Mobile thermal unit for PCB destruction

Cornellier, René & Cornellier, Sophie
FRALMA Technologies Inc.

91, Chemin des Patriotes, Saint-Mathias sur Richelieu, J3L 1A6, (Québec), Canada

ABSTRACT

The most widely used and proven technology to destroy PCBs is high temperature incineration. Properly done, this has been shown to destroy PCBs at a destruction efficiency of 99.9999% or more. Inadequately controlled incineration risks the emission of harmful substances.

Fralma Technologies Inc has been working to develop and built a mobile incinerator to destroy the PCB contaminated oils at the storage site thus eliminating transportation cost and hazardous operation..

With a processing capacity of one metric ton a day the FRALMA MOBILE UNIT is operational within 2 hours of arrival on site.

The FRALMA system meets all the requirements for air quality.

Keyword: PCB oil destruction, CFC and cooling gases destruction, thermal unit, incineration.

1 BACKGROUND

In 1988, there was a fire in a warehouse with a stockpile of paint, solvents and also contaminated oils with PCB in Saint-Basile-le-Grand, Province of Québec, Canada. Mr. Réne Cornellier was living in the city next to where the accident took place. At that time, the Canadian Environmental Authorities didn't know what to do or how could they solve the problem, and some mistakes were done. Some people were randomly evacuated from the area and some others were not; Mr. Cornellier, children and wife were one of those families. This accident was the beginning of his research, once he found out what was inside that warehouse and the consequences to human health. He decided to move his family away from that danger and start finding for an answer to finish with contaminated oils with PCBs. It took him about ten years to be able to produce a prototype, the first that would lead to the next generation and to the commercial size unit that FRALMA presents in this document.

FRALMA Technologies Inc. (by its abbreviations in French - Four Rotatif Â Lit Moléculaire Agité) was born in Québec, Canada on November 1999 and is dedicated to the development and manufacturing of special equipment dedicated for the destruction of POP's.

1.1 Actual situation

The most widespread and most effective technique for destroying PCB-contaminated oil is high temperature incineration or thermal destruction. Properly employed, it allows the PCBs/PCTs contained in these oils to be effectively destroyed without endangering the environment or human health. It is particularly effective for destroying oils contaminated with high concentrations. When improperly done, there is the possibility of highly toxic and harmful dioxin and furan emissions. But a series of parameters exists to ensure that incineration is effective and that the constituents are destroyed. Temperature, gas flow, and residence time are just some of the parameters that must be scrupulously followed and observed to ensure that destruction efficiency of 99.9999% and over is attained. These parameters do not change, regardless of the size of the facility involved.

In the incineration sector, we currently find very high capacity facilities that handle significant quantities of domestic and/or hazardous waste. These are large static facilities built of concrete, which means that waste must be transported to their locations. So, there are several measures that must be taken when shipping products to them for destruction.

Among other things, the current facilities pose two major problems: as they are static facilities, toxic and hazardous products must sometimes be transported great distances. The transport of PCB/PCT is highly monitored and is governed by the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. There is also the risk of spills and contamination, and the shipment could eventually be the target of ill-intentioned attacks. A spill would result in significant consequences for the affected infrastructure, the ground and water tables, and the contamination would be significant and difficult to manage due to its volume. Another element that must be considered in transportation is the condition of the containers in which the PCB/PCT is stored. The barrels are often old and cracked, allowing liquid to leak out, already contaminating the storage area. Retention and confinement plans must therefore be implemented.

These big facilities have also become increasingly socially unacceptable, which poses a problem for establishing new facilities.

2 R & D

Fralma Technologies decided to use the best technique for destroying PCBs, and also respond to the problems of transportation and social acceptability. To remedy the problem of transporting toxic and hazardous waste, the destruction process must go to the various places where these products are found. We therefore need a unit that is mobile and small. As far as social acceptability is concerned, a temporary facility that will only operate for a well defined time and which will burn a smaller volume of waste than the static facilities is more readily acceptable.

In 1998, Fralma Technologies instituted a research and development program aimed at defining a set of parameters for building a **mobile** unit to destroy PCB-contaminated oil, while at the same time meeting the standards governing the combustion and destruction of this oil and the atmospheric emission of waste gas.

