[Sustainable Environmental Economic Development (S.E.E.D)]

Weathered crude contaminated soil treatment by Thermal Treatment systems

Khaled Al-Haid

Soil Remediation Group

Kuwait Oil Company (KOC)

Introduction & Background:

- KOC Oil & Gas Exploration & Production operations have given rise to environmental pollution and damage to the natural desert environment.
- Typical non-operational redundant polluted features include the following:
  - Effluent Pits
  - Sludge Pits
  - Contaminated Soil Piles
  - Gatch Quarry Pits

PROJECT OBJECTIVE

The Project's high level objective:-

- To remediate a number of contaminated features to acceptable levels and restore ecological function.
  - Remediate – Treatment to remove contaminants (Hydrocarbon & Salt)
  - Acceptable Level – Contamination not reduced to zero but to a level not harmful to human health / environment
  - Ecological Function – Following remediation, soil to be capable of supporting native plant growth

شركة نفط الكويت
Kuwait Oil Company
إحدى شركات مؤسسة البترول الكويتية
A Subsidiary of Kuwait Petroleum Corporation

PROJECT SCOPE

- split into 3 distinct ‘Lots’ all within the South & East Kuwait Asset.
  - Lot A
  - Lot B
  - Lot C
- Each Lot consists of a selection of “features”:
  - Sludge Pits.
  - Effluent Pits.
  - Gatch Pits.
  - Contaminated Soil Piles.
- Total = 25 features

Lot	Effluent Pits	Sludge Pits	Gatch Pits	Contaminated Soil Piles	Total Pits
A	**5**	**2**	**2**		**9**
B	**3**	**2**	**2**	**1**	**8**
C	**6**	**1**		**1**	**8**
Total					**25**

SCOPE OF WORKS

EOD Clearance

Radiological Surveys

Site Characterisation

Oil Recovery

Remediation of Contaminated Sludge & Soil

Ecological Restoration

www.kockw.com

Kuwait Oil Company

إحدى شركات مؤسسة البترول الكويتية

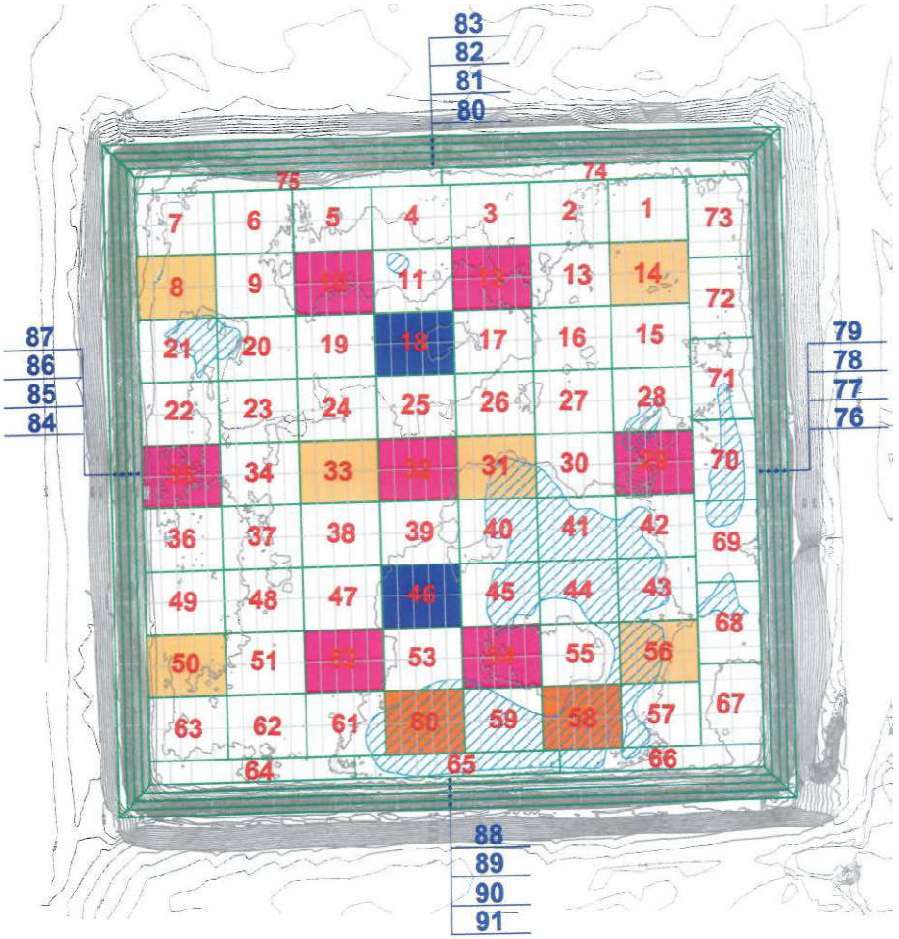
A Subsidiary of Kuwait Petroleum Corporation

Weathered crude contaminated soil treatment by Thermal Treatment systems

- **Site Characterization:**

- Scope: to obtain detailed Physio-Chemical Properties of the feature's soil including concentrations of :
    - TPH contaminants.
    - Salinity.
    - Heavy Metals.

