

# DEDICATION

To My

Family, Company and Colleagues

With special love to Atta Elfadeel

## **Acknowledgements**

First, thank To Allah almighty for helping me to complete the  
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## Abstract

In this study, problems of corrosion and environmental hazards affecting the electrical power generation plants and the surrounding areas were undertaken. In addition, gas turbines' hot Gas Path Parts Failure due to hot corrosion was also investigated. The study extends to cover the cooling water system at Kassala Electrical Power Generation Plant and the causes of serious hazards manifested in concrete cubes tests failure in Kosti Power Station Project. The study revealed that the cause of the high level of corrosion in some parts of Garri Power Plant was due to the dissolved ammonia that .contaminates water used for cooling the power Plant

In Kassala Electrical Power Generation Station the underground water pipes corrosion problem was studied. Water was sampled from 100 wells around the area and analysed for determination of water quality and records of water analysis in the area were traced for the period from April 2000 to December 2009. Results shows high metal deposits as well as microbiological fouling which directly lead to deterioration of the cooling system. The level of water hardness was .found to reach 700 ppm in both cooling water system and power hole

The investigation in the causes of cube failure test at Kosti Power Plant project let to the fact that the concrete was subjected to excessive heating due the hydration heat librated during concrete setting. Remediation of the problem was suggested in terms of controlling the concrete temperature by mixing ice and using child water hence compensate for excess of heat generated during setting. .The suggestion was applied and completely eradicates the problem

The study show that The level of dissolved ammonia in cooling water was as high as 1.3 ppm during summer and 1.9 ppm during winter, while the recommended standard for water to be used in such cooling systems demands that dissolved ammonia level should be zero. Furthermore, The

study found that the presence of high amounts of sodium and vanadium in the fuel used in the station was a major cause of corrosion. The levels of these metals far exceed the recommended level by the .turbine manufacturer

Finally, the study examined Elroseris and Jebel Aulia hydro power generation plants problems. The major causes of the high iron corrosion and high deposits were due to the activities of Bacteria. .Consequently remediation was suggested and applied successfully

## ملخص

أجريت هذه الدراسة للتعرف على مشاكل التآكل والأخطار البيئية التي تؤثر على محطات توليد الطاقة الكهربائية والمناطق المحيطة بها. بالإضافة لذلك تمت دراسة اسباب فشل قطع غيار التوربينات الغازية بمسار الغاز الساخن والتي أثبتت بعد التحقق انه بسبب التآكل الساخن. إمتدت الدراسة لتشمل منظومة مياه التبريد في محطة توليد كهرباء كسلا، كما درست أسباب المخاطر الجسيمة التي تتجلى في فشل إختبار مكعبات خرسانة قواعد مشروع محطة توليد كهرباء كوستي، وكشفت الدراسة أن سبب إرتفاع مستوى التآكل في بعض قطع الغيار من محطة توليد الكهرباء في قري بسبب الأمونيا الذائبة التي تلوث المياه المستخدمة لتبريد المحطة. تمت دراسة لمشكلة تآكل أنابيب المياه الجوفية في محطة توليد الطاقة الكهربائية بكسلا وتم أخذ عينات بهدف تحديد نوعية المياه ومن ثم تم رصد ودراسة نتائج تحاليل جمعت من تقارير لـ 100 بر بالمنطقة تعود للفترة ما بين أبريل 2000 إلى ديسمبر 2009، وقد أظهرت النتائج وجود رواسب معدنية عالية فضلاً عن تلوث بكتيري حيوي والذي له الأثر المباشر لتدهور نظام التبريد في المحطة. حيث عثر على مستوى عسر للماء (املاح الكالسيوم والمغنيزيوم) يصل إلى 700 جزء من المليون في نظام تبريد المياه ومبنى القدرة. نتيجة التحقيق في أسباب فشل إختبار مكعبات خرسانية في مشروع محطة توليد كهرباء كوستي بسبب تعرضها للحرارة المتولدة من التفاعل الكيميائي أثناء عملية الخلط بالماء وتشكل المركبات الرئيسية في الأسمنت (تصلب الخرسانة)، ومن ثم أقترحت معالجة لهذه المشكلة عن طريق التحكم في درجة حرارة الخرسانة بواسطة اضافة و خلط الثلج والمياه المبردة وبالتالي مقابلة إرتفاع الحرارة، تم تطبيق الاقتراح وحلت المشكلة نهائياً.