Since then FRALMA Technologies Inc. conducts an elaborated research and development program, in close collaboration with CEPROCQ, Training Centre of Chemical Processes of Quebec, affiliated to the School of Maisonneuve to define the parameters of operation of a piece of equipment capable of destroying contaminated oils with PCBs, within the international regulations established by the Stockholm Convention for combustion, destruction, and gas discharged into the atmosphere. (Patent pending Worldwide)

After years of research, FRALMA created a thermal procedure that uses a properly employed method of incineration that effectively destroys contaminated oils with PCBs without endangering the environment or human health. This technology is particularly effective with high concentrations of PCBs (more than 50 mg/kg), and following the right parameters between temperatures, gas flow and residence time FRALMA Technologies achieved a destruction efficiency of 99.9999% or over.

The first prototype under this program was built in 2002 and in 2005 the company began the final phase of research and development to manufacture an industrial version of the FRALMA™ mobile unit.

One major concern was to avoid toxic materials to be transported, avoiding risks of spills and contamination that could result on serious harm to the environment (soil, water, air), and difficult to remediate due to its spreading capacity.

The new incinerator is a mobile unit, which is smaller and easily moved to storage sites to destroy PCB-contaminated oil in situ, with an elimination efficiency of 99.999993%. Our mobile unit meets world environmental standards and it's been built to meet the goal line of the Stockholm Convention, with a capacity of one (1) metric tonne a day.

3 HIGHLIGHTS OF THE TECHNOLOGY

- Designed to be able to destroy very high concentrations of PCBs,
- Can be adapted to handle large or small quantities (economic),
- Does not require water to scrub gas – no accumulation of residue,
- Dry process that recovers chlorine as by-product,
- Combustion chambers that produce small amounts of non contaminated ashes,
- PCB destruction efficiency of over 99.9999% with no liquid or solid contaminated residue (almost 100%),
- Includes a real time gas emission analyzer that continuously read the following gases emitted to the atmosphere: Carbon Monoxide (CO), Chloric Acid (HCl), Carbon Dioxide (CO2), Oxygen (O2), NOX, Sulphur dioxide (SO_2).
- Programmable controller and remote monitoring system that stops system in case of any emergency. All operating data are simultaneously recorded (including gas analyzer – records condition of gas before is emitted to the atmosphere, and monitors temperature and saturation of filtration systems)
- One person operation system
- Can be pulled around with a pick up truck

3.1 Caracterisitcs

The mobile unit has a destruction efficiency rate of over 99.9999%, which is almost 100%, and eliminates both the solid and the liquid waste of these pollutants. The unit was designed to be able to destroy very high concentrations and high contaminations of PCBs. This means that once it is on site, the unit is able to treat all of the contaminated oils directly in situ, regardless of its concentration.

As the unit can be used on all types of storage sites, regardless of their size, it has many advantages. The ease with which it is transported allows it to access places where the accumulation of contaminated oils would otherwise continue. This therefore eliminates the accumulation of large quantities before they are sent to the big incinerators. The unit is also adapted for small sites and is an economical solution for smaller quantities.

The process used does not require water to scrub the gas, so there is no accumulation of residue. The treating process is dry, and chlorine is recovered for use by producers of

Clean Technology 2009, www.ct-si.org, ISBN 978-1-4398-1787-2

chlorine products. Thus, the unit provides raw material for companies that manufacture Javel water and chlorine. The design of the unit has the advantage of limiting the management of contaminated ash. In fact, the destruction process includes two combustion chambers so that the small quantity of ash generated is not contaminated.

Thanks to its design, no accumulation remains on the site at the end of the process. Also, because there is no waste, there is no risk of air, soil or water contamination. As the unit can be moved to the storage sites, the transport of hazardous residue is therefore eliminated together with the associated risks, such as spills that cause contamination and environmental pollution.

