

RCRA PERMITTING OF A VACUUM THERMAL DESORPTION SYSTEM

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ABSTRACT

Envirocare of Utah, Inc. (Envirocare) is in the final stages of permitting a vacuum thermal desorption (VTD) system as a Resource Conservation and Recovery Act (RCRA) miscellaneous unit. Vacuum thermal desorption is a process that removes volatile constituents from a waste matrix, leaving the solid processed material amenable to further metals treatment and/or direct disposal in Envirocare's Mixed Waste Landfill Cell (MWLC). This paper documents the permitting process that began in mid-2002 and includes lessons learned throughout the endeavor. Cooperation and continual communication with local regulatory authorities has been an integral part of the permitting process. The VTD system is being permitted as a Subpart X miscellaneous unit in accordance with the requirements in the Code of Federal Regulations (CFR): 40 CFR 264.600 through 264.603. The permitting process added several new attachments to Envirocare's existing permit that describe operating conditions, shakedown operations, and Demonstration Testing for the VTD system. Shakedown operations were used to refine the system and prepare for Demonstration Testing. Demonstration Testing is the term used for the specifically designed tests to ensure that VTD operations are protective of human health and the environment, specifically assuring that adequate removal efficiencies (REs) are attained for the principal organic hazardous compounds (POHCs) spiked into the feed. During shakedown operations, Envirocare performed several preliminary demonstration tests using waste and clean sand spiked with various spiking compounds. The data from these preliminary demonstration tests has been used to provide additional support of the permit required Demonstration Testing data and is being used to justify interim operations while the Demonstration Testing data is being reviewed. Demonstration Testing was conducted between August 16 and September 8, 2004. During Demonstration Testing, Toxic Substance Control Act (TSCA) parameters were also examined for a national TSCA permit that is being pursued at the same time. The permitting process shows how a regulatory agency and private company can combine resources to achieve the most proactive solution for waste generators and local stakeholders.

INTRODUCTION

Over the years, Envirocare has examined numerous technologies with the capability to treat organic compounds within a waste matrix. Thermal desorption was examined as a volume reduction process that could separate large quantities of organic waste into a solid material that meets the Land Disposal Restriction (LDR) concentrations codified in the Code of Federal Regulations (CFR), 40 CFR 268, and a smaller volume liquid component (condensate) that would then require additional management. Vacuum thermal desorption (VTD) provides an extra level of protection by performing the operation under a vacuum, thereby assuring releases to the environment are minimized. With the aid of a Request for Proposal from Fluor Fernald,

Inc., Envirocare turned full attention to mobilizing the VTD technology to the Clive, Utah facility.

The VTD system employed at Envirocare was designed, constructed, and operated by TD*X Associates, LLC (TD*X). The TD*X principals have experience with the thermal desorption process since the infancy of the technology back in the early 1990's. They are very knowledgeable in the theory and application of the technology and have been used constantly throughout the permitting process.

This paper summarizes Envirocare's permitting process with VTD from its conception in mid-2002 through its present day status.

Technology Description

The thermal desorption technology separates volatile contaminants from solid matrices by indirectly heating the contaminated material in a relatively inert atmosphere and condensing the resulting off-gas. Figure 1 provides a schematic block diagram of the VTD process which consists of three major subsystems: a thermal separation system (dryer), an off-gas treatment train, and a condensate collection system.

The dryer is a cylindrical vessel that is totally enclosed and indirectly heated by a separate propane fired furnace. Material within the dryer is never subject to an open flame. Further, the dryer is kept under vacuum and is purged with a nitrogen carrier gas such that the atmosphere within the dryer has a reduced oxygen concentration (generally less than 6% during operation).

Waste (feed material) is introduced into the dryer through a feed hopper. The waste in the dryer is brought up to a predetermined temperature and then discharged as processed material. During heating, organic material is volatilized and the off-gas is conveyed through a system of condensers and filters to remove the volatile contaminants from the waste stream prior to emission to the atmosphere. The condensate is collected for future management. The processed material is a dry solid material that is below United States Environmental Protection Agency (USEPA) treatment standards for organic contaminants.

Permitting History

Preliminary Research

In January, 1997, the USEPA distributed an Engineering Forum Issue Paper on thermal desorption [1]. Within this document, it is noted that thermal desorption systems are physical separation systems, and that destruction is not the primary form of treatment provided (although some thermal destruction may occur). In this respect, thermal desorption was considered a more favorable organic treatment technology than incineration. With regard to permitting, this document noted that the best advice is to meet early and often with state air and hazardous waste personnel. The document also provided the foundation that thermal desorption systems that do not employ an afterburner technology on the off-gas stream should be permitted using the 40 CFR 264 Subpart X requirements rather than the more rigorous Subpart O incinerator requirements.

