ABSTRACT

Public private partnership has played a major role in development and successful operation of the current KMS Peel Waste-to-Energy Plant located in Peel Region, Ontario.

On December 10, 1998 KMS Peel Inc. and the Region of Peel entered into an agreement to expand the waste-to-energy facility by 36,000 tonnes (one additional incineration unit). Due to expansion, new, more stringent emission limits were imposed by the latest Ontario Ministry of Environment A-7 Guideline and the Canada-Wide Standards developed by Canadian Council of Ministers of Environment. A Selective Catalytic Reduction (SCR) system with a sodium tetrasulphide injection was selected to supplement the existing dry scrubber/fabric filter air pollution control system for additional reduction in mercury, nitrogen oxides and dioxins/furans emissions. With the upgraded air pollution control technology, the facility will be able to meet the latest emission standards and, to a certain degree, any new standards that may be enforced in future years.

This paper outlines a partnership model that has been successfully implemented in Ontario and has contributed to the public accepting waste-to-energy as integral part of the waste management system, ultimately resulting in facility expansion. It also describes the current facility and upgrade to the existing air pollution control system.

INTRODUCTION

In mid 80s, the Region of Peel (Region) decided to add a waste-to-energy (WTE) plant into their integrated waste management system. The Region's prime goal was to have an environmentally sound municipal solid waste (MSW) disposal method that will reduce their dependence on landfill while they continue to promote and expand the 3 Rs (reduce, reuse, recycle) program.

KMS Peel Inc., formerly Peel Resource Recovery Inc. (PRRI) proposed to the Region to design, build and operate a WTE plant. The WTE plant was sized to handle approximately 30% of the Region's MSW, thus avoiding competition with the Region's recycling effort.

The Region retained MacViro Consultants Inc., an independent consulting firm, to assist them in development of the facility, and defining the roles and responsibilities of the partners, as well as the expected environmental performance of the WTE plant. This agreement became a corner stone of the relationship between the partners; a relationship that is based on trust and commitment towards achieving a common goal having a state-of-the-art facility that operates under the highest environmental standards.

KMS Peel Inc. constructed the 400 tpd WTE facility in Brampton, Ontario (northwest of Toronto) in 1991, and started commercial operation in 1992. Since then, the facility typically has processed approximately 145,000 tonnes of MSW each year, of which approximately 130,000 tonnes is residential waste from the Region of Peel. The other 15,000 tonnes a year is comprised of the selected industrial, commercial and institutional (IC&I) solid waste. The facility generates approximately 8 MW of electricity.

Most recently, in an effort to manage an increased quantity of solid waste generated in the Peel Region due to rapid population growth, and with the main Region's sanitary landfill site closure in the near future, Peel Regional Council decided, based on 8 years of positive experience with waste-to-energy, to expand the existing WTE facility capacity by 25%. This amounts to expansion from 145,000 tonnes per year to 180,000 tonnes. It was also decided to upgrade the existing air pollution control system to satisfy the most stringent emission standards.

PUBLIC PRIVATE PARTNERSHIP

In 1984, the Region of Peel began the process of developing a waste-to-energy facility to handle approximately one third of the Region's non-hazardous solid waste, thereby extending the life of the landfill and generating electricity for distribution to the grid. The strategy the Region adopted to obtain environmental approval, design, construct and operate the facility for a
20 year period, was to form a public private partnership with KMS Peel (formerly PRRI). This private sector group had been selected through a WTE technology selection process as the most suitable bidder for the size of facility that the Region was contemplating. At the time, PRRI had the rights to manufacture the "Consumat" two-stage combustion process.

With selection of the incineration technology and facility developer, the Region added MacViro Consultants Inc. to the partnership to provide technical support to the Region so that an environmentally and cost effective facility would be implemented. As the project moved forward, a waste supply agreement (WSA) was prepared for establishing the specific responsibilities of the partners. From the Region's point of view, the agreement focused on the following main elements:

- Establishing a put or pay contract with fixed tipping fee (escalated over 20 years) and waste quality/quantity limits.
- Establishing emission criteria that at the time were significantly more stringent than local standards.
- Establishing Region control over the method of residue disposal and treatment.
- Establishing continuous emission and operating parameter monitoring requirements, together with remote viewing access on a real time basis, via remote modem from the Region's and MacViro offices.
- Providing for monthly performance reports submission to the Region for review, and unrestricted access to the plant.
- Providing for the Region to undertake annual emission testing and ash testing programs to confirm all discharges meet the WSA.

