Scarborough Power

Technology: Flash Pyrolysis

The following technical summary has been written by Defra's Project Managers on the New Technologies Demonstrator Programme (NTDP), SKM Enviros. The content of this summary is derived from the activities undertaken, results obtained and information produced by the individual Demonstrator's final report.

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Introduction

Scarborough Power Ltd (SPL) took part in the Defra New Technologies Demonstrator Programme (NTDP) to produce energy from Municipal Solid Waste (MSW), using an Advanced Conversion Technology Flash Pyrolysis. SPL was primarily set up to deliver the project and ensure that all milestones were achieved under the NTDP.

Other companies involved in the project were:

- Yorwaste Ltd, a local waste management company
- Graveson Energy Management (GEM), the pyrolysis technology provider
- BB Newco, an asset management and finance company.

The project aim was to construct and operate a cost effective integrated energy recovery plant, using GEM pre-existing pyrolysis equipment. The generated syngas was to be utilised in an internal combustion engine driven generator.

Other objectives of the project were to demonstrate the viability of the flash pyrolysis technology, understand the commercial financing involved and any issues regarding planning and licensing. It was also important that the developed project demonstrated its ability to meet the criteria laid out in the Renewable Obligation Order.

Technology Process

The flash pyrolysis technology employed was developed by GEM and had been proven feasible on stand alone projects. However, this project presented the first case where the technology was being used as part of an integrated system for the treatment of MSW, to be supplied by Yorwaste.

The pyrolysis plant is capable of processing 25,000 tonnes per annum of MSW which allows for a maximum throughput of 1.5 tonnes per hour in order to produce between 1.5 – 2.0 MW of electrical energy.

The integrated process consists of the preparation of the waste, fuel conversion, gas cleansing and electricity/ heat generation.

This is transferred to the pyrolysis chamber via a continuous rolling seal that prevents the flow of oxygen. Instant heat within the chamber and the presence of low oxygen cause pyrolysis to occur when the Refused Derived Fuel (RDF) is introduced, generating syngas and char.

To make the syngas suitable for power generation using a gas engine, it is cleaned to remove water/hydrocarbon condensate before being compressed and stored.

The stored syngas is fed directly into a gas engine which drives an electrical generator to produce power. The generated power is fed into the grid directly and will also supply the parasitic load of the plant.

The engine exhaust is used as a direct heat source for the dryer, after the level of Nitrogen Oxide (NOx) has been reduced using a Selective Catalyst Reduction (SCR).

A Thermal Oxidiser (TOx) is used to remove Volatile Organic Compounds (VOCs) from the wet exhaust and ensure that the stack emission meets the Waste Incineration Directive (WID).

Development Timeline

The timeline for the development of the project is summarised in the table below.

Milestones	Approx Date
Initial proposal discussion between Yorwaste, GEM and NEL Power	January 2005
Consultation on formal planning application	January 2006
Consultation meeting with the Environment Agency (EA) for Pollution Prevention and Control (PPC)	August 2006
Consultation meeting with Local Councillors	October 2006
Submission of planning application to North Yorkshire County Council (NYCC) Atmospheric Dispersion modelling report submitted as an addendum	January 2007
Submission of PPC Application	March 2007
Planning permission received	July 2007
PPC Permit received	August 2007
Site meeting with Scarborough Council Environmental Health Officer (EHO) Consultation meeting with Local Councillors Application for revised plant design submitted to NYCC Submission of Application for PPC on revised plant design	August 2008
NYCC Planning Committee Meeting Planning Permission Received Permit Variation Determined and transferred from Yorwaste to SPL and new issue of Environmental Permitting (EP)	October 2008
Completion of plant	December 2008
Start of Demonstration Period	January 2009
End of Demonstration Period	March 2009

Risk

In order to manage the risk involved in the project, an assessment was undertaken on the programme as a whole, as well as reputation, financial and technical aspects. Further risk assessments continued during the entire period of the project, pre-construction, design and construction phase.