Safety was the top priority when considering the various elements during the research and development phase. For the process to be acceptable, it was important for operational safety to be beyond reproach and for any potential shortcoming to be addressed and resolved as soon as identified. For this reason, the safety system includes a real time gas emission analyzer as well as a programmable controller and a remote monitoring system capable of stopping operations. The entire security and remote monitoring system operates continuously and in real time. Control of the device is constant and all operating data are simultaneously recorded. The same applies to the gas analyzer, which records the condition of the gas before it is emitted into the atmosphere, and monitors the temperature and saturation of the filtration systems.

It was also important to have a unit that would be simple to operate. The system is therefore designed so that only one operator is required.

3.2 Major unit component

- Combustion chamber equipped with a hybrid burner (clean or contaminated oil), and with 2 thermocouples located in strategic places to continually register the temperature,
- Destruction chamber equipped with a fuel oil burner,
- Exhaust and flue gas cooling tube,
- Dry gas scrubber and detachable chimney,
- Electronic control for managing operation, continuous gas analysis, data accumulation and automatic safety stop,
- Pumping system (supplied with incinerator) and homogenizing system (maintain the homogeneity of the contaminated oil),
- Contaminated oil reservoir:
    - Batch type operation with capacity of 1 ton per day,
    - Contaminated oil reservoir capacity of 1,200 l (one day work),
    - Reservoir can be filled from different storage drums and the homogenizer assured a uniform mixture for a constant and steady operation,
    - Back-up fuel oil tank,
- Continuous gas analyzer system,
- Diesel generator:
    - Required to operate the incinerator in remote area where electrical supply is not available.
- Chimney:
    - The chimney is retractable for transportation. A mechanical winch is provided for the installation easily done by one person,
- Trailer:
    - Double axle with 20,000 pounds capacity.

3.3 Unit dimensions

For operation:

Length	5.60 metres	(18.4 feet)
Width	3.00 metres	(10.0 feet)
High	6.00 metres	(19.9 feet)

For transportation:

Length	5.60 meters	(18.4 feet)
Width	1.50 meters	(5.0 feet)
High	2.85 meters	(9.4 feet)

Weight: 18,000 Lbs = 9 ton

Chimney:
A prefabricated chimney with 45cm external and 38cm internal diameter, made by 5 removable pieces (to facilitate transportation) of 1m length each one.

4 OPERATION

Once the unit is on site, it takes less than half a day for it to be up and running, ready to destroy oil.

When starting the operation it's important to check on all systems, electrical circuits, scrubber, analyzer and control. Transferring the contaminated oil to the reservoir is the starting operation and the homogenizer start automatically. The system cannot be operational until these steps are complete.

The mobile destruction unit operates at very high temperatures, which requires monitoring and continuous control of many parameters to ensure the smooth operation and destruction of the contaminated oil.

Each chamber operates at a different temperature, the electronic controller ensures that these temperatures of 850°C and 1200°C are always maintained and are stable.

Once the temperatures are stabilized, the automatic control switches the oil supply for the burner in the lower chamber to contaminated oil. The burner in the upper chamber continues to be supplied with fresh fuel oil so that the required 1,200°C temperature is maintained. The destruction process is now working and the electronic control accumulates all the programmed data. Should a fault occur in the operation, it will trigger the safety system and sound the alarm. In such event, the supply of contaminated oil will be interrupted and clean fuel oil supply will be reinstated for a determined period prior to completely shutting down the system. A sensor is located at the base of the chimney where the gas flow begins. This sensor constantly analyzes the HCl content of the gas and sends the reading to the programmable controller. Once the established limit has been reached, it sends a signal to the dry gas scrubber and inserts a new cartridge of absorbent molecules.

4.1 Safety control

The mobile destruction unit operates at very high temperatures, which requires monitoring and continuous control of many parameters to ensure the smooth operation and destruction of the contaminated oil.

Each chamber operates at a different temperature, the electronic controller ensures that these temperatures of 850°C and 1200°C are always maintained and are stable. Once the temperatures are stabilized, the automatic control switches the oil supply for the burner in the lower chamber to contaminated oil. The burner in the upper chamber continues to be supplied with fresh fuel oil so that the required 1200°C temperature is maintained. The destruction process is now working and the electronic control accumulates all the programmed data. Should a fault occur in the operation, it will trigger the safety system and sound the alarm. In such event, the supply of contaminated oil will be interrupted and clean fuel oil supply will be reinstated for a determined period prior to completely shutting down the system. A sensor is located at the base of the chimney where the gas flow begins. This sensor constantly analyzes the HCl content of the gas and sends the reading to the programmable controller. Once the established limit has been reached, it sends a signal to the dry gas scrubber and inserts a new cartridge of absorbent molecules.