The KMS responsibilities included obtaining all necessary approvals, detailed design and tendering, construction, and operation of the facility, all in accordance with the WSA and regulatory requirements. MacViro have throughout, provided on behalf of the Region, independent auditing during each phase of the project, and continue to review monthly reports and manage the annual testing program.

Since start-up of the plant in 1992, the partnership has continued in a spirit of cooperation, with the WSA agreement being modified on several occasions, to the benefit of both parties. Amendments to the WSA over the years have resulted in adjustments to the cost and revenue sharing formulas as well as changes to the waste handling and discharge criteria, with the result that the following improvements to the operation were implemented:

- Receipt of limited quantities of high BTU commercial waste to supplement the municipal waste.
- Addition of a bottom ash processing system to recover ferrous metals and produce a reusable product, thereby minimizing the materials requiring landfill.
- Addition of an emission control system to the existing dry scrubber/fabric filter system to reduce nitrogen oxide, mercury and dioxin levels to meet the most recent Ontario and Canadian emission guidelines.

The continued success of this private public partnership over the years has directly resulted in the most recent expansion of the facility. The expansion by 25% benefits both parties, improving the economics of the facility for KMS, providing increased disposal capacity for the Region of Peel and the surrounding Regions, as their respective landfill capacities reduce over time.

**FACILITY DESCRIPTION**

The original KMS Peel WTE facility comprised five main sections; the waste tipping floor, fuel enhancement system, solid waste incinerators/ waste heat recovery boilers, steam turbine generator set and an air pollution control (APC) system.

The municipal, post-blue box, solid waste is delivered to the WTE facility by the trucks and dumped onto the tipping floor. The tipping floor acts as a buffer, or storage area for the waste prior to being loaded into the incinerator. The storage area has a capacity in excess of three days. Here, large items such as mattresses and bicycles are removed.

The waste is transferred from storage location to the fuel enhancement system. The original fuel enhancement system consisted of two NRT trommel and metals separation units, was designed to open the bags, remove the non-combustible material (broken glass, grit and grass) and the recyclable material (ferrous and aluminum) from the waste stream and to homogenize the waste prior to combustion.

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The processed waste is loaded into the two-stage starved-air incinerator from the tipping floor by a front-end loader. Waste remains in the primary chamber and as it burns, it is moved slowly towards the back end by the transfer rams. The ash residue, or bottom ash, is discharged from the primary chamber into a quench tank to cool. It takes approximately five hours to burn the processed waste from the time the waste is loaded into the furnace until the ash residue is discharged from the quench tank.
The combustion conditions in the primary chamber are maintained at the sub-stoichiometric level, generating combustible gases. The combustible gases then enter a secondary chamber to complete combustion. The flue gases that exit the secondary chamber enter a heat recovery boilers where high pressure superheated steam is generated. Steam is used to run a steam turbine and generate electricity.

The air pollution control (APC) system is used to clean the exhaust gases prior to their discharge into the atmosphere. This system includes a wet-spray humidifier which cools and humidifies flue gases; a venturi dry hydrated lime injection tower to neutralize acidic gases; and a jet pulse fabric filter system which removes the particulate matter.

Both the incinerators and the APC system were designed to fully comply with the requirements of the WSA and the Ministry of the Environment Certificate of Approval (CoF). The system's conformance has been demonstrated in the monthly reports and during the annual stack testing campaigns.

INTEGRITY AND COMMUNITY RELATIONS

Many steps are undertaken in order to maintain integrity and commitment to the local community. For monitoring the real time WTE plant operation and environmental performance, provision was made to allow staff from the Peel Region and MacViro to remotely access the KMS plant computer system to assess current and immediately past operating history. In addition, a separate computer terminal was provided at the Region's office for the public to observe the plant's real time environmental performance. Emission parameters such as CO, HCl, O2, opacity and temperatures are continuously monitored. The results are summarized and submitted to the Region and the Ministry of Environment (MOE) on a monthly basis. The Region of Peel contracts an independent testing group to conduct an annual stack emission testing on the facility. Emission results and other issues related to the facility environmental performance are discussed at public liaison committee meetings held by the Region of Peel, approximately every three months.

