List of Tables, Figures and Photos

List of Tables	Page
Table 1.1 Egyptian Standard Specifications for transformer oil.	**22**
Table 3.1 formulation of the component used in the treatment of acid sludge	65
Table 4.1 Physico-Chemical properties of the used transformer oils (UTO1 & UTO2)	79
Table 4.2 Assignment of the Vibration of the Functional Groups in the Infrared Spectra of the Used Transformer Oils	**86**
Table 4.3 Parameters calculated from the FTIR Spectra of the and UTO2	**86**
Table 4.4 Molecular weight and molecular formulae of some studied polyaromatic hydrocarbons	**92**
Table 4.5 Chemical Analysis for by–Pass kiln dust	93
Table 4.6 Effect wt % of sulphuric acid and mixing time on properties of the recovered transformer oil RTO1	97
Table 4.7 Effect wt % of sulphuric acid and mixing time on properties of the recovered transformer oil RTO2	97
Table 4.8 effect of the by-pass Kiln dust on the properties of the treated oil (RTO1) with 5 % H_2SO_4 at 40°C	98
Table 4.9 effect of the by-pass Kiln dust on the properties of the treated oil (RTO2) with 5 % H_2SO_4 at 40°C	98
Table 4.10 Effect of mixing time on polyaromatics distribution at optimum conditions	99
Table 4.11 physico-chemical properties of the recycled transformer oils at optimum conditions	109
Table 4.12 the efficiency test of formulation	113

List of Figures and Photos

Chapter (2)	
Figure 2.1 Waste Management	25
Figure 2.2 sulfuric acid re-refining (flow chart of the meinken process)	40
Figure 2.3 flow chart of the KT1 process: thin film evaporator (TFE) with hydro-treatment.	42
Figure 2.4 Flow chart of the PROP Process.	42
Figure 2.5 The safety Clean process.	43

Figure 2.6 Introduction of selective solvent extraction in the re-refining process (DEA/mineralöl-Raffinierie Dollpergen, Germany).	44
Figure 2-7 Cement By-Pass Dust	55
Chapter (3)	
Figure 3.1 A typical simplified power system	59
Figure 3.2 Test cell with spherical surfaced electrode	67
Figure 3.3 Test Set-Up for Power Factor Measurements at Elevated Temperature Using Three-Electrode Test Cell.	71
Figure 3.4 Loss tangent test cell recommended by CIGRE (quantity of oil required to fill cell 45 ml, approx.)	73
Photo 3.1 the Hiptronic test apparatus	66
Photo 3.2 the electrodes	66
Chapter (4)	
Figure 4.1 Infrared spectra for the first used transformer, UTO1	85
Figure 4.2 Infrared spectra for the second used transformer, UTO2	85
Figure 4.3 Gas chromatographic analysis of the first used Transformer oil, UTO1	88
Figure 4.4 Gas chromatographic analysis of the second used Transformer oil, UTO2	88
Figure 4.5 Paraffinic Carbon distribution for used transformer oils, UTO1 and UTO2	89
Figure 4.6 HPLC chromatogram of the UTO1	91
Figure 4.7 HPLC chromatogram of the UTO2	91
Figure 4.8 Effect of mixing time on the TAN at different oil temperature for RTO1	104
Figure 4.9 Effect of mixing time on the TAN at different oil temperature for RTO2	104
Figure 4.10 Effect of mixing time on the Kin. viscosity at different oil temperature for RTO1	105
Figure 4.11 Effect of mixing time on the Kin. viscosity at different oil temperature for RTO2	105
Figure 4.12 Effect of mixing time on the Yield at different oil temperature for RTO1	106
Figure 4.13 Effect of mixing time on the Yield at different oil temperature for RTO2	106
Figure 4.14 Effect of mixing time on the BDV at different oil temperature for RTO1	107

Figure 4.15 Effect of mixing time on the BDV at different oil temperature for RTO2	107
Figure 4.16 Effect of mixing time on tan δ at different oil temperature for RTO1	108
Figure 4.17 Effect of mixing time on tan δ at different oil temperature for RTO2	108
Figure 4.18 Component type analysis of MCR and hydrocarbon	113

INTRODUCTION

One of the major concerns has been the disposal of by-products generated during the regeneration of the used transformer oil by turning problematic waste products into saleable. Egypt is now faced with enormous problems of environmental protection, a continuous decrease in petroleum reserves and the ever increasing demand for energy.

Transformer oil represents today, one of the most important of a long series of petroleum specialty oils. This oil serves as a dielectric and coolant medium in transformer units. In performing these functions, the oil gradually deteriorates by oxidation and picks up moisture. If the free moisture content rises above a certain level, its insulating efficiency deteriorates and arcing therefore may occur deteriorate. As the result, asphaltenic materials precipitate and deposit on the core and in the transformer cooling coils; thus giving bad insulating and cooling.

Reclamation of the used transformer oil eliminates insoluble and dissolved contaminants to attain oil with characteristics similar to those of new oil. Clay is used in the refining step of the used oils to improve their color and to remove asphaltic and resinous materials. The refining action of the clay depends on its nature, method of application and treating.

The cement industry produces a large amount of waste dust. This dust arises from two sources. Firstly, cement dust from the rotary kiln, known as kiln dust , that settles from the electrostatic precipitation used to purify the flue gases evolving from the kiln ;and secondly, by-pass dust, which constitutes a "purge" from the kiln in order to minimize the amount of alkalis in the effluent flue gases from the kiln. The first type can usually be recycled to the kiln since its alkali content is usually low. By-pass dust, on the other hand can not be recycled to the kiln, its alkali content usually exceeding 10%. The rate of by-pass dust production usually ranges from 3 - 8% of the kiln production rate. A capacity of 4000 ton/day clinker will produce about 200

ton/day by-pass dust. This large amount has to be disposed, which represents an environmental hazard, primarily because of its extremely low particle size about 10 microns.

In this thesis, an approach for the regeneration of waste transformer oil by using acid/by-pass kiln dust cement was achieved. Different ratios of sulphuric acid and by-pass kiln dust at various mixing times were investigated. The chemical composition of cement kiln dust was determined.

The physicochemical and electrical properties of waste transformer oils and recycled samples were studied according to standard methods of analysis including structural group analysis, infrared spectroscopy and capillary gas chromatography. In addition, the distribution of the hydrocarbon components for oil before and after treatment oils was performed using capillary gas chromatography. The AC breakdown voltages (BDV) and dissipation factors were determined for used transformer oils and recycled samples according to the ASTM standard tests D877 and D150.

Therefore, the present study program encompasses three main phases: The first phase deals with the laboratory treatment of the used transformer oil with different ratios of sulphuric acid at different time mixing in order to determine the most efficient condition. In the second phase, the physicochemical properties of transformer oils and recycled samples, in addition to the AC breakdown voltages (BDV) were determined. In the third phase, the possibility of using the by-pass kiln dust to solve pollution problem, for the reclamation of waste transformer oil, was investigated.