THE AVENUE COKING WORKS REMEDIATION

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Abstract

The Avenue coking works site in Chesterfield (UK) is being remediated. The works started in September 2009 and will be finished late 2013. The specific nature of the contaminated materials on site, such as the large waste tip and the sludge lagoons, require a combination of on-site treatment techniques that are specially designed and built for these materials. For this reason thermal desorption, bioremediation, complex sorting, and soil washing is being applied.

Introduction

Coking plants could be found in most countries with coal mining and/or steel production. Most steel plants still operate an own coking plant as metallurgical quality cokes are needed to power the blast furnace process. Some coking works however operated independently and delivered cokes for various industries or domestic applications.

The process that turns coal into coke basically consists of the dry distillation of the coal at high temperatures. This process eliminates the volatile and tarry compounds, from which byproducts can be made, such as coal tar, creosote (wood protection), benzol (basis for organic chemistry), naphthalene,… In addition other compounds released during the coking process, such as ammonia, could be transformed into useful products (e.g. ammonium sulphate fertilizer).

It is not surprising that such a complex process caused serious pollution problems. The various chemical compounds formed during the process (BTEX, PAH’s, ammonium, mercury, cyanides,…) polluted the subsoil and groundwater. Such process generated also a lot of operational waste: asbestos insulation and packing, slags, blue billy (spent oxide), liquid gas scrubbing sludges,… All of these were found in abundance on the Avenue site in Chesterfield.

Site Background

The Avenue Coking Works is the site of a former coking plant that was opened in 1956 and ceased operation in 1992. It was a fully integrated plant producing smokeless fuels and processing byproducts that were produced through the carbonisation of coal. The byproducts concerned included sulphuric acid, ammonium sulphate, pure benzene and toluene, xylene, naphthalene and other acids and organic compounds.

Heavy contamination of the site, and the consequential contamination of the adjacent River Rother, after many years of industrial productivity, has resulted in the Avenue site being regarded as one of worst single point sources of pollution in the UK.
The termination of mining activities to the north of Derby and Nottingham in the British East-Midlands, resulted in the 1980s in a legacy of severely contaminated sites. The areas around the Avenue coking works in Chesterfield were part of that. The 'East Midlands Development Agency' (EMDA), owner of the Avenue site, selected DEC (DEME Environmental Contractors) as the preferred contractor for the massive clean-up operation, one of the most major ones in Europe.

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Three typical polluted areas can be found on the site: the two lagoons that store heavily polluted sludges, the waste tip, and the former plant area. In the waste tip all solid waste of the plant was tipped during many decades. This waste comprises soil, ashes, cyanide infected timber, asbestos gaskets,… The lagoons were infilled with heavily polluted sludges from the various processes on site, and contain high amounts of tar, ammonium, sulphate, gypsum, lime,… Figure 1 below shows the various areas on the site.

