ATTACHMENT 19

HYDROLYSIS SYSTEM DESCRIPTION

Cartridge Actuated Device Hydrolysis Prototype Production Plant (CAD HPPP)

1.0 The CAD HPPP is a chemical processing facility which has been designed to demilitarize explosive and propellant containing devices in an environmentally friendly manner. The process utilizes a warm Sodium Hydroxide (NaOH) solution to hydrolyze energetic species into non-energetic, benign by-products. Optimally, the energetic containing devices will utilize aluminum structures to house the energetic species thus allowing a single step processing mode. This is due to the fact that aluminum is rapidly dissolved in NaOH solutions. Once dissolved the NaOH solution accesses and hydrolyzes the energetic species present in the munition. Non-aluminum bodied munitions will require an up-front accessing step to provide a path for solution to energetic contact.

1.1 Non hydrolysable byproducts (non-aluminum metal, plastic and rubber) are removed from the solution, rinsed with water, and visually inspected for complete energetic destruction before disposal and/or recycle. The rinse water, and blowdown from the scrubber sump, supply make-up water for the main hydrolysis tank. The spent hydrolysis solution, which contains excess NaOH and low molecular weight organic salts, is disposed of as a hazardous waste.

1.2 The semi-automated facility is operated in batch mode and will process up to 1625 lbs (net) of munitions in a 10 hour day. Automated functions will be via programmable logic controller custom programming.

1.3 The CAD HPPP has been designed to protect the personnel and the environment during operation. Numerous safety features, both hardware and procedural, are present to assure safe and efficient operation of the facility.

2.0 EQUIPMENT OVERVIEW

2.1 The CAD HPPP utilizes commercially available chemical processing equipment including tanks, pumps, compressors, heating system, conveying system, ventilation equipment, pollution abatement system, instrumentation and computer control equipment.

<u>2.2 Tanks</u>

Concentrated (50 wt%) NaOH is stored in a 6500 gal, high density linked polyethylene, double-walled tank on the outside of the facility. Spent hydrolysate, to be disposed of at a commercial TSDF facility, is transferred to a commercially available tanker truck also located outside of the facility. The hydrolysis reactions occur in a custom 1500 gallon, 316 SS tank located within the building. The hydrolysis tank is equipped with four rotating stations that accept perforated baskets containing the munitions to be processed. Rinse water is contained in a similarly designed 500 gallon tank equipped with two rotating stations.

<u>2.3 Pumps</u>

Concentrated NaOH is pumped from the outside storage tank into the hydrolysis tank via a centrifugal pump located in proximity to the storage tank. Hydrolysate fluid is recirculated within the hydrolysis tank via an air driven, double diaphragm pump. This same pump can be used to empty the hydrolysis tank into a tanker truck or other suitable tank outside. Rinse fluid is delivered to the hydrolysis tank with a similar air driven double diaphragm pump.

2.4 Heating Equipment

The hydrolysis solution is heated prior to the initiation of munition processing. A steam boiler rated for a minimum of 3.35 MBTU/Hr at 1600 lb/Hr provides the required heating. Heat transfer devices within the hydrolysis tank provide the required surface area to transfer heat into the hydrolyzing media.

2.5 Conveying Equipment

2.5.1 The CAD HPPP utilizes an automated conveying system to transfer munitions and byproducts through the processing steps. This system is similar to those used in commercial electroplating processes. Perforated stainless steel baskets contain the munitions to be processed. The perforated baskets are mounted to a carrying frame which provides the interface with the hydrolysis tank and the automated conveying system. The basket/frame assembly interfaces with a wheeled load cart to allow easy, manual movement of the basket/frame equipment. The load cart is equipped with a locking brake system to assure that un-wanted movement of the equipment doesn't occur when the equipment is un-attended.

2.5.2 An automated crane system transports the basket/frame assembly to an un-occupied station in the hydrolysis tank. The crane deposits the basket at the station which is equipped with an air driven rotation system. Once deposited, the compressed air driven motor spins the basket within the solution to assure adequate mixing to maintain high hydrolysis reaction rates.

