Abstract of Thesis Form 3

Name: Antoine Francis OBAME NGUEMA	
Title	Occupational Health Risk Assessment on Benzene Exposure at Gasoline Storage and Distribution Facility in Developing Countries (発展途上国のガソリン貯蔵・流通施設におけるベンゼン曝露に関する労働衛生リスクアセスメント)

In order to convey refined petroleum products from the refinery to the end users, gasoline storage and distribution facility (GSDF) is considered as a critical process to successfully achieve this operation. Benzene is one of those vapor emissions that workers are likely to be exposed at high exposure level during conducting out specific tasks such as loading gasoline to various petroleum storage transport modes. This results in many problems on human health such as cancer and non-cancer diseases. However, if we consider that there is a priority for developing countries towards economic benefits to sponsor other urgent social needs compare to investing in occupational health and safety; the main remaining concerns is to which extent health risk can be assessed for benzene exposure at GSDF in developing countries. This presents a problem of attempting to evaluate occupational health risk at GSDF with developing countries' challenges. Therefore, there is a need to develop a framework to assess health risk at GSDF for developing countries where there is a lack of measurement data; high benzene concentration in gasoline; engineering controls and among other challenges.

This research is structured around three main objectives to assess benzene exposure at GSDF for developing countries: (1) to analyze factors influencing occupational benzene exposure concentration in loading operations at GSDF in developing countries; (2) to estimate occupational benzene exposure and effectiveness of control measure at the GSDF and finally (3) to assess occupational health risk for benzene exposure at GSDF and compare between developing and industrialized countries; conclusions and recommendations.

The chapter 1 presents the introduction and definition of the concept of occupational health and safety. This chapter also describes an overview of occupational health and safety in developing countries and the facing challenges. The context of the research, its problem statement and the overall research framework are also included in this chapter.

The chapter 2 tackles the first specific objective of analyzing the factors that influence occupational benzene exposure concentration in loading operations at GSDF in developing countries. Then, 6 mains factors were identified and represented the 23 sub-factors. Theses 6 mains factors were as analyzed based on questionnaire survey for the purpose of ranking. The interpretive structural model (ISM) was applied to understand the interactions of factors that influence benzene exposure concentration during loading operations at GSDF in developing country. This would help management to conduct a more comprehensive and accurate chemical risk assessment. The results of this study reveals that the identified factors such as: ''product'', ''regulation'', ''working practices'' and ''installation'' are the most influential for benzene exposure concentration level at GSDF in developing countries. Based on those results, the first these factors should be tackled for management before others. It also emphasizes strategy to improve labor's conditions based on these factors, for example, providing a safe working place with a benzene exposure concentration level lower than the occupational exposure limit.

The chapter 3 dealings with the second specific objective of the research. In this study, the occupational exposure estimate of benzene in Gabon's GSDF was investigated by using a quantitative and predictive exposure inhalation model, which estimated benzene concentration before and after applying control measures. The implementation of control measures including vapor recovery system use, chemical filter mask use and worker's behavior improvement might contribute to reduce benzene concentration to the range of 4.52 – 29.08 mg/m³ for short term and down to 4.55 mg/m³ for long term.

The chapter 4 addresses the final objective of the research. This chapter aims to assess occupational health risk for benzene exposure at GSDF in developing countries. Finally, through the overall risk probability (ORP) technique was used to give a quantitative description of uncertainty and variability in evaluating the risk of adverse health effects at GSDF for developing countries. The results gives a significant health risk for workers in GSDF in developing countries. The highest health risk occurs when benzene concentration in petroleum products is high while engineering control measures such as vapor recovery system are missing. A comparison between health risk between developing countries and industrialized countries was then implemented.

The conclusion of this research contributes to assess occupational health risk of benzene exposure at GSDF in developing countries, where exposures assessment challenges occur. Recommendations are provided in how to improve exposure assessment including conducting a more accurate health assessment and, proposing the strategies for stakeholders and policy makers.

様式 7

論文審査の結果の要旨及び担当者

氏　名	（Antoine Francis OBAME NGUEMA ）

	(職)	氏　名
論文審査担当者		
主 査	教 授	東海明宏
副 査	教 授	近藤 明
副 査	准教授	町村 尚

論文審査の結果の要旨

発展途上国におけるガソリン貯蔵・流通施設におけるベンゼン暴露に関して、標準的なチェックリストと作業者への面談のみによって行われてきており、作業環境中濃度の把握や曝露評価を通じた健康リスク管理が可能となってはいない。そのため、事業所の健康、安全、環境といった面についての管理状況は先進国と比して低い水準にある。一方で、ガソリンの製造、貯蔵、流通の過程で排出されるベンゼンに代表される発がん性物質の管理はグローバルに進行しつつあることから、途上国においても適切なリスク管理水準の確保に向けた取り組みが必要とされている。そこで、本論文では、第一に、途上国において、ベンゼンの曝露量の把握を阻害する要因構造を構造モデルによって明らかにすること、第二に、発展途上国としてガボンを対象として、ガボンにおける典型的な規模のガソリン貯蔵・供給施設をとりあげて曝露解析をおこない、曝露管理対策導入の効果を推定すること、そして第三に、実測値にもとづいたベンゼンの健康リスクの経年推移を先進国と途上国とで比較し、今後において必要となる技術移転等優先的な取り組みについて考察をおこなっている。

第二章では、途上国におけるガソリン貯蔵・流通施設の実態に関し、作業者の側に立って、Interpretive Structural Model を適用して、ベンゼンの曝露濃度の把握が進まない構造的理由を、文献調査と関係者への質問紙調査を通じて解析している。その結果、規制内容と履行チェック体制、装置の導入水準、作業手順、製品中の化学物質含有量管理の困難さが原因であることを明らかにしている。

第三章では、ガボンにおけるガソリン貯槽・流通施設を取り上げて、欧州の労働安全衛生機関で標準的に手法として使用されている作業者曝露推定モデルを適用して、現状の曝露濃度の推算、曝露低減対策を導入した際の低減効果を推定する方法を手順化するとともに、現実に導入されている対策の組み合わせを通じて、労働現場での健康管理目安濃度以下に可能となる方策を見出している。

第四章では、先進国と途上国におけるガソリン貯蔵・流通施設におけるベンゼンのモニタリング結果を経年的に調査し、非発がん、発がんリスクの経年変化を明らかにするとともに、総合リスク指標を定義して、リスクレベルの比較を行っている。その結果、ベンゼン曝露による被影響人口規模と曝露目安値超過確率の関係を見出し、今後の途上国へのリスク管理技術移転についての示唆をうる知見を明らかにしている。

以上のように、本論文は、途上国のなかでも産油国で生産されたガソリンの貯蔵・流通過程における作業者曝露評価のデータ構造を明らかにし、今後の事業所の健康、安全、環境に関する基盤的部分の充実に向けた実用的知見を明らかにしている。

よって本論文は、博士論文として価値有るものと認める。