperbuat daripada konkrit, manakala kepekatan radon gas yang paling rendah adalah sebanyak 14.13 Bq/m^3 iaitu terdapat di dalam perumahan jenis kayu yang terletak di Felda Sg Koyan 3 , Pahang. Walaubagaimanapun, beberapa Langkah pencegahan perlu lah diambil untuk mengurangkan gas radon di dalam bangunan termasuk menyediakan sistem pengudaraan yang baik di dalam bangunan.

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LIST OF ABBREVIATIONS

UTM	-	Universiti Teknologi Malaysia
IAQ	-	Indoor Air Quality
HVAC	-	Heating, Ventilation and Air Conditioning
VOC	-	Volatile Organic Compound
DOSH	-	Department of Occupational Safety and Health
ICOP	-	Industrial Code of Practice
PM	-	Particulate Matter
CO_2	-	Carbon Dioxide
CO	-	Carbon Monoxide
O_3	-	Ozone
WHO	-	World Health Organization
IRCC	-	International Research and Cancer Centre
SSNTD	-	Solid State Nuclear Track Detector
RH	-	Relative Humidity
BC	-	Black Cabon
LET	-	Linear Energy Transfer
OECD	-	Organization of Economic Co-peration and Development

LIST OF UNITS

Bq/m^3	-	Bacquarel per Cubic Metrer
Bq/kg^1	-	Bacquarel per kilogram
pCi/L	-	picocurries per litre

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Indoor air quality is very important to human because most people spend about 90% of time indoor either at home or in working area (Robert Dales, 2008). There are few factors in indoor environment which might affect to the air quality and it includes home water damage, heating and ventilation, renovation work, cleaning product accidents, the presence of pool or hot tub, and also hobbies included art, craft and building model (Joseph M. Seguel, 2016). Other than that, the activities relate to repair work, gardening, pet exposure, wood, or coal exposure and dirty close also can affect human respiratory health. The indoor air pollution is 100 times more dangerous compared to outdoor air pollution and it has been categorised as top 5 of the environmental risk to the public. Thus, this indoor quality has a significant impact on human health, especially on the respiratory system. The indoor air pollutant usually consists of second-hand smoke, radon, carbon monoxide, nitrogen dioxide, formaldehyde, house cleaning agent, animal, and dust mites. All these pollutants are hazardous and harmful to human who inhales them.

One of hazardous indoor air pollutants is radon. Radon can be defined as a radioactive gas originated from the geological materials. It formed from radium element and known as a noble gas with 3.8 days half-life. It is important to know about the concentration of indoor radon in the building. The materials used for building construction like soil, sand, cement, and rock usually originate from the different rock or earth's crusts that may highly be contaminated with radon which is a naturally occurring radioactive. The concentration of indoor radon depends on the condition of the local geological and type of building material. The exhale of radon gas from the soil, rock or other building materials will accumulate in indoor air of the

building. If radon is decay from the soils grain's, it will cause atom of radon exhale from the soil grain material to the atmosphere. The total number of exhale radon are known as radon exhalation rate. The factor which might affect to the number of exhalation rate of radon is soil morphology, soil grain size, soil moisture, temperature, atmospheric pressure and rainfall (Amin, 2015). However, radon exhalation rates from the building materials like bricks, concrete, sand, aggregates, and soil depended on its source. If its source contains high level of radon, the exhalation rates of radon from the building material also high.

If indoor radon gas been inhaled by human, its progeny will cause the damage of lung and respiratory system (G.R. Nonka a, 2017) and it had been agreed by N Nisar Ahmad (2017). World Health Organization(WHO) (WHO, 2020) and Internal Research on Cancer Canter (IRCC) had declared the radon gas as a carcinogenic gas for lung 7. To-date, radon gas known as a second cause of lung cancer after tobacco.

1.2 Background of the Problem

The inhaled radon gas progeny had caused the percentage of person got lung cancer disease to increase. This radon progeny will be the first causes of lung cancer for people who are not smoking. Based on the previous study, about 20000 of lung cancer death each year due to exposure to the radon and it included 2900 of never-smoker death and the other death is among smoker which exposed to the radon concentrations as low as 74 Bq/m^3 on air (Joseph M. Seguel, 2016).