2.5.3 The conveying system automatically removes the basket from the hydrolysis tank upon completion of the hydrolysis reactions. Materials that are unaffected by short term exposure to the caustic media (e.g., plastics, brass, stainless steel) remain in the perforated basket. These "tramp" materials are then rinsed in a freshwater tank to remove any residual hydrolyzing media. Upon completion of rinsing, the conveying system transports the baskets to the unloading station where operating personnel manually empty the tramp material from the baskets onto an inspection tray. The tramp material is then manually deposited into drums for disposal.

2.6 Ventilation Equipment

The aluminum hydrolysis reaction produces hydrogen. Ventilation is required to assure that hydrogen concentrations do not exceed the flammability limit. Room air is drawn over the surface of the hydrolysis bath via an induced draft blower located outside the processing building. The nominal flow rate of ventilation air is 18,000 CFM which is adequate to assure that the hydrogen concentration does not exceed 50% of the lower flammability limit (LFL) of hydrogen. The hydrogen LFL in atmospheric air is 4%. The ventilation blower is provided with a back-up power supply generator that will automatically activate if the electrical power supply is lost. This safety measure assures that hydrogen concentrations do not exceed 50% of the LFL even in emergency shutdown situations.

2.7 Pollution Abatement System

A wet scrubber based pollution abatement system is installed immediately upstream of the induced draft blower. The scrubber is designed to prevent the discharge of caustic bearing materials into the environment. The scrubber system is comprised of the scrubber housing, recirculation pump, and sump tank. Included in the scrubber housing are random-dump packing, spray nozzles, and mist eliminator pads. The scrubbing liquid for the scrubber system is provided by fresh water as required. The scrubbing liquid is pumped from the sump tank to the spray nozzles where it is sprayed onto the scrubber packing. The wet packing provides enough interactive surface area for the scrubbing liquid to remove any caustic material from the exhaust gas. Mist eliminator pads located above the spray nozzles are designed to remove mist particles as small as two microns in diameter at 99.3% efficiency. The scrubbing liquid is continuously recirculated between the sump tank and the scrubber housing. Evaporated liquid is replenished by fresh water as required.

2.8 Instrumentation

The CAD HPPP utilizes typical process instrumentation to assure safe and complete processing of munition items. Instrumentation includes thermocouples, pressure transmitters, pressure gauges and limit switches. Additionally, the system ventilation gas is constantly monitored for hydrogen to assure that concentrations do not exceed 50% of the LFL during the processing of munitions that contain aluminum.

2.9 Computer Control Equipment

The CAD HPPP utilizes a programmable logic control (PLC) system to monitor and control process functions. A custom program was developed specifically for the application. The PLC system includes In/Out (I/O) modules that interface with the process equipment and instruments. The system includes automated function programming, ladder logic and alarm and interlock logic to assure safe and efficient operations. The human interface (HMI) is by way of a standard computer located remotely in the CAD HPPP control room. The HMI includes numerous, custom developed screens that provide operators a graphical interface with the process. The HMI computer is also programmed to perform data logging functions to allow the capture of all process functions during system operation. The data will be downloaded and backed up at pre-determined frequencies to assure the accurate capture of the CAD HPPP operational history.

3.0 OPERATIONAL OVERVIEW

3.1 The munitions to be processed are transported from their storage location to the processing facility per standard TEAD transport procedures. Munition handlers weigh out the required quantity of individual munitions to make up a predetermined batch size. A predetermined number of batches sized to consume the desired quantity of NaOH are prepared prior to and during system operation as required. The munition batches are contained within the perforated baskets prior to processing.

3.2 The fresh hydrolysate solution is prepared in the hydrolysis tank prior to munition treatment. Water from the rinse tank is pumped to the hydrolysis tank. Additional make-up water, as required, is added to the tank from the facility water supply. Fresh concentrated NaOH (50 wt%) is then pumped from the outside storage tank into the hydrolysis tank to create a ~25 wt% solution in the hydrolysis tank.