Throughout the 2002 calendar year, the Department of Energy (DOE) Mixed Waste Focus Area Group (MWFG) convened monthly meetings to develop strategies that could be used to permit a

VTD unit. The group used the Engineering Forum Issue paper as the basis for their discussions. This group was assembled after it was recommended that VTD was the method of choice for processing organic laden wastes within the DOE complex. Much of the MWFG discussions focused on waste from Fernald, Ohio, that was slated for disposal. Early on, the DOE realized that the greatest opportunity to implement this technology was at the Envirocare facility. Therefore, Envirocare and regulators from the Utah Division of Solid and Hazardous Waste (UDSHW) were invited to participate in the discussions of the MWFG. Overall, the MWFG included participants from DOE technical groups, DOE operation groups, USEPA regulators, state regulators, consultants, and industry.

An unpublished final report from the MWFG was distributed to participants in December, 2002. This report summarized the work and discussions that occurred over the previous year. The report contains information regarding several different VTD technologies that were available at the time. Permitting approaches were also discussed, including potential options using 40 CFR 264 Subpart O (incinerators), Subpart X (miscellaneous units), and Subpart AA (air emissions from process vents). It was decided that the subpart X risk-based approach was most suitable, but that appropriate requirements from Subparts O and/or AA be utilized as appropriate based on the nature of the VTD system being permitted.

The permitting framework compiled by the MWFG provided the foundation for the permitting process that was utilized by Envirocare and the UDSHW. This framework included discussions on performance-based emission standards (organics, dioxin/furan, particulate matter, acid gases, etc.), key operating parameters (minimum and maximum treatment temperatures, minimum vacuum pressures, maximum waste feed rates, etc.), and compliance demonstration testing methodology.

RCRA Permitting

The Permitting process was designed in accordance with the work performed by the MWFG. However, the VTD unit employed by Envirocare was not one of the systems that were examined by the MWFG. Therefore, even though a basis was formed by the MWFG, additional permitting concepts were required for permitting of the VTD unit at Envirocare.

The permitting process officially began on May 2, 2002 when Envirocare submitted a letter to the UDSHW requesting an interpretation of the permitting method. Specifically, Envirocare used arguments from the USEPA Engineering Forum Issue paper and the MWFG discussions to request a response from the UDSHW that permitting of the VTD system should proceed in accordance with the 40 CFR 264 Subpart X methodologies. UDSHW confirmation was received in a letter dated May 20, 2002.

Shortly after the permitting method was verified, draft permit language was written. This permit language began more than six months before the VTD system was built, and therefore relied on a lot of previous experience from TD*X. The draft permit language was written by Envirocare and TD*X and submitted informally to the UDSHW for review and comments. This process continued through the first three revisions of the permit language. During this time, discussions were made regarding the class of modification that the submission will require. Since the treatment process was significantly different than anything Envirocare currently was permitted to do and also required additional tank systems to operate, the VTD system was permitted as a Class 3 Modification. In accordance with federal regulations at 40 CFR 270.42 and 40 CFR 124,

and Utah state regulations at R315-3-4.3 and R315-4-1.10, a Class 3 Permit Modification requires an initial 60-day public information period, followed by a public comment period of at least 45 days after permit changes have been made from the comments received during the 60-day public information period. The public information period is conducted by the permitting facility and the public comment period is conducted by the regulatory authority.

The Class 3 Permit Modification was submitted to the UDSHW on November 18, 2002. The modification added three new attachments to Envirocare's State-issued Part B Permit (Permit) and slightly modified four other attachments and modules. The three new attachments included a VTD operation plan, a plan for waste management in the building that houses the VTD system, and an outline plan for shakedown and demonstration testing operations. The VTD operation plan contained definitions unique to the system, a description of key operational parameters, VTD feed material requirements, off-gas and secondary waste management requirements, analytical verification procedures, and recordkeeping requirements. The permit modification, as submitted, was built on the assumption that the Permit would contain an outline of what would be required for Demonstration Testing and a detailed Pre-Demonstration Testing Plan (PDP) would then be submitted separately utilizing this outline. The submission also included a Subpart X Risk Assessment report that theoretically analyzed the impacts to human health and the environment from VTD operations.

During the public information period, Envirocare compiled a PDP that provided the information required by the pending Permit attachment. As with the Class 3 Modification permit language, Envirocare worked through draft documents with the UDSHW prior to submission of the final language on January 22, 2003. The main purpose of the Demonstration Testing for which the PDP was written was to confirm that waste feed material could be processed through the VTD system and maintain the required emission limits to protect human health and the environment. The PDP included a description of the objectives of the testing, provided a technical approach to the testing, described the VTD system in more detail, and detailed a plan for conducting the Demonstration Testing. Three major concepts were introduced in the Permit language and further developed in the PDP: waste families, principal organic hazardous constituents (POHCs), and removal efficiency (RE). These concepts are detailed below:

1. Waste Families

Waste families are described as chemical groups that have similar separation characteristics. The permit requires unique demonstration tests be conducted for each separate waste family that is desired to be processed through the system. Envirocare identified three broad waste families for Demonstration Testing: volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs). With respect to properties alone, PCBs could have been defined as a subcategory of the SVOC waste family; however, since PCBs were being permitted utilizing a separate USEPA Toxic Substances Control Act (TSCA) permit, it was decided that it should be a separate waste family class.

