REDESIGN OF THE PREPP FEED, ASH DISCHARGE AND SLUDGE HANDLING SYSTEMS[1]

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The Process Experimental Pilot Plant (PREPP) incineration system is designed for processing mixed (chemical and radioactive) hazardous waste. The facility accepts solid waste contaminated with alpha emitting transuranics (TRU) and incidental quantities of hazardous materials such as solvents and lubricants. PREPP consists of a shredding and feed system for containerized waste, a rotary kiln incinerator with a secondary combustion chamber, an ash cooling and grouting system, and a wet offgas cleaning system followed by two stages of HEPA filtration. The facility has undergone an extensive test period where a number of improvements to the process and equipment have been identified (Figure 1). The incinerator feed system, ash discharge system and the sludge handling system are areas where improved performance is desired.

Planned PREPP Process System Simplified Schematic

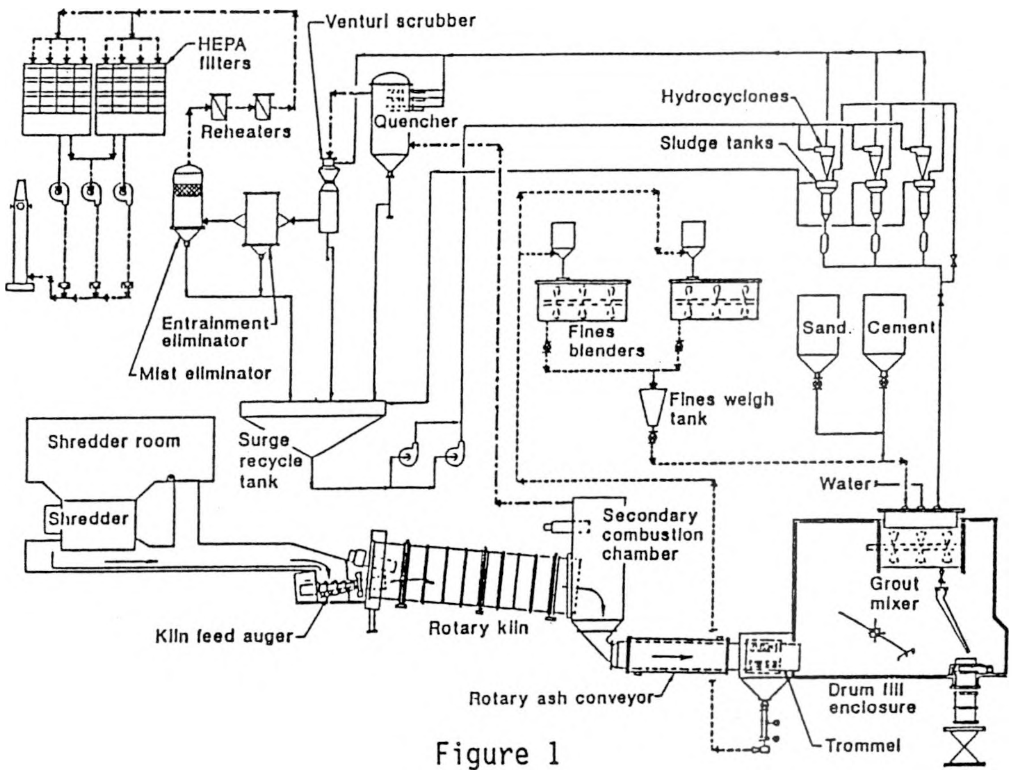

Figure 1

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INCINERATOR FEED SYSTEM

The existing kiln charging system consists of a hopper which drives into the kiln to dump the waste. The two areas where this system is deficient are the process upset inherent with batch feeding and the reliability/maintainability problems associated with PREPP's particular drive mechanism. A Feeder/Auger has been located which appears to solve most of the problems associated with the present system. The modified system will substitute a KOMAR Feeder/Auger unit for the Feed Shuttle/Hopper assembly (Figure 2). The Feeder/Auger system selected is a model HBA-1-75, manufactured by KOMAR Industries, Inc., Groveport, Ohio. The Feeder/Auger unit is constructed of heavy carbon steel and is approximately 1.42m x 1.35m x 1.83m (56"H x 53"W x 72"L) with a hopper .97m x .91m x .76m (38"W x 36"L x 30"Deep) open at the top. The hopper sides slope to a tapered auger in the bottom; the hopper bottom is shaped to the auger. The auger is driven by a hydraulic motor and forces material through a waste tubing system into the kiln.

The system is provided with a hydraulically driven steel isolation gate (knife) at the waste tube entrance to isolate the kiln from the feed system. The unit also possesses a self-contained material flow meter. Hydraulic reservoir, pumps, controls, etc., will be contained in a supplementary cabinet. System controls, electrical disconnects, programmable logic controller (PLC), etc., will be contained in a secondary supplementary cabinet. PREPP will provide a hood to cover the auger hopper and connect to the existing Feed Conveyor Enclosure to assure a totally enclosed waste path for alpha contamination control.