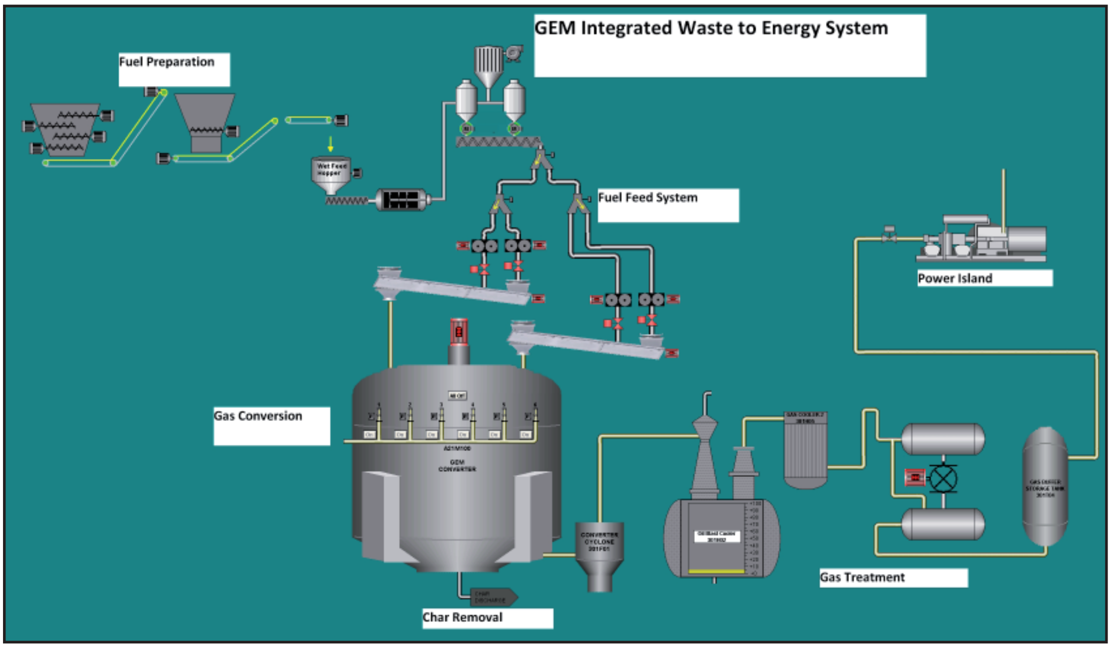
The highest priority risks were identified as the programme and the budget. These were actively managed at the daily planning meetings with regular reviews presented to the board through the weekly report. Reports were also given at the regular SPL Board meetings.

The NTDP project is located at the Seamer Carr Landfill site near Scarborough. Site selection was deemed ideal and proved to be a low risk as it provided the existence of the waste management infrastructure including delivery traffic, landfill availability, weighbridge facility, existing fuel preparation plant (operated by Wastec Ltd).

Planning Issues and Application

Consultants were used by Yorwaste to obtain the planning permission and PPC permit. Two planning applications and PPC permits were submitted to NYCC

Figure 1: Integrated System



Yorwaste prepares the fuel to be used by sorting the MSW into three categories:

1) Recyclates (metal, glass, wood and rigid plastic)

2) Organic (food, garden waste etc)

3) Residue (paper, light plastic, textile etc).

The latter is then shredded and mixed with the organic waste to form Refused Derived Fuel (RDF). The size of the RDF is reduced to <25mm and fed into a dryer to reduce the moisture content to <5%.

and Environment Agency respectively. Permission was granted for both the initial submitted planning application and PPC permit. Further modification to the original design meant that a second planning application and PPC permit was required. The main modification to the design was the increase of stack height from 13m to 27m. The changes were made because of the redesigning of the char and feed system. The increment in height of the structure, meant that it was necessary to submit an Environmental Impact Assessment (EIA) and also carry out a visual impact assessment. The initial planning application did not include any EIA, as it was deemed unnecessary. This was because the plant was being subjected to various limits included within the WID and regulation by the Environment Agency under a PPC permit. To ensure that all concerns were addressed by the initial planning application, Yorwaste undertook an independent assessment on emissions from the plant to accompany its first planning application.

Financial Process and Close

The project was part funded by Defra through its NTDP in addition to shareholder funds raised by Yorwaste, GEM and BB Newco.

Design and Construction

The integrated nature of the project meant that each system had to be constructed and commissioned separately. NEL Power (latterly Carron Engineering and Construction (CEC)) were responsible for the overall delivery of the integration system. SPL later took control of the construction after time overran.

The fuel preparation was designed and built by Wastec Ltd. GEM was responsible for the design and commission of the flash pyrolysis chamber. The generation of power from the syngas was designed and built by Edina UK.

The main design issue was considered to be the overall system and project management. It was acknowledged that the lack of in-depth experience within the NEL Power team and the unfortunate passing of the technical director in GEM, caused delays in the delivery of the project at the design stages.