  Other characteristics as:
    - General characterization (Soil, Sludge, Oil)
    - Soil Particle size fractions.
    - Total Volume of contaminated soil.



www.kockw.com

Weathered crude contaminated soil treatment by Thermal Treatment systems

- Site Characterization:
  - Sampling:
    - The future is divided into 50 m2 Cells (5 x 10 m each).
    - Grab & Composite samples collected from different depths (up to 100 cm).
  - Samples Boreholes:
    - Mechanical excavation.
    - Geo-Probe (Mechanical Ogre).
    - Manual Ogre.

Geo-Probe

Weathered crude contaminated soil treatment by Thermal Treatment systems

www.kockw.com

شركة نفط الكويت
Kuwait Oil Company
إحدى شركات مؤسسة البترول الكويتية
A Subsidiary of Kuwait Petroleum Corporation

Weathered crude contaminated soil treatment by Thermal Treatment systems

- Selection of treatment systems.
  - Particle Size Distribution & Composition (Degree of Sand, Clay, Silt, Rock).
  - Contaminants Concentration. (ppm)
  - Contaminants Complexity (HC Chain)
  - Moisture Content.
  - Contaminant Type, Concentration, and Distribution.
  - Heavy Metals Concentrations.
  - Salt Content.

Weathered crude contaminated soil treatment by Thermal Treatment systems

- Thermal treatment system process description

Weathered crude contaminated soil treatment by Thermal Treatment systems

- **Thermal Desorption (TD).**

  TD systems have varying degrees of effectiveness against the full spectrum of organic contaminants.

  The process is applicable for the separation of organics from refinery wastes, coal tar wastes, wood-treating wastes, **hydrocarbon-contaminated soils**, synthetic rubber processing waste, pesticides and paint wastes.

Weathered crude contaminated soil treatment by Thermal Treatment systems

- **Limitations:**

  - High soil moisture content .

  - Highly abrasive feed potentially can damage the processor unit.

  - Heavy metals in the feed may produce a treated solid residue that requires stabilization.

  - Throughput time increases for high Clay and silty soils as a result of binding of contaminants.

OVERVIEW OF VARIOUS TYPES OF THERMAL DESORPTION SYSTEMS.

Thermal desorption systems can be further divided into two broad categories:

1. Continuous feed
2. Batch-feed types.

Types of continuous-feed thermal desorption technologies:

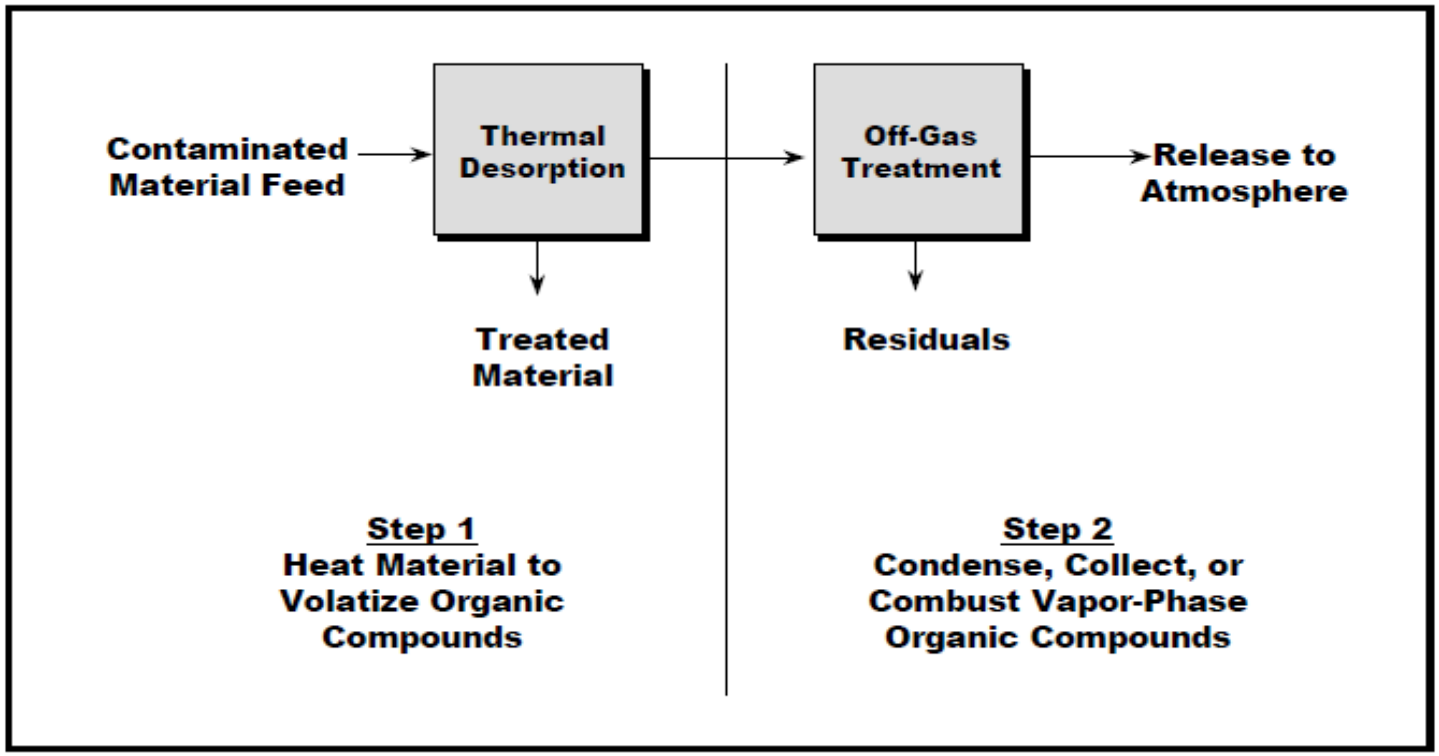
- Direct-contact thermal desorption.
- Indirect-contact thermal desorption.

Types of batch-feed thermal desorption technologies:

- Ex situ—heated oven and hot-air vapor extraction (HAVE)
- In situ—thermal blanket, thermal well, “enhanced” soil vapor extraction.

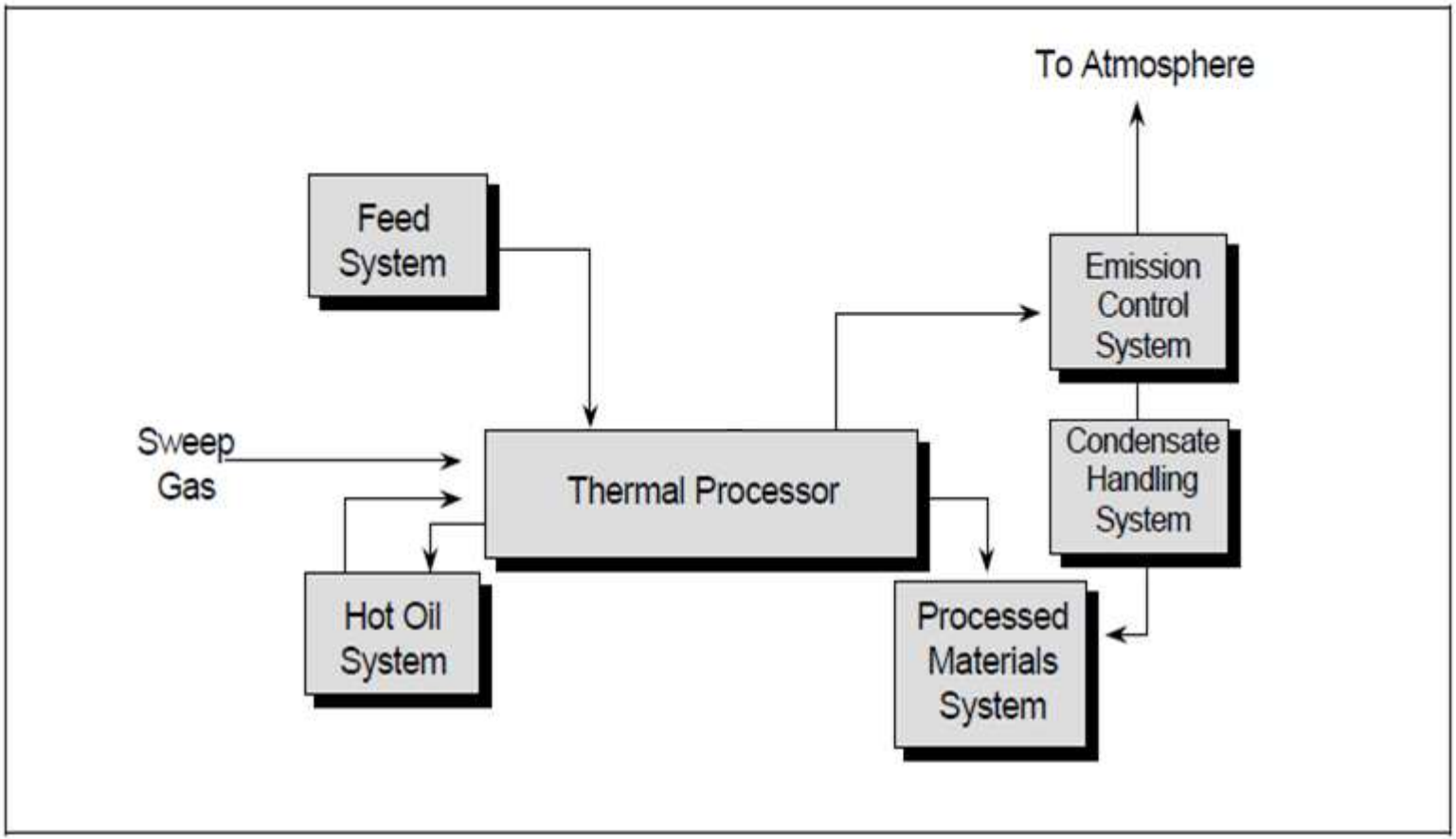
Thermal Desorption.