2. POHCs

The use of POHCs is a concept borrowed from incinerator regulations that provides an alternative to testing every compound that could be processed through the VTD system. The POHC concept goes hand-in-hand with the waste family concept to develop appropriate testing protocol for all desired compounds. POHCs are specific

representative compounds from within a waste family that are spiked into the feed material to represent the processing characteristics of the entire waste family. In the original PDP, trichloroethylene (TCE) and carbon tetrachloride were chosen as POHCs for the VOC waste family and m-cresol was chosen as a POHC for the SVOC waste family.

3. Removal Efficiency (RE)

RE is defined as the percentage of contaminants removed from the feed material prior to emissions to the atmosphere. The main objective of the Demonstration Testing, as presented in the original PDP, was to assure that a RE of at least 99.99% was attained for all of the POHCs.

The 60-day public information period for the Class 3 Permit Modification ended on January 19, 2003. The only comments received through this portion of the permitting process were from the Utah Chapter of the Sierra Club. One of the main points of the Sierra Club comment letter was that much of the information regarding the VTD system was lacking in the public participation documentation provided in the Class 3 Permit Modification. In addition, specific comments regarding the operating requirements were also presented. Most of the comments required technical responses about the system and operations. Envirocare worked with the UDSHW to put together well thought out responses to the comments. An official response letter was sent to the Sierra Club on February 25, 2003.

The UDSHW agreed with the Sierra Club premise that additional public participation information was required for this new technology. Based upon that premise, and some additional comments from Envirocare and the Sierra Club, the PDP was re-reviewed and changes were suggested to make the document more informational in nature. A new revision of the PDP was submitted to the DSHW in a letter dated March 12, 2003. The main objective of the PDP remained as described above, but additional information regarding the VTD system and exact Demonstration Testing procedures was added. Sampling matrices were also created for all Demonstration Testing process cycles (batches).

Upon further review, the UDSHW requested that Envirocare update the new VTD Permit attachments to include more of the information that was written into the PDP. The basis for this decision was so that more detailed information regarding the VTD system could be placed in a more publicly accessible document (the Permit). Changes were made to the attachments and submitted to the UDSHW in a letter dated May 12, 2003. These changes included:

- more and better definitions;
- additional descriptions and requirements for operational safety controls;
- additional operating parameters; and
- details on Operational Parameter development through Demonstration Testing, including the potential for an interim operational period.

In conjunction with the additional information in the Permit attachments, the UDSHW requested much more detail within the PDP. Based upon this request, a revision to the PDP was written and submitted on May 15, 2003. This revision included more organization within the entire document and added sections on data quality objectives and additional data management such as efficiency calculations and mass and heat balances over the system. At the request of the

UDSHW, this revision of the PDP also included three categories of tests for the demonstration of the unit: preliminary testing, Air Pollution Control (APC) demonstration testing, and operational demonstration testing. Details for these tests follow:

1. Preliminary Testing

Preliminary testing consists of the functional testing, systems demonstration testing, shakedown operations, and any preliminary tests done on the system. Functional testing is a dry run of the unit to assure that all parts are functioning properly when no load is placed upon them. Systems demonstration testing is similar to the functional test, but a non-hazardous feed material is processed to assure all systems are operational. Shakedown operations are an optimization process for the VTD system where waste is processed and system knowledge is obtained prior to actual demonstration testing. Preliminary testing is actual emissions monitoring tests that provide information on the performance of the VTD unit and provides an opportunity for system modifications if necessary.

2. APC Demonstration Testing

APC Demonstration Testing is designed to evaluate the proper operation of the off-gas treatment train (APC system). This test is designed to challenge the APC system by processing a large amount of organic material (POHCs) and measuring the resulting off-gas emissions. For the PDP as written, the APC Demonstration Test was to consist of four process cycles of clean fill material spiked with appropriate POHCs. These four process cycles were to consist of two conditions, wet and dry clean fill material, both performed in duplicate, so that the affect of water within the matrix could be examined. The list of POHCs was also expanded to attain a better range within the waste families. POHCs for the VOC waste family include TCE, carbon tetrachloride, and 1,2-dichloroethylene (1,2-DCE). POHCs for the SVOC waste family include m-cresol. Additionally, 1,2-dichlorobenzene (1,2-DCB) was chosen as a POHC for both waste families because its properties are on the border between these two.

