Thermal desorption treatment of dioxin-contaminated soil - report example

Science, Agriculture

Thermal Desorption Treatment of Dioxin-Contaminated Soil

The paper " Thermal Desorption Treatment of Dioxin-Contaminated Soil" is a perfect example of a report on agriculture. The former Allied feed is located at the Rhodes Peninsula. Historically this particular site was used for the manufacturing range of chemicals that are not limited to chlorinated compounds, explosives, and tar among others. This very site was contaminated with dioxins/furans, organochlorine pesticides, chlorophenols, and chlorobenzenes. It is due to this fact that the property is now being remediated for open space, medium-high density residential use, and commercial development. This particular remediation work that is valued at approximately $35M was conducted by Thiess Services, whereby the 5-hectare remediation site was established in August 2005 and the project concluded in August 2009. This particular project is now representing one of the largest dioxin remediation projects ever undertaken across the globe by embracing thermal treatment technology. Some of the remediation activities on the site entail treating some 175, 000 tonnes of dioxin-contaminated soil by directly heating the thermal desorption plant. The feed material being used in the remediation process is made up of extreme concentrations of dioxins/furans and other potential dioxin/furan precursor compounds (e. g. chlorobenzenes and chlorophenols) and some other high proportion of fine-grained spent lime with high moisture content. Directly Heated Thermal Desorption was used at the Allied Feeds site as one of the key technologies used to treat contaminated soil. This particular method was selected as a result of a detailed review of best-performing technologies for such kind of work. This very technology also met strict emission criteria and contaminant destruction efficiencies that were stipulated by the project regulator in the proposal. The emission criteria also adhered to standards set by other regulatory bodies such as Climate Change and Water (DECCW), and the department of environment. The remediation process involves heating soil that contains hydrocarbons under some pre-defined temperature that is generally below 500ºC so that the integrity of soil mechanics and desorption of hydrocarbons contaminants can be maintained. This specific process also requires some time frame usually in the range of 10-20 minutes. The actual site remediation strategy that was initiated after the site investigation involves

- Actual Site Remediation
- Commencing of Earthworks
- Operation of remediation Plant (Shakedown)
- Proof of performance testing
- Continuous treatment operations
- Effectiveness of Actual Site Remediation
- Remediation Results

Fig 1. 0 Diagram depicting Directly Heated Thermal Desorption (DTD) the basic process

- Actual Site Remediation

Remediation works commenced on Friday, 12th August 2005. The Peninsula site is being cleaned to allow significant residential developments to take place. Some of the preliminary processes conducted by Thiess services include;

- Establishing site facilities such as offices and other necessary infrastructure
- Implementation of health, safety, and environmental controls
- Site clearing and preparations of earthworks to enable constructing of treatment facilities
- Construction of water treatment facilities
- Construction of soil treatment buildings
    - Commencing of Earthworks

The estimated quantity of material requiring thermal treatment is approximately 175, 000 tones. The material density is quite low due to low density from lime sludge that accounts for approximately 50% of the material required for treatment. Fig 2. 0 Remediation work Map

- Operation of Remediation Plant (shakedown)

The propose of this operation is to ensure the safety of the mechanical operation of plant units, a guarantee of all instruments in the remediation plant is working well, and calibrating all equipment at the remediation plan.

Treatment Operations

Excavation StrategyVarious fill materials have been kept in the site in horizontal layers, and these materials comprise of soil and ash overlying spent lime. The excavation of contaminated materials was conducted from North to South in order to facilitate concurrent re-development. The materials were being excavated in vertical lifts in order to provide a blending of coarser upper fill soil and ash with underlying fine-grain spent limes. The fill comprised 13-20% moisture content and the lime contained 30-45% moisture. The lime was liquefied during the processes of excavation, handling, and transportation. It was estimated that the overall site material balance comprised of 40% lime and 60% fill. However, with time, the proportion of spent lime in the excavated section shifted tot eh south, and as a result, there were variations in feed moisture content, grain size distribution, and contaminant type over the course of the entire project and this impacted efficiency of thermal treatment operations.