أظهرت الدراسة في محطة قرى أنّ أعلى مستوى للأمونيا الذائبة في مياه التبريد 1.3 جزء من المليون خلال الصيف و 1.9 جزء من المليون خلال فصل الشتاء ، بينما المعيار الموصى به للمياه المستخدمة في أنظمة التبريد ينبغي أن يكون خالياً من الأمونيا، كما أظهرت الدراسة أيضاً أن وجود كميات عالية من الصوديوم والفناديوم في الوقود المستخدم في محطة قرى كان سبباً رئيسياً من أسباب التآكل. مستوى التركيز لهذه المعادن يتجاوز بكثير المستوى المسموح به من قبل الشركة المصنعة للتوربينات.

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	<b>Abbreviations</b>
	NEC                      National Electricity Corporation
	SLWC                      Sudan Light and Water Company
	KW                      Kilowatt
	MW                      Megawatt
	CEWA                      Central Electricity and Water Administration
	CMEC                      China Machinery Engineering Corporation
	NTU                      Nephelometric Turbidity Units
	NOM                      Natural organic matter
	Alum                      Aluminum sulphate
	PAC                      Poly aluminum chloride
	AVT                      All volatile treatment

	SSC	Sulfide stress cracking
	MIC	Microbiologically induced corrosion
	SRB	Sulphate Reducing Bacteria
	IRB	Iron reducing bacteria
	LPG	liquefied petroleum gas
	TG	Turbine generator
	PCL	Progressive company limited
	ppm	part per million
	W01, W02...	Underground wells numbering
	GGBS	Ground granulated blast furnace slag, used to make durable concrete
	D.A	Dry Air
	NO <sub>x</sub>	Oxidation of nitrogen compounds contained in the fuel
	SO <sub>x</sub>	Sulphur oxides generated by burning sulphur

	contaminants
	US EPA                      United States Environmental Protection Agency
	Omega-3                      FA's Polyunsaturated Fatty Acids
	ALA                              Alpha- linolenic acid
	EPA Eicosapentaenoic acid
	DHA Docosahexaenoic
	BOD                              Biological Oxygen Demand
	COD                              Chemical Oxygen Demand
	OSHA                              Occupational, Safety and Health Administration
	HMIS                              Hazardous Materials Identification System
	PPE                              Personal Protective Equipment
	HCS                              Hazard Communication Standard
	NFPA                              National Fire Protection Association
	CPR                              Cardiopulmonary Resuscitation
	LSI                              Langelier's Saturation Index

	RSI	Ryznar Stability Index
	TDS	Total dissolved solids
	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
	D.O.	Dissolved oxygen
	C <sub>3</sub> S	Tricalcium silicate
	C <sub>2</sub> S	Dicalcium silicate
	C <sub>3</sub> A	Tricalcium aluminate
	C <sub>4</sub> AF) <sub>4</sub>	Tetra calcium) alumino ferrite
	PAM	2-Propen-1-aminium, N, N-dimethyl-N-2-Propenyl-, chloride, polymer with 2-propenamide
	PFS	Poly Ferric Sulphate $[\text{Fe}_2 (\text{OH})_n (\text{SO}_4)_{3-n/2}]_{n/2}$
	TOC	Total Organic Carbon
	KRC	Khartoum Refinery Company
	TLV-TWA	(Threshold Limit Value - Time Weighted Average
	TLV-STEL	(Threshold Limit Value -

	ID	identification
	MSDSs	Material Safety Data Sheets
	KAPLAN	Type of matrix turbines
	LOT	module of Hydro-matrix units
	FRP	Fiberglass Reinforced Plastics
		Light diesel oil LDO
		Quality management QMS system
	QA	Quality assurance
	CP	Cathodic Protection
	EGCO	Electricity Generating (Public Company Limited (THAILAND
	ESCO	Energy service (company (THAILAND
	WDX	wavelength-dispersive X-ray detector