3.3 The hydrolysis solution is initially heated to ~100^0C with pressurized steam from the steam boiler. The heated solution is re-circulated within the tank to ensure good mixing and high heat transfer rates. The design solution heat up time is 1 hour. The steam condensate is returned to the boiler with a pump located at the hydrolysis tank. Thermocouples located within the tank continuously measure the solution temperature. The PLC operating program compares the solution temperature to the temperature set-point and automatically opens and closes a steam delivery valve as required to maintain the desired solution temperature.

3.4 System operators manually transport the munition batches to the designated load station located at the front of the processing line. The automated transport system picks up the basket/carrier assembly and deposits the munition batch into the pre-heated caustic solution. The baskets are rotated within the solution to allow adequate contact between the munition items and the hydrolyzing media. System operators manually “re-load” the pickup station with another batch of munitions to be processed.

3.5 Aluminum containing munitions produce hydrogen during the hydrolysis process. The mass rate of hydrogen evolution is proportional to the surface area of aluminum exposed to the hydrolyzing media.

The duration of hydrogen evolution is proportional to the mass of aluminum contained in the munitions. Ventilation air is continuously drawn through the hydrolysis tank to dilute the hydrogen concentration to safe levels. The introductions of the munition batches into the hydrolyzing tank are staggered by 30 minutes. This reduces the vent gas hydrogen concentration by preventing the peak generation rates (i.e., at treatment onset when the aluminum surface area is at a maximum) of multiple additions from coinciding.

3.6 The exothermic heat of the hydrolysis reactions may increase the temperature of the hydrolyzing media, ultimately, to its boiling point if the energy is not dissipated. Although reaching the boiling point poses no safety threat, it is desirable to mitigate hydrolysis tank foaming. Hydrolyzing media spilling over into the secondary containment pan creates a housekeeping issue. The process control program responds to the rising temperature by halting the addition of steam. Careful selection of the hydrolysis bath temperature control setpoint normally prevents hydrolysis bath temperatures from reaching the boiling point. Munition batch staggering also assists in media temperature control, as the hydrolysis of aluminum represents, by far, the most significant portion of the heat input.

3.7 The hydrolyzing media level will tend to drop due to the evaporation of water. Make up water comes from the scrubber sump tank or the rinse tank. An ultrasonic level transmitter constantly monitors the hydrolysis tank level. The process control program automatically activates the transfer of scrubbing liquid from the scrubber sump tank or rinse water from the rinse tank to the hydrolysis tank when the hydrolysis bath level drops below a predetermined set point. The scrubber sump tank and rinse tank are replenished with fresh water in a similar fashion.

3.8 Each munition batch is exposed to the media for ~ 2 hours. Munitions that possess thin aluminum containment bodies and small quantities of energetic material require less exposure time than those with thicker bodies and greater quantities of energetic material. The basket is continuously rotated within the media to assure high reaction rates. The computer control system tracks and controls the exposure time of each munition batch.

3.9 The completed munition batches consisting of un-hydrolyzable materials (e.g., plastic, rubber, stainless steel, brass) are automatically removed from the hydrolyzing media by the automated conveyor system in response to the process control program. The conveyor system removes the basket from the hydrolyzing tank station and deposits it at a rotating station in the rinse tank. The residual material is rinsed for ~ 10 minutes to remove the hydrolysate liquid from the solids.

3.10 The automated conveyor system transports the rinsed solids to a dedicated drop off station. System operators manually “wheel” the basket/carrier assembly to an inspection area where the basket contents are inspected. The solids are visually inspected for the presence of energetics. If the presence of un-hydrolyzed energetic material is suspected, the solids are loaded back into the barrel and re-processed. Energetic-free solids are loaded into containers for disposal or re-cycle.

3.11 The CAD HPPP will typically be operated on a 10 hr/day schedule. Assuming a 1 hr bath heat-up time, a ½ hr “stagger” time between batches and a 2 hr total exposure period, 13 batches are processed in each 10 hr day. The target basket net load will vary with munition type, the design maximum basket load is calculated to be 125 lbs. The total weight of munitions processed in a 10 hr day is 1625 lbs. However, the potential exists to run 24 hours per day resulting in a maximum capacity of 3,900 lbs. per day assuming 1.3 baskets could be processed per hour.