3. Operational Demonstration Testing

This testing was designed to challenge the VTD system by processing several consecutive process cycles using varying waste matrices (e.g., soil, sludge, liquid, etc.). For this test, actual waste matrices were to be utilized and off-gas analysis would not be necessary, since the objective of the test is to observe the system performance with regard to continuous operation and various types of waste.

As these documents were being reviewed, a paradigm shift occurred at the UDSHW. Based upon the public's request for additional supportive information, the UDSHW decided that the PDP should be added as an attachment to the Permit. Since the current PDP was written in a report style rather than a permit attachment style, it was necessary to reorganize the entire document to fit the style of the Permit. In addition, the UDSHW thought it best if the other attachments were also rewritten to provide a better flow of information and allow more accurate responses to potential public criticism. Over the course of three weeks, Envirocare personnel and UDSHW personnel worked together to rewrite the VTD permit attachments. This consisted of a line-by-line review of the documents with all parties present for comment. During this phase, some critical changes were made to the permit that has the potential for public scrutiny.

Many of these changes were made based upon initial marketing information presented to the UDSHW by TD*X and Envirocare that could not be removed through subsequent discussions. These controversial changes are described below.

Based upon matrix effect discussions, the UDSHW decided that it would be a better test of the system if waste was used instead of clean fill material within the APC Demonstration Test. Although the originally designed test would be cleaner and easier to analyze, Envirocare did not object to this change. Along with this change, the UDSHW suggested a requirement that all known waste contaminants other than POHCs would also have to conform to the RE requirement of 99.99% efficiency. Envirocare objected to this requirement on the basis of its enforceability and fairness. The 99.99% RE requirement was taken from incinerator regulations; however, incinerators are only required to perform this assessment for their POHCs, not all other constituents. In fact, an incinerator would not be able to attain a 99.99% RE for constituents that were found at low concentrations in the feed. Envirocare also questioned the VTD systems ability to meet this criterion for compounds that are detected at low concentrations in the feed, particularly if laboratory detection limits could not verify if the required efficiency could be obtained. In response to Envirocare's objections, the UDSHW added a caveat into the PDP acceptance criteria that allowed approval of compounds that do not meet this requirement "based on a review of explanations, demonstrations, and/or research provided by the Permittee."

Another change objected to by Envirocare was to add a requirement that compounds identified in the condensate or exhaust gas stream could not differ from those identified in the waste matrix. Due to compound concentration in the condensate, residual contamination in the VTD system and lower detection limits in the off-gas; Envirocare guaranteed the UDSHW that this requirement could not be met. The basis for this requirement was that, since the VTD system was being permitted as a Subpart X miscellaneous unit, no combustion should take place. Based upon initial quotes from Envirocare and TD*X that no compounds would be created within the system, the UDSHW took the most conservative route to assure that the public could not question whether combustion was occurring within the VTD system. Upon Envirocare's objections, additional language was placed into the permit suggesting that "the Permittee can demonstrate that the testing was actually successful or that minor corrections can be made to the TD unit that will provide successful results." Since the time this language was written, both parties have agreed that there is the potential for a small amount of pyrolysis or other chemical breakdown within the system. Both parties also agree that the lack of combustion is the main issue and is the criterion that should be addressed when making the determination whether a test is successful or not.

The rewrite of the permit was completed and the UDSHW sent the modification out for the required public review period on July 15, 2003. Since the changes to the permit were substantial, the UDSHW decided to allow the public more time to review the material, thereby making a 60-day public comment period rather than the nominal 45 days required by state regulations.

Many comments were received in response to this public comment period. Substantial comments came from the Sierra Club and an undisclosed technical source. Additionally, many form emails were sent to the UDSHW by a citizens group that targeted this particular permit modification. The Sierra Club comments were similar to the previously submitted comments and showed concern that the VTD technology should be considered an incinerator (adding more credence to the necessity of assuring that no combustion within the unit can be verified). The undisclosed source showed a technical understanding of the matters at hand and provided

thought provoking discussions between Envirocare and the UDSHW. Comments included the applicability of using REs, examination of the potential for products of incomplete combustion (PICs), the consequences of volatile metals within the waste, applicability of the automatic waste feed cut off (AWFCO) system, and the disposition of the secondary waste created through the process. All comments were taken into consideration by both the UDSHW and Envirocare. Minor changes to the permit attachments were written in accordance with the comments and the UDSHW provided approval of the Class 3 Modification on December 5, 2003.

VTD Permit Elements

The permit modification, as approved on December 5, 2003, provides for shakedown and demonstration testing of the unit. The permit language contains the potential for an interim operational period as designated by the UDSHW Executive Secretary. This interim operational period is to allow operation of the system after the demonstration test has been completed while the data from the test is being compiled and reviewed. Upon completion of the demonstration testing and submittal of a report, Envirocare is required to submit an additional permit modification to add the operational information learned from the demonstration testing into the permit through additional operational attachments for each waste family demonstrated. Full approval of the VTD system will occur after this final permit modification is approved by the UDSHW.