During construction it was critical that each individual system was well integrated with each other to allow a seamless operation. It was acknowledged that poor planning and design meant that during the groundwork and civil engineering, there were delays

Fuel Preparation: Shredder

Power Island

Drier Installation

Fully Constructed Plant

because of existing activities onsite. Mechanically, lack of attention to detail meant that the dryer unit was incorrectly located. This increased the installation cost by at least £300K. The most significant issue under the management of the project was the lack of communication between designers, vendors and the construction team. Planning the overall project at system level rather than an activity level caused an undesired cost and construction overrun.

Initially, NEL Power had joined the project on the basis of equity. However, financial difficulty encountered by the company resulted in the take-over by CEC. This caused a total re-organisation which led them to drop away from the equity position and assume a contractual on-delivery basis.

Commissioning and Operational Period

The project was commissioned in the following order:

- Infrastructure and Utilities
- Package commissioning (i.e. pyrolysis chamber, gas engine etc)
- System commissioning (connected system commissioning)
- Integrated system commissioning (full process runs from waste feed to Electricity production).

Traditional plant start-up and commission usually require gradual throughput rates to ensure a rigorous testing regime. Construction overrun meant that the SPL plant had to be operational at maximum rate as quickly as possible to achieve the operational hours set by the NTDP. This meant that faults were rectified using the quickest solution to get the plant back online as opposed to addressing the root cause of the fault. Subsequently, the plant was shutdown to address root causes of the technical faults.

There were issues regarding the pressure control and system preparation in terms of warm up times, fuel loading etc. There was also issues regarding the build up of char and the char pinch roller. Char build up was caused during the multiple warm up and cool down coupled with oil leaks. Problems with the char pinch roller occurred during abnormal conditions, when large pieces of char blocked the pinch roller, forcing a plant shutdown.

The commissioning period provided insights into required design improvements such as improving converter efficiency and throughput, reduction of capital and operational cost, and optimising plant eligibility for Renewable Obligation Certificates (ROCs).

The power output was a blend of the syngas and natural gas with a Calorific Value (CV) of 26MJ/KG. This exceeded the CV achieved during the pilot plant trial of 19MJ/KG. The capacity of the demonstrator was 25,000 tonnes of waste with 18,000 tonne to be turned into RDF and sent for energy production. The fuel was prepared for 8 hours per day, 5 days per week and provided SPL with sufficient fuel stock for continuous operation for up to 4 days.

Given the limited period that the plant was operational, only 60% of the intended operational target was achieved. A total of 242 MW of electricity was produced during the operational phase; this was exported to the grid. The system had a parasitic demand of 0.4MW.

The total operating hours achieved by the integrated system was 886 hours and treated 584 tonnes of MSW, meaning the same 584 tonnes of MSW was diverted from landfill. Unplanned downtime cannot be determined as the plant was never in continuous operation. It is estimated that approximately 70 tonnes of char was produced. The exact quantity cannot be given as there were no accurate measurements taken due to a lack of instrumentation.

The main issue surrounding the purchase of power was to demonstrate that the Advanced Conversion Technology being used was eligible for ROCs. Negotiation was therefore necessary with Ofgem to agree on a suitable protocol for fuel testing that would fit the stringent testing criteria. Although a lot of power companies were interested in purchasing the produced power, they were only prepared to enter into agreement if SPL could guarantee consistent and secured level of power. There were significant penalties involved if this was not achieved. Due to the demonstrational nature of the project this risk was not taken and instead energy brokers were approached. After speaking with various brokers and undergoing screening processes a contract with EnDco was signed in December 2008. This meant that the produced electricity was sold on the imbalance market at a lower rate.

Conclusion

Although there were many challenges during the designing, construction and demonstration of the SPL project, it achieved its main objective of producing energy from waste. The continual operation of the plant was limited due to the time constraint set by the Programme.

Thorough consultation and communication with NYCC meant that planners were familiar with the project. This was a key factor in obtaining the planning permission and a successful application. The location of the site also played a part in the project being granted permission, as it was very distant from all residential and sensitive receptors.

To reduce the amount of time and money spent on rectifying problems, it is also important that 3D modelling be incorporated within the designing of the project. The utilisation of experienced engineering teams is also crucial in the delivery of a cost effective project.

Financial issues occurred mainly because the project did not meet the timescale requirement target set in the NTDP contract. Lack of management meant that certain stages of the project overran thus increasing the cost. Critical to this scale of project is clear and regular communication between designers, vendors and the construction team, this could have avoided undesired delays in construction and associated costs.