According to study by Amin (2015) the presence of indoor radon gas and alpha activity in the building is very dangerous because this kind of radiation are 1000 times more carcinogenic compared to the gamma radiation (Amin, 2015). The knowledge about indoor radon is very important to people nowadays because most of peoples spend their time indoor and exposed to indoor air pollution. Thus, the research needs to be carried out to identify the radon exhalation rates in the buildings.

The research by Alberto Ruano-Ravina (2017) had recommended the scientific societies to get the corporation with the multidisciplinary approach like pneumologist, epidemiologist, oncologist, architects, industrial hygienist to enhance the communication related indoor radon risk awareness. The main key role are pneumologists and public health authorities because this is involving lung cancer disease. The new ventilation system or radon mitigation system shall be installed to ventilate the air out of the building (Joseph M. Seguel, 2016).

According to Ghazali (2016), American Government had encouraged their resident to measure the radon concentration in their residential. If the radon concentration reading is exceeding 148 Bq/m^3, they need to do the mitigation measures to get rid of the radon from their house. Other than that, England Government also had recommended their resident to reduce the radon concentration in their house if the reading is more than 200 Bq/m3. However, in Malaysia, there are less exposure and awareness given to public by government and local authority about the dangers of indoor radon. Therefore, most of peoples are still unaware and have no knowledge on the dangers of indoor radon especially in their house and workplace. It can be considered as a very serious issue because radon concentration might be increase with the increase of building ages. The type of building materials which exhale the high rate of radon can give significant impact to the indoor radon concentration.

1.3 Research Statement

There are few methods and equipment had been used by previous researcher to measure the indoor radon concentration includes Solid State Nuclear Track Detectors (SSNTD) CR 39, SSNTD LR 115, Gamma spectrometer and RAD 7 detector. Many researchers had studied the indoor radon concentration. The study by G.R. Nonka a (2017) revealed the value of indoor radon concentration in some residentials in Yopougun is in between 26.3 Bq/m^3 to 173.3 Bq/m^3 . The average value of radon concentration for this study is 93.04 Bq/m^3 and it still below than 100 Bq/m^3 which is the world minimum level. However, there are some lacking area

whereby the research did not clearly mention the source of indoor radon in the building. Therefore, the study should be carried out to investigate the indoor radon concentration in residential building especially its correlation to its ages and types of building material.

The concentration of indoor radon has been studied by many researchers. There are, however, some missing areas where the source of indoor radon in the building was not explicitly mentioned in the study. The study should therefore be conducted to investigate the concentration of indoor radon in residentials buildings, especially its association with their age and type of building material.

There is currently no clear law and regulation in Malaysia implemented by policy makers related to guidelines, requirements, or solutions to mitigate the risks of residential indoor radon concentration. This research was therefore carried out to identify the radon concentration in indoor residential buildings in order to help policy makers and industry solve the problem of indoor radon contamination in residential building.

1.4 Research Aims and Objctives

This study is conducted to measure the indoor radon concentration for the different types of residence. There are three objectives of this research:

i. To measure the indoor radon concentration for different types of residential in Johor, Pahang, Negeri Sembilan, Kelantan and Putrajaya by using Radon Eye detector.
ii. To investigate the correlation between indoor radon concentration and its building materials.
iii. To investigate the correlation between indoor radon concentration and its ages.
iv. To identify the correlation of different elevation of residential with indoor radon concentration.

1.5 Scope of Study

This research was conducted in order to determine the degree of indoor radon concentration in the residential building. Several studies had clarified that the existence of indoor radon in the building may lead to lung cancer disease (Jose A. Becerra, 2019). The indoor radon concentration measurement activity began from 17 August 2020 and was finished on 9 September 2020, taking approximately 22 days to complete. In the various types of residence, radon concentration measurement was performed, including at single storey terrace, double storey terrace, multistorey, and residence on the village lot. The number of years of residency ranges from 2 years to 30 years.

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