Demonstration Testing is to be performed in accordance with the PDP permit attachment that was generated during the permitting process. The PDP lays out a series of four APC demonstration tests and additional operational demonstration tests for each matrix that Envirocare desires to process through the VTD system. The APC demonstration tests include spiking wet and dry waste material with appropriate POHCs (POHCs have not changed since the previous revision). Specific parameters such as the temperature of the off-gas leaving the condensing system and the internal pressure of the dryer are to be examined during demonstration testing in anticipation of potential permit changes during the post-demonstration permit modification. During testing, emissions sampling is to be conducted for VOCs, SVOCs, dioxins/furans, hydrochloric acid (HCl), particulate matter (PM), carbon monoxide (CO), and metals. Further, samples of the feed, the processed material, and the condensate are to be completed for each process cycle of demonstration testing.

Demonstration testing is considered successful if the following acceptance criteria are met:

- The processed material meets LDR for VOCs and SVOCs;
- All POHC and known waste contaminant REs are greater than 99.99% (or are approved by the Executive Secretary of the UDSHW);
- Visual opacity monitoring is 0% for all both emission points (propane heater and off-gas);
- Carbon monoxide, after dispersion modeling, is below 9 ppm (volume) averaged over an 8-hour period;
- The cancer risk, based upon off-gas concentrations, is less than 1×10^{-6} for an adult residing at the point of maximum concentration;

- The hazard index, based upon off-gas concentrations, is less than one for a child residing at the point of maximum concentration for the duration of the test;
- The average overall total mass balance has a recovery greater than 75% of the feed;
- Compounds identified in the condensate or off-gas do not differ from those identified in the waste matrix; and
- The off-gas does not exceed the effluent concentration limits for specific materials in accordance with the Utah radiation control rules (R315-15-302).

VTD System Testing

This section summarizes the testing that has been performed from the initial testing of the unit through the recent demonstration testing. The testing elements were described previously and include preliminary testing, APC demonstration testing, and operational demonstration testing.

The VTD system employed at Envirocare was fabricated in Clemson, South Carolina in January, 2003. The unit was assembled and initially tested at the fabrication shop on February 10 and 11, 2003. Envirocare and UDSHW personnel flew to South Carolina and witnessed the original functional and systems demonstration tests. All parts were carefully inspected and operated dry to assure they were in working order. After this functional testing was completed, approximately two drums of a clean soil material were fed into the unit and all operating parts were tested. Some minor problems occurred during this testing, but the overall test was effective enough to ensure that the system would operate properly. After this testing was completed, the VTD system was mobilized to Envirocare's facility in Utah. Another similar test was conducted at Envirocare after the unit was re-assembled.

Waste was first introduced into the unit during shakedown testing in March, 2003. Envirocare used this period as treatability study testing to assure that the system would achieve the stated goals. Since the unit generally processes 2000 to 2500 pounds (lbs) of waste per batch, and the regulations (40 CFR 261.7(f)) limit the amount of "as received" hazardous waste that can be treated in all treatability studies in a single day to 250 kg (~550 lbs), it was necessary for Envirocare to request a variance from the Utah Solid and Hazardous Waste Control Board (the Board) for the quantity of waste that may be processed in a treatability study. This request was approved by the Board in an emergency session on March 6, 2004. This approval was for 30-days only. During this initial shakedown operations treatability study period, waste was successfully processed; however, several problems occurred as is expected of a new start-up operation. These problems included issues with seals, filters, and the vacuum pump. All problems were good lessons learned and corrections were made to the system as these problems developed.

Based on the positive initial reaction of the system and the fact that more testing was required to improve operations, Envirocare submitted a second variance request to process up to 8,000 kg of waste per day for 30 operational days. This variance request was approved on June 12, 2003. Treatability study variances were not required after UDSHW approval was granted on December 5, 2003.

During the treatability study and shakedown testing time periods, several tests were conducted on the system. To date, Envirocare has performed three separate pre-tests and the Permit required demonstration testing. These tests are detailed below.

1. Preliminary Demonstration Test

The first preliminary test was performed on July 30, 2003. This test was performed on one process cycle with a feed of approximately 1,000 lbs of an oily/watery waste material spiked with TCE, 1,2-DCE, 1,2-DCB, and m-cresol. Calculated spike concentrations ranged from 1,058 ppm for m-cresol to 11,582 ppm for TCE. The total process cycle took approximately seven hours to complete. All acceptance criteria were met with the exception of the criteria that compounds identified in the condensate or off-gas could not differ from those identified in the feed. However, examination of the compounds concluded that they were too complex to be formed by contaminants within the feed material. The off-gas was sampled, using EPA stack testing methodology, for VOCs, SVOCs, PM, Metals, CO, and HCl.