The Peel Liaison Committee was formed prior to construction of the KMS Peel WTE facility in response to a recommendation of the Environmental Assessment Board. The role of the committee is to be a liaison between KMS Peel and the community and to maintain communication between the parties over the entire life period of the WTE facility. The committee is made up of interested volunteers from the community together with knowledgeable representatives from the Region and KMS Peel.

FACILITY EXPANSION

When the Region decided to expand the capacity of the WTE facility by adding a fifth incinerator unit, their wish to upgrade the existing APC system to meet the current air emission limits became a reality. Once a state-of-the-art APC system, the existing system had lost its status due to its inability to satisfy the new environmental guidelines for mercury, nitrogen oxides and dioxins/furans. The current emission standards for the WTE plants in Ontario are more stringent than the standards set originally for the KMS Peel facility. The evolution of the emission limits for the WTE plants in Ontario since the initial KMS Peel plant approval is presented in Table 1. With the expansion, the Region has enhanced the incinerator with new air emission technology to not only meet the new emission standards and guidelines, but also to have a capability to exceed them in future. The unique private/public partnership between The Region of Peel and KMS Peel Inc. has enabled the KMS facility to be the first solid waste incinerator in North American to utilize the new technology for controlling emissions of mercury, nitrogen oxides and dioxins/furans.

The facility expansion will increase capacity by 36,000 tonnes per year. Peel has a "put-or-pay" commitment to this expansion as follow: 36,000 tonnes in each of 2001 and 2002; 31,000 tonnes in 2003 and 15,000 tonnes in 2004 and thereafter. The disposal fee for this additional tonnage will be at a reduced rate. After 2002, the Region will have a first right of refusal to use any remaining capacity for Regional disposal needs. Any capacity not used by the Region can be filled by tonnage from the commercial market and/or other municipalities.

SODIUM TETRASULPHIDE SELECTIVE CATALYTIC REDUCTION TECHNOLOGY (Na2S/SCR).

KMS Peel and the Region evaluated the two proven technologies for upgrading the emission capabilities of the existing dry scrubber/fabric filter system: Selective Non-Catalytic Reduction with Powdered Activated Carbon (SNCR/PAC) and Sodium Tetrasulphide with Selective Catalytic Reduction (Na2S/SCR). The Na2S/SCR technology was selected for the following reasons:

- Greater emission reduction potential: >90% for nitrogen oxides (NOx), >95% for mercury (Hg) and >95% for dioxins/furans (PCDD/F);
- Capability of achieving even lower emission levels for NOx and PCDD/F than required by current
standards through addition of an extra layer of catalyst;
• NOx emissions will be 40% below the new A-7 guidelines thus will generate emissions credits, estimated at $100,000/year;
• Capability for further reduction in NOx emissions thus generating more emission credits;
• SCR with catalytic oxidation is used to minimize and reduce the emission of NOx and PCDD/F;
• Minimal increase in fly ash disposal quantities as a result of increased mercury and dioxins/furans emission reduction.

L&C Steinmüller GmbH developed a process using Na₂S₄ as an additive for the emission control of mercury especially for use in the municipal solid waste combustors in Europe. This relatively simple and inexpensive process is designed to remove both ionic and elemental mercury with removal efficiencies of greater than 95%. Sodium tetrasulphide chemically reacts with mercury to form mercury sulphide, an insoluble salt that is efficiently removed in the fabric filter.

The selective catalytic reduction process is well proven NOx reduction technology used in many combustion applications throughout the world. Recently, a special catalyst capable of dioxins/furans reduction was developed. The SCR process selected for the KMS Peel facility has capability for reduction of both NOx and dioxins/furans. The catalytic reactivity of the catalyst is maintained by pre-cleaning the flue gases prior to entering the SCR. In case of the KMS Peel facility, the SCR unit is installed downstream the dry scrubber/fabric filter, thus substances such as acidic gases, particulates and metals, which permanently attach themselves to the catalytic surface and block their catalytic reactivity, are removed.

The nitrogen oxides in the exhaust flue gases from the MSW incinerators consist of nitric oxide (NO) and nitrogen dioxide (NO₂) which both chemically react in the catalyst with added ammonia to form nitrogen (N₂) and water. Dioxins/furans are split up catalytically by oxidation into hydrogen chloride, carbon dioxide and water.