4.2 Flow gaz diagram

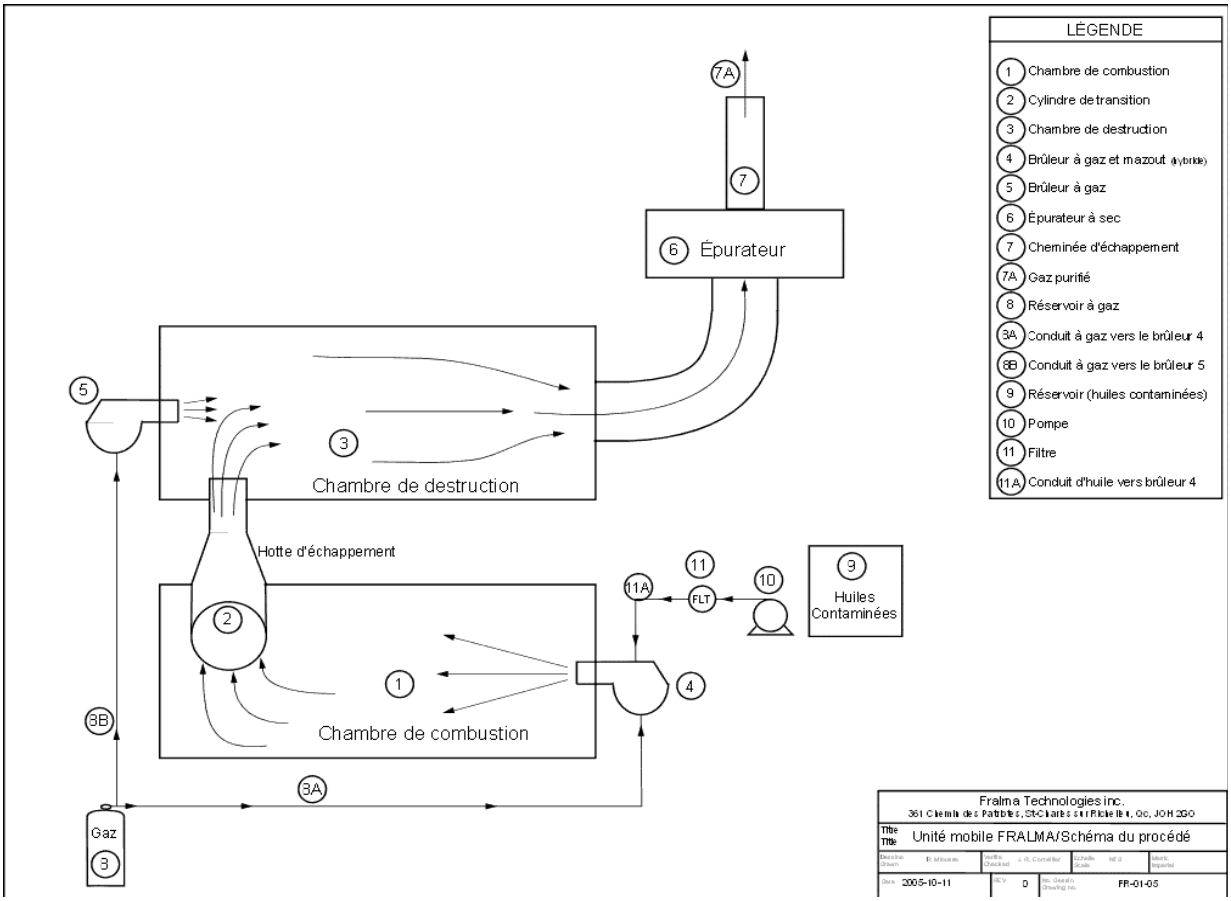

Figure1: Flow diagram

Clean Technology 2009, www.ct-si.org, ISBN 978-1-4398-1787-2