Generic Thermal Desorption Process



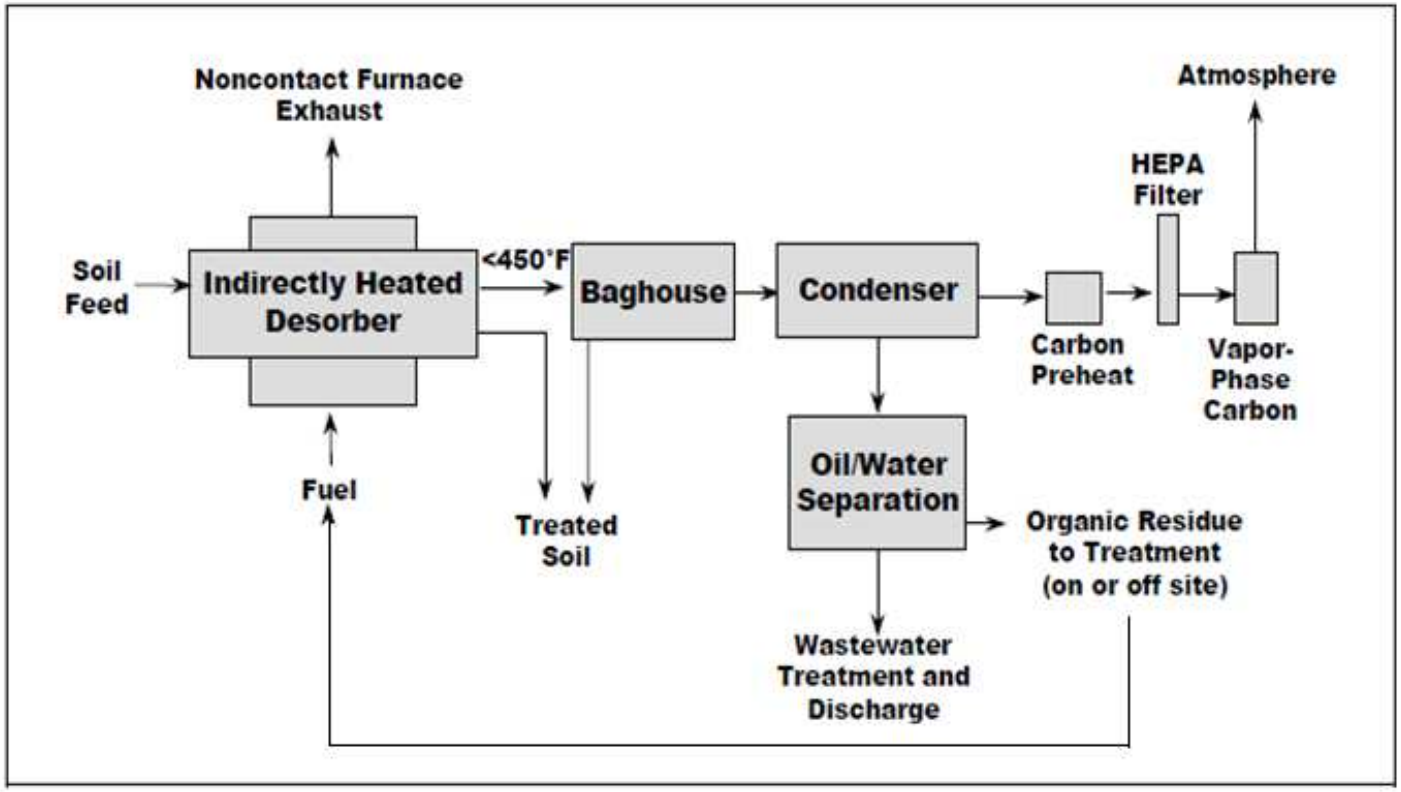
Continuous-Feed Systems — Indirect Contact..