As this was the first test of this type conducted by Envirocare some errors occurred that required correction before another test was performed. These errors included the fact that the test was performed in the middle of a processing campaign and not as a stand-alone test, sample tracking did not collect all of the necessary samples required, process streams were not accurately measured, the laboratory did not provide the level of attention desired on the analyses, the volatile air emissions were only performed in the first half of the process cycle, and regulators were not properly informed of the schedule of this test. Due to these errors, an official results submission was not made to the UDSHW. An unofficial copy was provided, but the results are not intended to be used as justification for any future tests or analyses.

2. Pre-Test

A second preliminary test was completed on March 9, 2004. This test was planned and conducted much better than the first preliminary demonstration test. The main purpose of this test was threefold: (1) to gain a better understanding of the operation of the thermal desorption unit, and where it stood in preparation for the permit required demonstration testing; (2) to be the permit required pre-test associated with Preliminary Testing; and (3) to provide data to the UDSHW in order to raise their confidence in the system and allow potential interim operations after the permit required demonstration testing is completed. A pre-test plan was compiled and submitted to the UDSHW prior to the test. Further, the UDSHW asked for testing protocol from the Emissions Testing Contractors. This testing protocol was to explain the off-gas testing used and also any deviations from the EPA methods that are needed for this particular situation. Deviations from the EPA methods were necessary due to the small diameter of the sampling manifold and the low flow rate of the off-gas. All parties agreed before the test that these deviations were within the tolerances required for a successful test.

The test consisted of one process cycle of a spiked clean sand feed material. The feed material was spiked with all five of the demonstration testing POHCs. The off-gas was sampled for all of the required demonstration testing parameters from the PDP. Background sampling of the sand showed tetrachloroethylene (PCE) present at 18 mg/kg and trichloroethylene present at 23 mg/kg. Therefore, by

definition, PCE was a known waste contaminant. The off-gas sampling had a very high concentration of tetrachloroethylene which caused the RE calculation to fall well short of the acceptance criteria of 99.99%. Since PCE was a known waste contaminant and did not meet the RE acceptance criteria, it was necessary to perform an additional demonstration test to justify this compound.

Additionally, compounds were identified in the condensate and off-gas that were not identified in the feed. Upon examination of the data, Envirocare theorized that the contamination in both the condensate and the off-gas was coming from residual contamination within the system from previous waste processing. In particular, the rubber hoses used to connect the sampling manifold to the system seemed a likely contamination source. Most of the compounds that were detected in the off-gas and condensate were predominant contaminants within the waste that had been processed within the VTD system prior to this test, thereby justifying the assumption. Corrective action for later tests included replacing these rubber hoses with stainless steel lines and providing a more thorough clean-out mechanism prior to demonstration tests. Envirocare acknowledged that a complete clean-out of the system was not possible and residual contamination would always be present. Furthermore, this residual contamination has the potential to be mobilized when a strong solvent is processed through the system.

To further verify that the additional compounds identified in the condensate and off-gas were residuals within the system and were not created by the system, Envirocare procured the services of an expert PhD chemist to provide a brief analysis of the results, with general knowledge of the process. The expert attested that the additional compounds identified could not have been created from the feed compounds under the conditions presented. This justified the results and allowed Envirocare to claim that the additional compounds acceptance criterion was successful for this test.

All information pertaining to the Pre-Test was compiled and officially submitted to the UDSHW in a post-test report.

3. PCE Pre-Test

The third preliminary test was the PCE test that was necessary to allow PCE to be processed through the system. This test was necessary because of the PCE RE failure within the second preliminary test. A PCE Pre-Test Plan was submitted to the UDSHW and approval was given prior to conducting the test.

This test consisted of two process cycles with feeds consisting of clean sand material spiked with carbon tetrachloride in the first process cycle and PCE in the second process cycle. The first process cycle was used as a clean-out process cycle and also to collect evidence of potential contamination within the system. Carbon tetrachloride was used in this clean out process cycle because it is a very good cleaning solvent, was not associated with the breakdown chain of PCE, and had easily achieved the RE criteria in the previous test. Care was taken to ensure that the clean sand used in this test did not contain any residual contamination as was found in the previous test. No problems were encountered during this test. The condensate contained only carbon tetrachloride in the first process cycle and

both carbon tetrachloride and PCE in the second process cycle. All RE calculations were within acceptance and the test was considered a success. A post-test report was submitted to the UDSHW as an official record of this test.

4. Permit Required Demonstration Testing

The permit required demonstration testing was conducted on August 17, 18, 19, 23, 25, 26, 27, and September 8, 2004. As required by the permit, a fully detailed plan was submitted to the UDSHW approximately one month prior to commencement of the tests. This plan provided a day-by-day breakdown of the testing as well as information on the waste to be utilized and the personnel performing key roles. Sampling matrices, including quality assurance samples, were included in this plan.

