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ในประเทศไทย พบว่า ร้อยละ 98.5 ของฟิล์มเอกซเรย์ที่นำเข้ามาถูกนำไปใช้งานทางการแพทย์
 ภายหลังจากการใช้งาน ฟิล์มเอกซเรย์จะถูกนำไปผ่านกระบวนการล้างฟิล์ม โดยพบว่าโลหะเงินประมาณร้อย
 ละ 55-65 จะคงอยู่บนแผ่นฟิล์ม ในขณะที่ส่วนที่เหลือจะละลายอยู่ในน้ำยาหยุดภาพ โดยปกติแล้วฟิล์ม
 เอกซเรย์ใช้แล้วจะถูกเก็บรักษาเพื่อใช้เป็นข้อมูลทางการแพทย์เป็นเวลาประมาณ 5 - 10 ปี ในขณะที่น้ำยา
 หยุดภาพ จะถูกใช้งานซ้ำอย่างน้อย 2 ครั้ง ก่อนเก็บรวบรวมเพื่อจำหน่ายให้กับผู้รับซื้อของเสียและ/หรือ ผู้รับ
 กำจัดของเสีย เพื่อนำไปผ่านกระบวนการรีไซเคิลโลหะเงิน ซึ่งส่วนใหญ่เป็นโรงงานแบบ In-house factory โดย
 ใช้วิธีการแยกโลหะเงินด้วยกระแสไฟฟ้า การชะด้วยกรด (HNO_3) หรือการเผา ซึ่งในระบบการจัดการของเสีย
 ในปัจจุบัน พบว่า ผู้รับซื้อของเสียหลุดรอดจากการกำกับดูแลโดยภาครัฐ ในขณะที่ผู้รับกำจัดของเสียหากมี
 คนงานและเครื่องจักรเป็นไปตามที่กฎหมายกำหนดจะต้องมีใบอนุญาตประกอบกิจการโรงงาน แต่อย่างไรก็
 ตามพบว่า ผู้รับกำจัดของเสียส่วนใหญ่จะไม่คำนึงถึงการจัดการของเสียที่เกิดขึ้น โดยจะเห็นได้ว่าการทิ้งและ
 ปล่ยสารเคมีที่มีความเป็นพิษสูงออกสู่สิ่งแวดล้อมอย่างต่อเนื่อง ดังนั้น จึงได้มีการนำแนวคิดเทคโนโลยี
 สะอาดมาประยุกต์ใช้ในการแยกโลหะเงินจากแผ่นฟิล์มเอกซเรย์ โดยการชะด้วยกรดอ่อน เช่น กรดอะซิติก
 กรดออกซาลิก กรดมาลิก โดยทำการทดลองที่อุณหภูมิต่ำ ซึ่งพบว่า การชะด้วยสารละลายกรดออกซาลิกที่
 มีความเข้มข้นร้อยละ 5 ที่อุณหภูมิ 100 องศาเซลเซียส เป็นเวลา 20 นาที มีประสิทธิภาพเกือบจะ 100% โดย
 ตะกอนเงินที่ได้จะอยู่ในรูปโลหะเงินที่เอื้อต่อการนำไปทำให้บริสุทธิ์ ยิ่งไปกว่านั้นได้มีการกำหนดรูปแบบ
 วิธีการบริหารจัดการของเสียจากกระบวนการถ่ายภาพรังสีเทคนิคขึ้น เพื่อลดความเสี่ยงจากการหกรั่วไหลของ
 ของเสียอันตรายที่ปนเปื้อนโลหะเงินออกสู่สิ่งแวดล้อม

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KEY WORD: RADIOGRAPHIC WASTE / WASTE MANAGEMENT / FACT SHEET / SILVER REMOVAL

PATTAMAWAN KHUNPRASERT: WASTE MANAGEMENT PLAN AND CHEMICAL RECOVERY PROCESS FOR RADIOGRAPHIC MEDICAL FILM. THESIS ADVISOR: ASSOC. PROF. VARAPAN DANUTRA, Ph.D., THESIS CO-ADVISOR : ASSOC. PROF. NURAK GRISDANURAK, Ph.D.
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In Thailand, 98.5% of the imported x-ray films are used for medical services. After the developing process, approximately 55-65% of metallic silver still remains on the developed x-ray films. The used films are practically kept at the hospitals for record-keeping purposes for 5-10 years, while the developing agents are reused at minimal twice. The discarded films and the spent (fixer) solution are normally sold to waste dealers. Wastes are delivered to in-house factories to recover silver by electrolysis, acid leaching (HNO_3), or combustion processes. The dealer for used x-ray waste is one of the major stakeholders who is apparently exempted from state control and regulations. Depending on its size and capacity, the processors must have a factory-operating permit. Most unlicensed processors have no concern about the handling of their wastes. Highly toxic chemicals are generally spilled and discharged into the environment. The cleaner technology concept of silver leaching from processed radiographic film was investigated using weak organic acids such as acetic, oxalic, and malonic acids. The tests were carried out under different temperature conditions. An oxalic acid solution at 5% (w/v) provided the best leaching conditions at 100°C , 20-minute retention time and at 90°C , 60 minute-retention time to achieve >97% SRE (Silver Recovery Efficiency). The reclaimed silver was in its metal form and ready for ingot transformation. Following this, a fact sheet on the waste management of radiographic film waste was developed to initiate and support the need to reduce the risks of contamination of hazardous silver into the environment.

Field of studyEnvironmental Management....Student's signature

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LIST OF ABBREVIATIONS

°C	Degree
µg/l	Microgram Per Liter
Ag ⁺	Silver Ion
Ag ⁰	Metallic Silver
AgX	Silver Halide
AgX [*]	Exposed Silver Halide
Btu	British Thermal Unit
cm	Centrimeters
cm ³ g ⁻¹	Cubic Centimeter Per Gram
F	Material Flow Into and Out for Each Hospital Inside the Control Volume
F&M	Fabrication and Manufacturing
HA	Hospital Accreditation
kJ	Kilo Joule
K _{sp}	Solubility Product Constant
kW-hr	Kilo Watt x hour
mg/kg	Milligram Per Kilogram
mg/l	Milligram Per liter
mL	Milliliter
mm	Millimeter
MOI	Ministry of Industry
MOPH	Ministry of Public Health
NIOSH	The National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
ppmv	Part Per Million (Volume Base)
PWG	Primary Waste Generator
S	The Stock of Material Retained or Depleted from the Reservoir over a Time Period
SRE	Silver Recovery Efficiency
SWG	Secondary Waste Generator
TCLP	Toxicity Characteristic Leaching Procedure

LIST OF ABBREVIATIONS (Cont.)

TLV-TWA	Threshold Limit Value - Time Weighted Average
U.S. EPA.	United State Environmental Protection Agency
w/v	Weight by Volime
WD	Waste Dealer
WG	Waste Generator
WP	Waste Processor
WR	Waste Regulator