Typical Indirect-Contact Thermal Screw Thermal Desorption Process



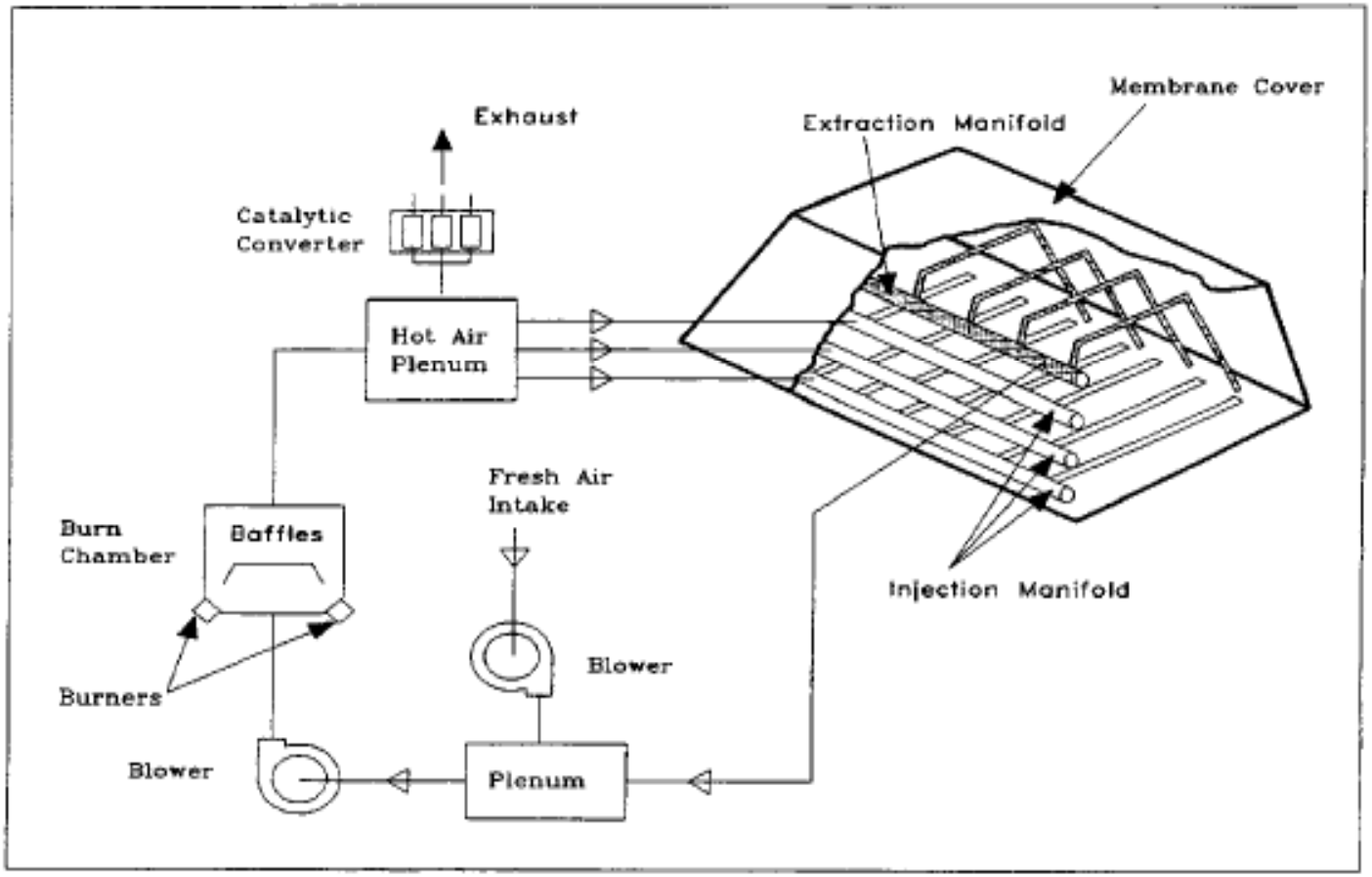
Continuous-Feed Systems — Indirect Contact.