Operational demonstration testing was conducted the first week (August 17, 18, and 19, 2004). Three waste matrices were examined: soil-like, sludge, and liquid. The UDSHW pointed out that, in accordance with the permit, it was necessary to obtain some RE data on each of the waste matrices to achieve success. Since off-gas sampling was not being conducted this first week, this analysis could not be performed. Since the same waste streams were being used in the APC demonstration testing the next week, Envirocare and UDSHW agreed that the two tests could be combined. However, operational testing was still conducted the first week to determine how the system would handle the differing waste matrices.

During the week of August 23, 2004, several problems occurred, but none were severe enough to disqualify the demonstration test. Rotameter calibrations and slow performance of the VTD system caused the first process cycle to run late into the night, ending after 2:00 AM. This necessitated repairs of the system on August 24, precluding any testing performed that day. On August 25, a leak in the system caused a no-flow situation through the off-gas sampling trains for approximately one-hour. Further, the sampling train leak check failed for dioxins/furans, making the test obsolete. Therefore, it was decided by all parties involved that the testing on August 25 would not be used as demonstration testing. Another problem occurred on August 27, when a liquid with a yellowish film appeared in the off-gas rotameters approximately one hour into the test. The substance eventually made the first rotameter unreadable and broke the dry-gas meter that was placed in-line to calibrate the rotameters. After the run was completed, it was discovered that this substance had a pH near zero and off-site analysis showed that it was hydrochloric acid. An analysis of the situation showed that some type of thermal breakdown occurred within the carbon adsorption drums that are used as a polishing step for organic compounds.

The problems that occurred necessitated an extra day of testing that occurred on September 8, 2004. No issues occurred on this day.

After the testing was completed, Envirocare suggested corrective actions to minimize the potential of a hydrochloric acid generation event occurring again. The root cause of the problem was that uncontrolled temperatures within the carbon adsorption drums were causing an environment conducive to chemical breakdown and the subsequent generation of hydrochloric acid. Testing of the

corrective actions was conducted in November, 2004, with the approval of the UDSHW. This testing proved that the corrective actions were appropriate.

Results from the demonstration testing event were compiled and provided in two separate reports to the UDSHW on December 16, 2004. The report concluded that the testing successfully demonstrated that the VTD system could process both dry and wet feed material.

Future Direction

The demonstration testing data has been compiled and submitted and is currently being reviewed by the UDSHW. Envirocare has requested interim operations, but has not yet received authority. The UDSHW has completed a completeness review of the demonstration testing report and has discovered a required test that had not been conducted during the testing. This required test that was overlooked by Envirocare was an emission grab sample to determine the gaseous radioactive concentration of the emission. In accordance with the PDP, this test was to be conducted to determine if the emissions exceed the radioactivity effluent concentration limits listed in the Utah Radiation Control Rules.

An additional demonstration test is being prepared to conduct this additional testing. After this testing has been completed, and the required samples collected, the UDSHW has stated that interim operations will be forthcoming.

Shortly after the additional demonstration testing is completed, Envirocare will be submitting a Class 3 Modification to our permit that will incorporate all of the lessons learned over the past two years of permitting and testing. Discussions have already begun with the UDSHW on the content of this modification. In general, the modification will change the permit to a more risk-based system with more emphasis on non-combustion rather than the hard-line language of non-identified compounds detected in the condensate and off-gas. Furthermore, the concept of RE for all known waste contaminants will be examined more closely.

At the completion of the public participation portion of this permit modification Envirocare foresees full-scale operations of the VTD system.

LESSONS LEARNED

During the VTD permitting process, many lessons have been learned. Several lessons were learned during the process and were fixed at later stages within the process. These lessons have been described previously and include properly informing all parties involved of all activities and their importance on future permit requirements or other actions, minimizing potential areas of cross-contamination in the system prior to testing, and assuring that the test media conforms to the requirements of the test plan. Assessing these issues prior to performing tests could save money and time by requiring fewer tests to achieve the same goals.

For future permitting action on this or similar projects, the biggest lesson learned is to provide the public with as much information as possible on the first submission. This may include several "brainstorming" sessions between the Permittee, regulators, and other interested parties to anticipate potential public issues and then address these issues with the initial permit modification submission. A practice such as this could avoid delays and unanswered questions that may arise later in the process.

Another area for improvement is the objectives and expectations of all parties involved. Several times within the permitting process, Envirocare and the UDSHW had disagreements over the interpretation and aims of issues that both parties had thought were already resolved. All parties should be open and honest about their objectives and expectations and communication should be directed to assure that all parties understand each other on all aspects of the process. This communication should be completed early in the process so that the issue does not escalate.

Finally, permitting should be completed so as not to contain requirements that cannot be attained and that require justifications and/or further research to prove compliance. This tends to degrade the public's confidence in both the Permittee and the regulatory agency. More thought should go into requirements that maintain the overall performance desired, but allow reasonable deviations to occur.