Feed Material PreparationThe feed material preparations were conducted inside the PTB in order to provide weather protection for stockpiled materials, control fugitive emissions, and also to minimize noise impacts. The PTB came equipped with a dual train emission system that provided approximately three air exchanges per hour. Some of the operations inside the PTB entailed blending, screening, stockpiling. The excavated material was blended and fed through a shaker in order to eliminate the oversize materials. These materials were initially screened via a 75mm screen that was later replaced by using a 50-mm screen. Excessive moisture content from the blended feed material led to the frequent bridging of thermal plant feed screen and blockages inside the soil feed system, and due to this bench-scale tests from several different additives were undertaken in 2007. Some of the additives tested include powdered quicklime, flash, agricultural lime, and cement kiln dust. The quicklime dried the feed material fast in order to enable the material to be screened within 24hours from the excavation. In order to minimize dust, Pebble's quicklime was used as opposed to powdered quicklime. From May 2007 onwards, quicklime was used with feed material so as to assist in soil conditioning and also in improving the soil's material handling characteristics. The project's license mandates that performance testing should be conducted in order to demonstrate compliance with soil treatment and stack emission standards. Initial stack testing indicated that the mission results complied with the regulatory criteria, and various modifications were made to the plant during the performance test period. This included;

1. Fitting insulations to cyclones in order to raise treatment temperatures of cyclone fines
2. Refurbishment of the bag-house
3. Modifying rotary dryer in order to increase fines retention
4. Modifying the pugmill

The first performance test was completed in January 2007 and commercial-scale treatment operations commenced immediately thereafter. However, come June 2007, stack emission results for dioxins/furans exceeded the required emission standards and this led to the suspension of operations. Some of the potential causes that were evaluated included; Poor combustion: After some reviews of process monitoring there were no indications of any abnormal thermal oxidizer conditions such as inadequate gas mixing, inadequate gas residence time, and abnormal thermal oxidizing conditions. Poor particulate control efficiency: The particulate emission concentrations during the period of June to July were of the same range as values that were derived prior to a successful monthly compliance test.

Some indicators also showed that data from the stack gas sampling showed that most of the dioxin/furan was collected in vapor form rather than being absorbed into particles. Poor Gas cooling: Some of the symptoms of poor gas cooling includes; damaged water injection nozzles, accumulated wet solids on inside of the evaporative cooler, inadequate atomization air pressure, and high evaporative cooler gas temperature. The evaporative cooler used in this project exhibited some of these symptoms, however, to a minor degree, and therefore poor gas cooling could not be eliminated as a possible cause of increased emissions. Increase in Dioxins in feed soils: There were some tests that were conducted in order to determine the relationship between concentrations of dioxins/furans in feed soil and stack gas. This particular analysis indicated some slight correlationIncrease in concentrations of dioxins/furans compounds in feed materials; In order for this to be professionally evaluated, fingerprints were developed for each feed soil sample that indicated relative percentage of the substituted congeners in the total mixture. Changes in the concentration of precursor compounds would have likely resulted in modified fingerprints into the treated soil. Fingerprints from the soil feed samples and treated soil samples from the compliance tests that were conducted between January to June 2007 indicated identical results hence leading to such potential cause to be eliminated. Even though the above potential causes could have contributed to emissions, there was an additional clue on dioxins/furans. A comparison stack gas emission fingerprints for stack samples was conducted between June-August 2007 compared to January to may 2007, and the results indicated a significant increase in percentages of 2, 3, 7, 8-TCDD congener and a corresponding reduction in OCDD congeners. The fingerprints from June-August 2007 also indicated much higher percentages of 2, 3, 7, 8-TCDD congeners than was present on feed soil and treated soil. In the end, these results implied that most of the dioxins/furans residing in the stack gas were subjected to process conditions (extreme temperatures) that were capable of dechlorinating more highly chlorinated congeners to lower chlorinated congeners.