Indirect-Contact Rotary Dryer Thermal Desorption Process



Batch-Feed Systems — HAVE System.

Batch-Feed Thermal Desorption System

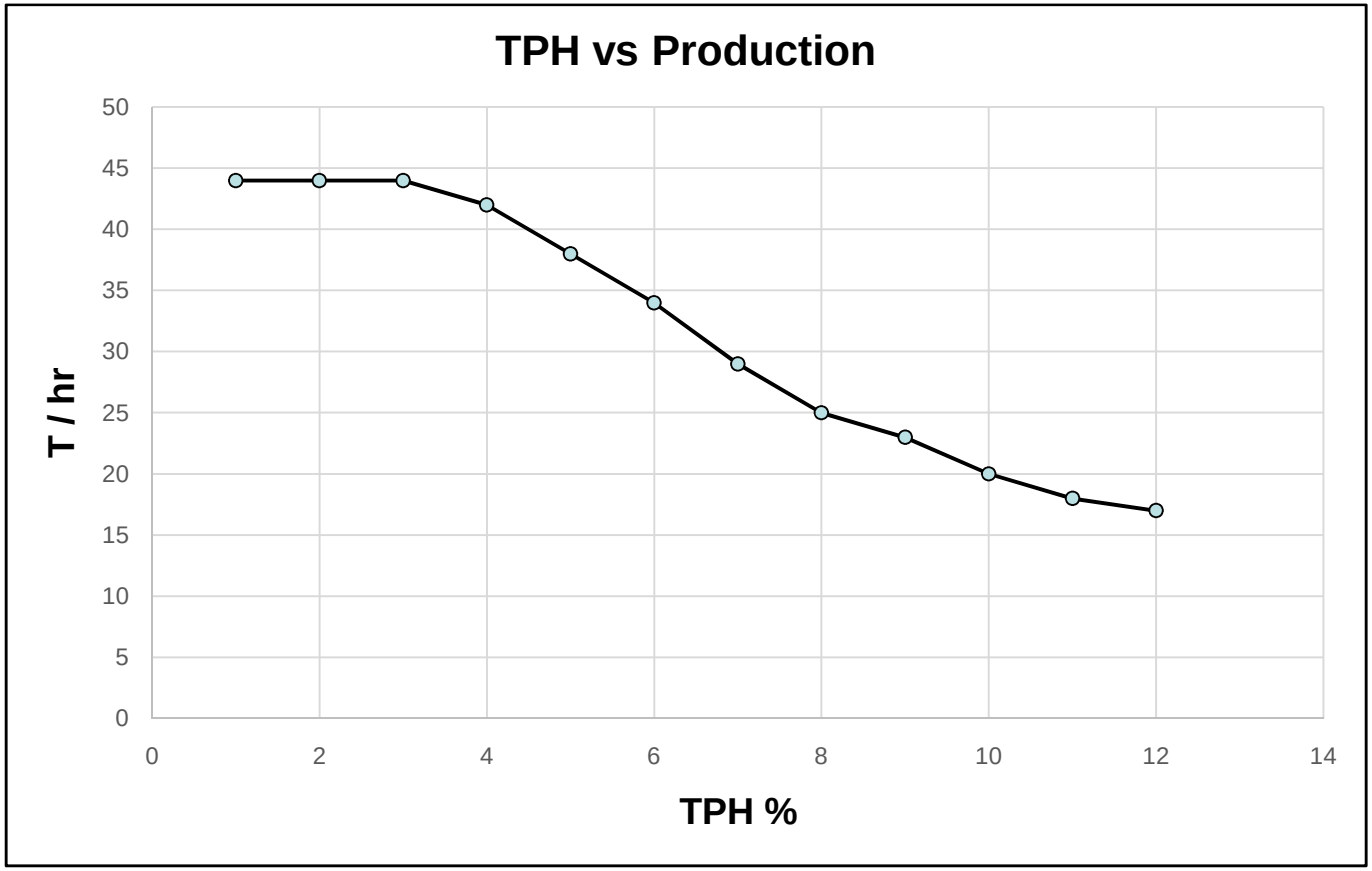


DESIGN AND PERFORMANCE CHARACTERISTICS

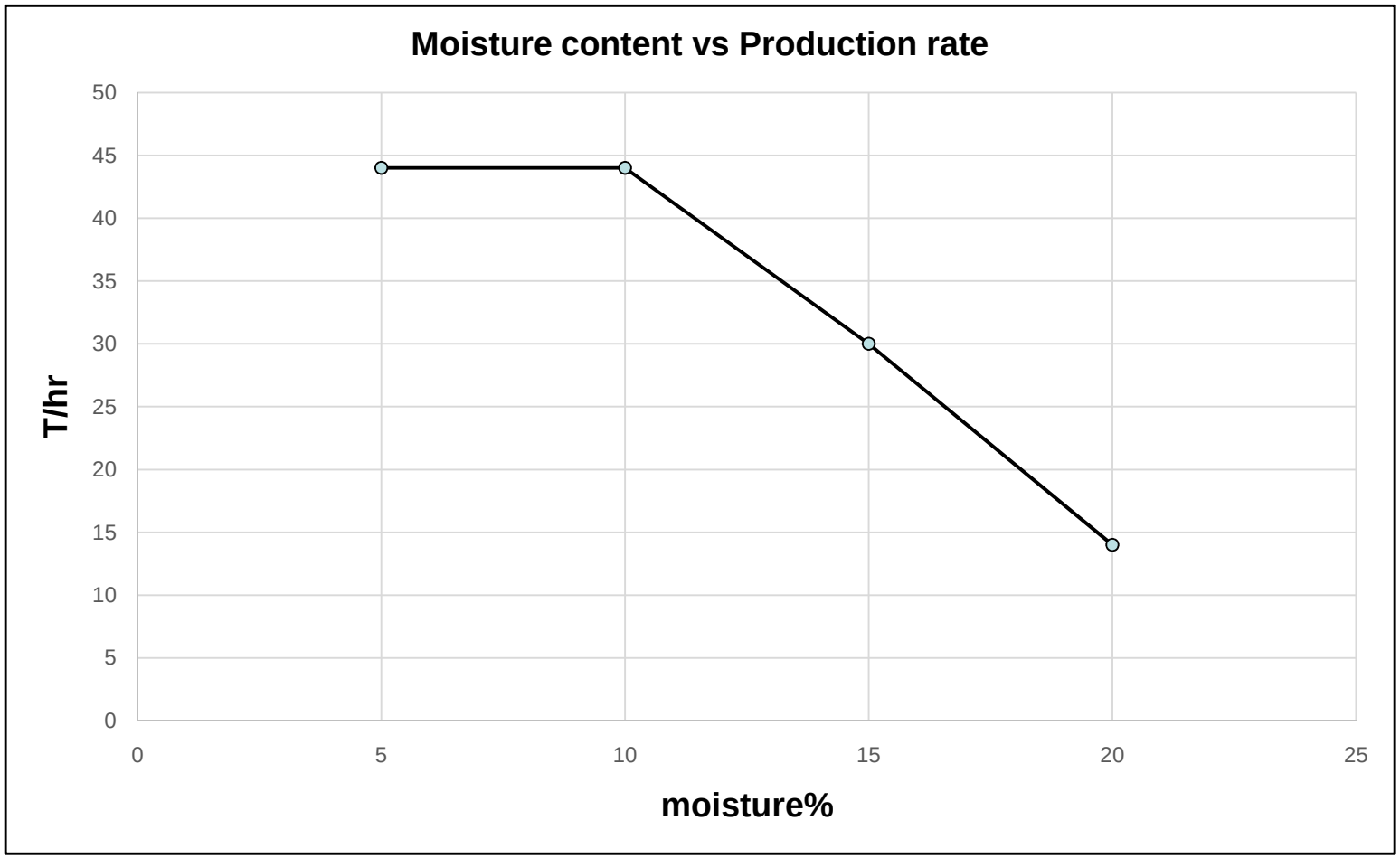
Case study

1. TPH %
2. Moisture content
3. Fines \ Clay content %

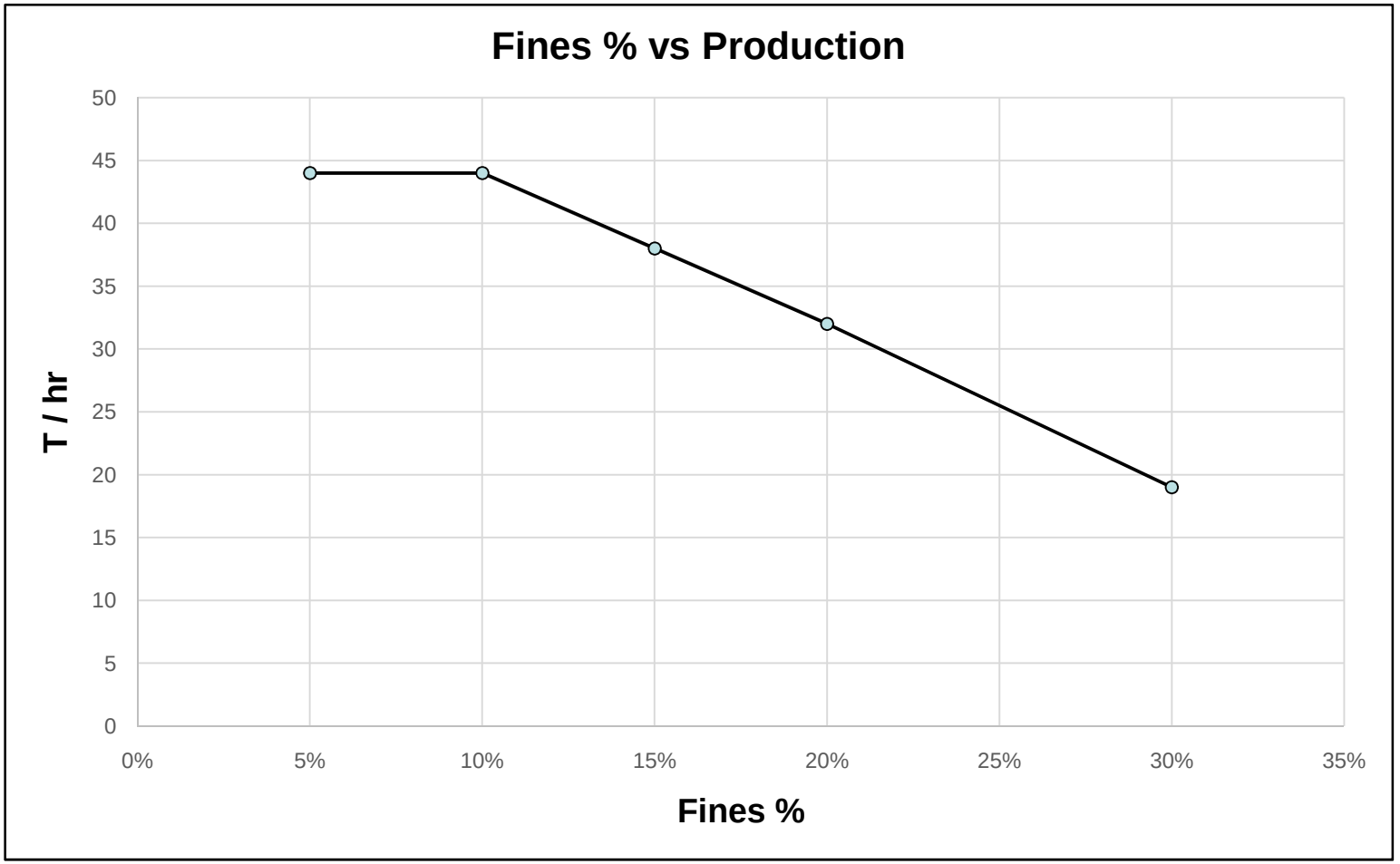
Case Study


TPH vs Production
T / hr
50
45
40
35
30
25
20
15
10
5
0
0
2
4
6
8
10
12
14
TPH %

Case Study


Moisture content vs Production rate
T/hr
50
45
40
35
30
25
20
15
10
5
0
0
5
10
15
20
25
moisture%

Case Study



www.kockw.com

Kuwait Oil Company
A Subsidiary of Kuwait Petroleum Corporation

Weathered crude contaminated soil treatment by Thermal Treatment systems

Acheavments

Total TDU Vol. treated in Lot A = 33,071 m3

Total TDU Vol. treated in Lot C = 92,863 m3

Grand Total = 125934 m3

www.kockw.com

Weathered crude contaminated soil treatment by Thermal Treatment systems

Lessons Learnt & Conclusions:

- **Homogenization of Feed.**
  - To set related TDU parameters.
  - To allow stability of TDU output.

- **TDU as main remediation technology.**
  - TDU is to be used as supportive soil remediation technology due to damage to, organic composition, minerals and ecological function of the soil.

- **Soil Characterization.**
  - Full characterization of the feature is required to identify the main & secondary remediation technologies to be used.

Weathered crude contaminated soil treatment by Thermal Treatment systems

www.kockw.com

Kuwait Oil Company
شركة نفط الكويت
إحدى شركات مؤسسة البترول الكويتية
A Subsidiary of Kuwait Petroleum Corporation

Questions

Thank you