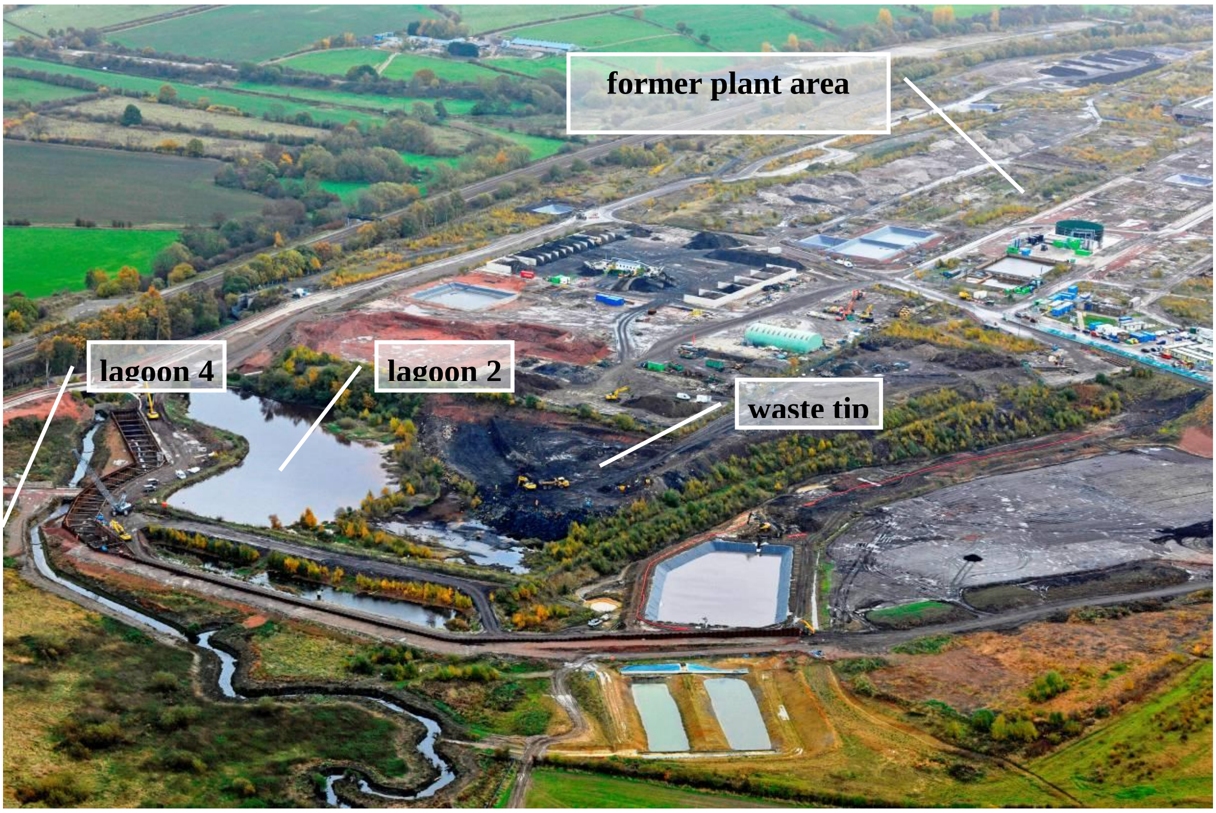

Figure 1. Overview of the site.

Design works

In an ECI (Early Contractor Involvement) relationship DEC was involved early in the design of the works, first with pilot tests, later with additional soil investigation, and finally in the design of the remediation as it is ongoing nowadays.

In 2001 and 2002, DEC performed trials on bioremediation and soil washing for the soils, solidification and thermal desorption on the lagoon sludges.
Later on, in 2006, DEC carried out a large on-site pilot investigation with respect to treatment of the waste tip material by means of selective separation and bioremediation. During the same period an extensive site investigation was being done in order to determine the qualities of the various materials to be expected (in particular waste tip and lagoons) and in order to delineate better the extent of the pollution.

An important boundary condition for the design was the fact that the client wanted to reuse as maximum as possible of the treated soils on the site. As four different set of reuse criteria were imposed on the site, it was a challenge to work out the ground balance for this site.

Remediation works

In 2009 the remediation works started. An extensive range of techniques is used on site: thermal desorption treatment of the most contaminated soils and sludges in order to produce very clean material, bioremediation of the slightly polluted soil, complex sorting for the waste tip material, and finally groundwater treatment. The latter comprises a combination of biological treatment and chemical oxidation.
During the works the air quality is monitored and regularly odour analysis are performed.

The work comprises the excavation and movement of more than two million m^3 of materials. 270,000 m^3 of these will undergo thermal treatment, 74,000 m^3 bioremediation, 327,000 m^3 complex sorting combined with soil washing.

The extensive Site Investigation data held enabled the majority of the contaminated material to affectively be pre-sentenced. The tarry, wet and highly calorific sludges from Lagoons 2 and 4 can only be treated by thermal treatment, whereas the more drier and granular material from the waste-tip is more amenable to bioremediation after first passing through the screening / picking process. The sentencing of material is, however, always undertaken on a case by case basis with considerations being moisture content, calorific value and contaminant types and levels.

Bioremediation is used to treat material to a standard to enable reuse in a low quality location. As such the screened, dry waste-tip material and plant area hot-spots are amenable for treatment and the leachable drivers of benzene, cyanide, phenol and thiocyanate are readily achieved by careful biobed management. The progress of bioremediation is followed through regular chemical sampling and determination of carbon dioxide and oxygen levels and bed temperature. NPK fertiliser is added as necessary to encourage microbial growth and green waste is added to increase bed temperature.

The trials of 2006 confirmed the design of the operation. The operation is required to remove the items that cannot be incorporated into the final landform. A screen splits the waste-tip material into 3 size fractions. The small fines fraction is relatively free of deleterious material and is, after screening, stockpiled and tested to determine whether it is fit for reuse or requires treatment. The largest fraction is subject to further sorting, screening and crushing as it contains concrete bricks, and belting, rags etc. The mid-size fraction goes through a picking station where items including asbestos bearing waste are manual sorted and removed from the stream. A final screen sorts the output of this stream. Gases volatilised at the screeners are subject to extractive carbon filtration. The workers in the picking station are fed fresh carbon filtered air as the environment within the picking station can be high in VOC’s and there is an asbestos fibre risk.

The separated waste is collected in skips below the picking station and sent from off-site disposal.

Figure 2. The complex sorting in operation.

Water from the dirty water holding ponds are pumped to the Water Treatment Plant (WTP). The plant utilises the concrete structures of the old site's WTP which have been modified to become an oil / water separator, mixing / pH correction tank and two settlement tanks.
Settled water is further treated with sodium hypochlorite to remove thiocyanates, then sand filtrated, and finally purified over granular activated carbon before it is discharged into the sewer. In the summer months biological treatment of the water reduces the reliance on chemical dosing and carbon filtration.

Thermal treatment is required to achieve the earthworks balance for the site by taking the most highly contaminated materials and making those comply to the strictest standards on site. This clean material is then to be used close to the river in the northern part of the site.

A thermal desorption plant was specially designed for this project, seen the volumes to be treated and the specific nature of the waste.

Highly contaminated lagoon sludges are mixed with drier and less calorific material to attain the appropriate calorific value and moisture content. The blended material is then processed through the 25t/hr kiln at temperatures in excess of 500°C to drive off all the organic contamination. As the off-gases are extremely loaded with various pollutants, including mercury, a special off-gas treatment system was designed for the plant.

Figure 3. The thermal desorption plant.