CONCLUSION

The permitting process for the VTD system at Envirocare has been a long journey filled with many bumps and sharp turns. However, with the cooperation of the UDSHW, the conclusion of the process is in sight. Further, the understanding of all parties involved has been greatly enhanced and the current permit provides a clear picture of the VTD process. The entire process shows how the cooperation of regulatory personnel, industry, and the public can combine resources to develop a successful permitting plan. This permitting process has taught both Envirocare and the UDSHW what to expect from complex permitting. Future permitting should learn from this process and not repeat the same mistakes, particularly regarding the amount of information provided at the beginning of the project. Furthermore, in the future, all sides should have a clear understanding of the process and goals prior to commencement of the permitting process.

REFERENCES

1. J. Blanchard and R. Stamnes, "Engineering Forum Issue Paper: Thermal Desorption Implementation Issues", USEPA Publication 9200.5-224FS, EPA 540/F-95/031 PB95-963315, (January 1997)

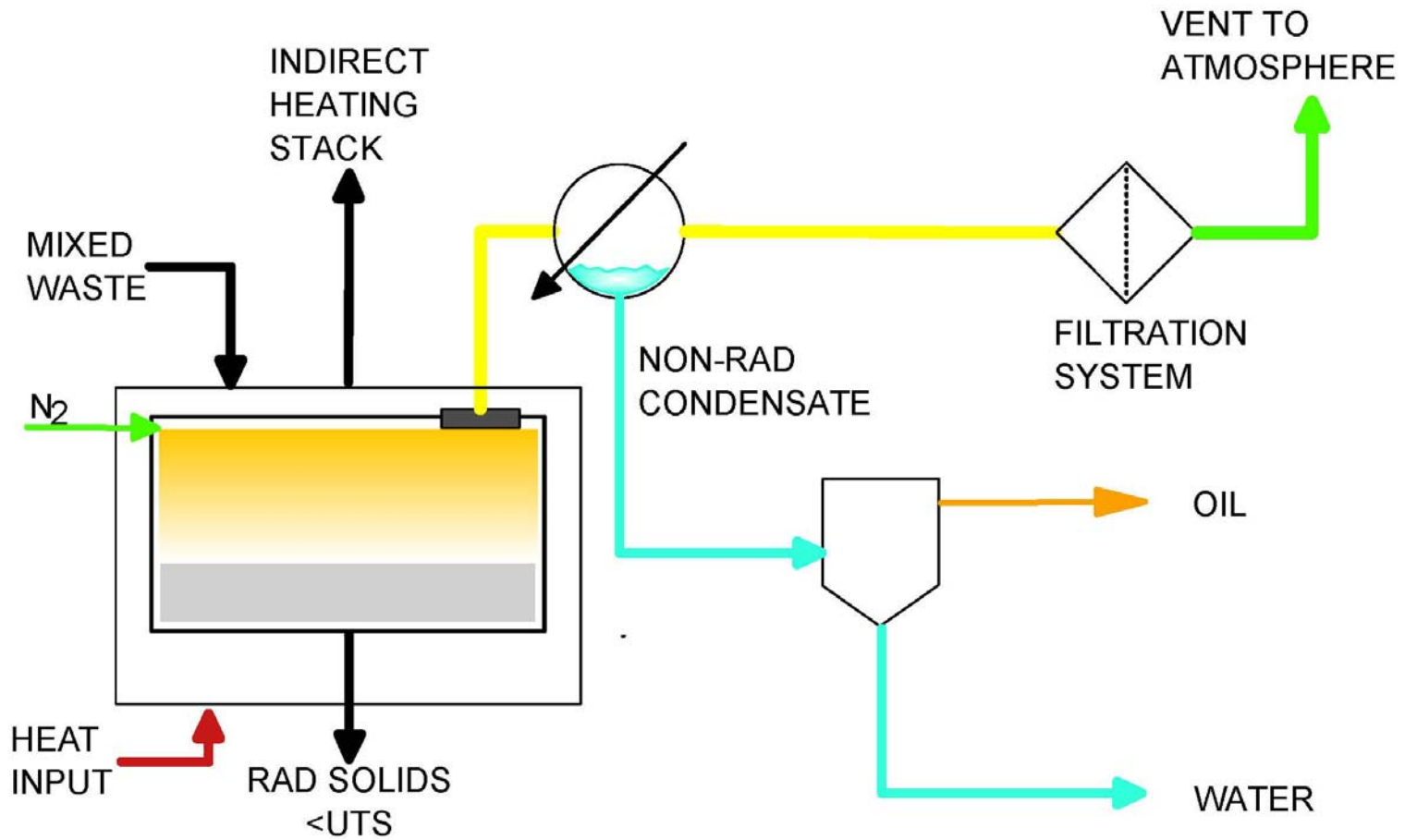


Fig. 1. Thermal Desorption System schematic diagram