

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ

قال تعالى :

( وَمَا أُوتِيتُمْ مِنَ الْعِلْمِ إِلَّا قَلِيلًا )

(سورة الإسراء-الآية 85)

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# **DEDICATION**

To my dearest mother.....  
To my dearest father.....  
To my brother and sisters.....  
To my lovely son Amro.....  
To all my family.....  
To all my teachers.....  
I dedicate this humble work.....

## Abstract

Sudanese fuel oil (furnace) is used in North Khartoum Power Station for boiler firing. Sudanese fuel solidified in ambient temperature due to high wax content. Steam has been used to heat Furnace during transportation, off loading and storage. Many problems are come out due to

mixing of steam and Furnace in combustion process beside problems of maintenance of pumps and cost of steam needed for such heating process. The aim of the present work is to investigate the possibility of using flue gas instead of steam to heat Sudanese fuel oil to avoid all problems associated with steam usage in all stages. A Test rig was designed and implemented to simulate different stages of Furnace usage. Tests were carried out using different flow parameters. Results show promising solution of using flue gas instead of steam for heating Sudanese fuel oil. Time and Economic evaluation show a big save in time during off – loading tankers, cost of producing auxiliary steam and maintenance cost besides the improvement in plant thermal efficiency due to heat recovered from flue gas.\_

## ملخص البحث

يستخدم الوقود السوداني (الفيرنس) في إشعال غلايات محطة الدكتور محمود شريف الحرارية (Khartoum North Power Station). الفيرنس السوداني يوجد في حالة صلابة في درجة حرارة الجو الخارجي أو العادية بسبب محتوى الشمع العالي. يستخدم البخار في التسخين المباشر للفيرنس في مرحلة التفريغ والتخزين. نتيجة خلط البخار مع الفيرنس تنتج مشاكل في عملية الإشتعال بجانب مشاكل صيانة طلمبات المنواله والتفريغ

وتكلفة البخار المستخدم في عملية التسخين. هدفَ البحث الحالي دراسة إمكانية استخدام غازات العادم بدلاً من البخار لتسخين الفيرنس السوداني لتفادي المشاكل التي إرتبطت باستخدام البخار في التسخين المباشر في كل المراحل صُممَ جهاز إختباري ونفذ لتقليد (محاكاة) مراحل مختلفة من استخدام الفيرنس. نفذت الإختبارات التجريبية لعدة أنماط إنسياب مختلفة. النتائج أوضحت حل واعد في إمكانية استخدام غازات العادم بدلاً عن استخدام البخار في تسخين الفيرنس السوداني، وبالتالي يمكن توفير المال الذي يصرف في صيانة و قطع غيار طلمبات التفريغ والمناولة و التخزين وتقليل الوقت المستهلك في عملية تفريغ شاحنات الفيرنس، إضافة إلي تحسين كفاءة المحطة الحرارية نتيجة لإستعادة الحرارة من غازات العادم.

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## List of Symbols

<b>Symbol</b>	<b>Description</b>	<b>Units</b>
$\dot{Q}$	Heat load capacity	kW
$\dot{m}_g$	Flue gas mass flow rate	kg/sec.
$\rho_g$	Flue gas density	kg/m <sup>3</sup>
$\dot{V}_g$	Flue gas volume flow rate	m <sup>3</sup> /sec
$c_{pg}$	Flue gas specific heat capacity	kJ/kg.°K
$\Delta T_g$	Flue gas temperature difference	°K
ID	Internal diameter	m
OD	Outside diameter	m
$A$	Cross-section area of tube	m <sup>2</sup>
$Re$	Reynolds number	---
$v_g$	Flue gas velocity	m/sec
$\mu$	Flue gas viscosity	Pa-sec
$Nu$	Nusselt number	---
$Pr$	Prandtl number	---
$q''$	Constant heat flux	kW
$T_o$	Constant temperature distribution	°K
$K_g$	Flue gas thermal conductivity	W/m.°K
$K_w$	Tube wall thermal conductivity	W/m.°K
$h_g$	Flue gas heat transfer coefficient	W/m <sup>2</sup> .°K
$h_o$	Fuel oil heat transfer coefficient	W/m <sup>2</sup> .°K
$U$	Overall heat transfer coefficient	W/m <sup>2</sup> .°K
$r_o$	Outside radius	m
$r_i$	Inside radius	m
$\theta$	Time of heating batch	hours
$T_{heat}$	Heating medium temperature	°F

$T_{initial}$	Initial temperature of liquid batch	°F
$T_{final}$	Final temperature of liquid batch	°F
$M_{batch}$	Mass of liquid batch being heated	lbs
$t$	Initial batch temperature	°C
$d$	Batch liquid density	$g/cm^3$
$cSt$	Centi-Stoke	---
$SWG$	Sudanese Wire Gauge	---