The SCR system requires that the flue gas temperature be raised to approximately 260 °C from the current 165°C to effectively control nitrogen oxides and dioxins. In the KMS Peel application, waste heat from a gas fired co-generation facility is utilized to increase the temperature of the flue gases prior to entering the SCR process. The overall Na₂S₄/SCR system configuration and integration with the existing dry scrubber/fabric filter system is presented in Figure 1.

ASH MANAGEMENT

Peel Region, as per the Agreement, is responsible for disposal of the residue material resulted from the burning of MSW at the KMS Peel facility including bottom ash, boiler/economizer fly ash and APC fly ash.

The bottom ash residue is currently disposed of at the Region’s sanitary landfill. With anticipated landfill site closure, Peel Region and KMS Peel developed a process that will recycle all bottom ash that is produced at the facility. The first phase of the ash processing facility includes grizzly, magnetic separation system and a vibrating screen to separate recyclables from unusable fractions. The facility was constructed last year. The processed ash is currently used as a daily cover at the landfill thus reducing amount of soil used. This ash can also be used in applications such as trench backfill and road construction. Since the Region’s ultimate goal is to divert the bottom ash from the landfill, research is ongoing to develop end markets for the processed bottom ash. The present target is to divert 42,000 tonnes per year, or 90% of the bottom ash from landfill.

Preliminary investigations were conducted to utilize the processed ash as aggregate in the asphalt paving material. However, the ash must dried for this application in order to be compatible with the normally used aggregate. Realizing that the waste heat is available in the exhaust flue gases after the SCR reactor, KMS Peel and the Region decided to utilize some of that waste heat in the ash drying process. As a result, the ash drying became economically feasible since auxiliary fuel will not be required.

The boiler/economizer fly ash and the APC fly ash, under Ontario regulations, are classified as a leachate toxic waste and therefore must be disposed of separately from the bottom ash at a secure landfill. Currently, the Peel Region with KMS Peel and MacViro assistance is evaluating two treatment technologies that will render the APC fly ash non-leachate toxic. If the results of the recently completed pilot testing program proves that the APC fly ash can be treated reliably on-site, this will allow material to be disposed of at the sanitary landfill, thus further minimizing environmental concerns related to the operation of the KMS Peel WTE facility. This will also create a possibility for the treated APC fly ash to be recycled in future which is the Peel Region and KMS Peel ultimate goal.
CONCLUSION

Since 1985, the public private partnership that was formed between the Region of Peel, KMS Peel (formerly PRRI) and MacViro has continued with the same spirit of cooperation that existed at the outset.

The expectations of the Region have been achieved in that the facility has operated successfully with respect to the waste quantities the plant has handled and the emission levels that were met. Despite this success, KMS over the years has proposed certain changes to improve the facility with the benefits having been realized by both parties. For example, while some changes that were accepted by the Region resulted in improved economic opportunities for KMS, they also featured the side benefits to the Region of reduced air emission levels, reduction of ash quantities requiring landfill disposal, and increased disposal capacity.

The success to date of this private public partnership, and the future success, has and will continue, as long as a genuine spirit of cooperation exists and the facility continues to meet and/or exceed the expectations of both parties. The expansion that is underway demonstrates the experience has been positive for both parties.

The Region of Peel in partnership with KMS Peel continue to reach and surpass all Ministry of Environment set guidelines for emission controls and continue to maintain its strong community relations and integrity commitments.

REFERENCES:

Table 1  
EMISSION LIMITS OVERVIEW  
KMS Peel EFW Plant, Brampton, Ontario  

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Notes:  
R - Reference conditions: 11% O₂; 25°C; 101.3 kPa; dry  
ITEQ - international toxic equivalents measurement for dioxins and furans  
CofA - MOE Certificate of Approval (Air)  
POI - Point of Impingement standard  
CWS - Canada-Wide Standards  
* - gas turbine off-line  
** - for new small facilities with aggregate capacity greater than 227 tonnes/day and units smaller than 227 tonnes/day
Figure 1 - KMS Peel Plant Expansion

Present

Modified

Sodium Tetrasulphide (Na₂S₄) Injection

For Backup Use Only

185 Deg C

By-Pass

Ammonia Injection Point

Selective Catalytic Reactor

Inonerater Combustion Air Supplement

Direct Fired Bottom Ash Dryer

Gas Turbine (5.3 MW)

Generator

Natural Gas

SCR

280 Deg C

149 Deg C

260 Deg C

260 Deg C