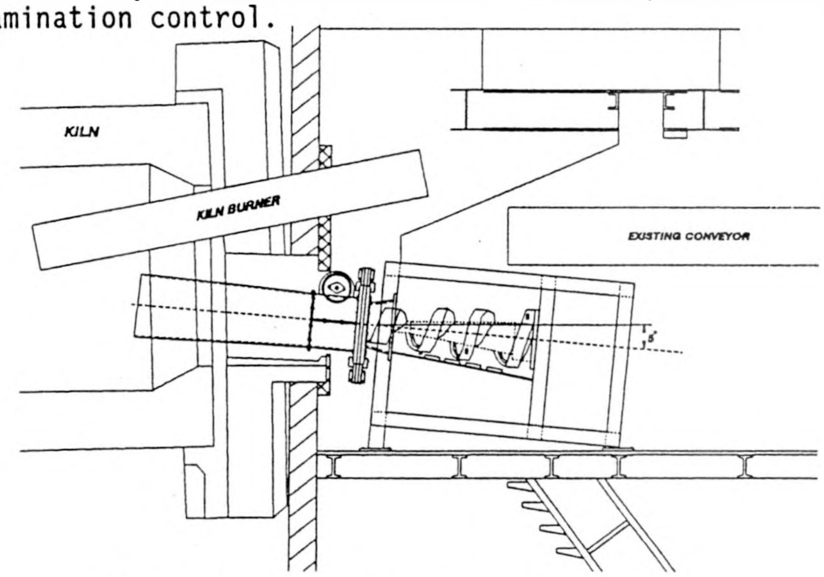


Figure 2 - PREPP Auger/Feeder System

NORMAL OPERATIONS

During normal operation, all equipment at the Incinerator Feed Station, except the Glove Ports and the Secondary Grapple, will be operated from the Control Room via the Control and Data Acquisition System (CDAS) or from the Shredder work station. The excepted equipment will be operated from the Incinerator Feed Station on an "as needed" basis only.

Waste material will drop from the Shredder (existing) onto the Feed Conveyor (existing) as at present. The conveyor will be run forward to move the waste to the auger hopper. If any material is not properly shredded, the conveyor may be stopped and an operator dispatched to the Incinerator Feed Station to operate the Secondary Grapple to return the material to the Shredder for reshredding. The conveyor may also be run in reverse to distribute the waste more evenly, if necessary. When the material has moved to the end of the conveyor, the waste will automatically drop into the auger hopper.

The auger will run independently from the conveyor. Operating the auger will move waste from the hopper into the waste tube and thus into the kiln. The auger will be interlocked with the waste tube isolation gate so that initiation of the auger will open the gate, if closed. However, the gate will not automatically close when the auger is stopped.

Controlling the conveyor independently of the auger will allow more operating flexibility in the operation. Material can be shredded and stock piled on the conveyor, if desired, without feeding the kiln. This will allow more optimum shredder operation.

If the auger encounters material it is unable to cut and compress into the waste tube, it will be sensed by the control unit, and the auger will reverse for a set time period, and then automatically start forward again. Reverse run time and speed can be set in the unit PLC. When waste feeding is completed, the system equipment will be stopped. The isolation gate may be closed or left open at the discretion of the operator.

Cameras or other sensing devices will be installed to allow the control room operator/shredder operator to view or determine the type and amount of material in the auger hopper and in the conveyor to aid in controlling the feed operation. A dedicated monitor or other indication will be placed in both the control room and the shredder operating gallery. The system will be controllable from either location.

Indications provided at CDAS for control and operation of the auger unit will consist of:

1. Start/stop and speed control
2. Forward/reverse and reverse override
3. Appropriate bypass switches (to allow operation of the auger when required interlocks are not satisfied, but testing or maintenance operation of the auger is required)
4. Open/shut isolation gate
5. Indication lights for:
   Isolation gate position; auger direction; auger on/off; high oil temp.; high waste tube temp.; source of automatic system shut down
6. Auger speed (RPM) and waste feed rate (ft^3/hr)

ASH DISCHARGE SYSTEM

During Series V testing, the PREPP Incinerator Discharge Conveyor exhibited several undesirable faults that have resulted in a redesign of the entire system. The major problems encountered included:

a) Warping of the conveyor bed and swing rods causing contact with the Secondary Combustion Chamber (SCC);
b) limited cooling capability of both the air and water cooling systems, resulting in high temperatures in the discharged ash and coarse waste;
c) frequent manipulation of air cooling systems when varying waste streams;

d) difficulty in moving certain ash types, stagnation of certain other waste types resulting in inadequate cooling;
e) waste jamming the internal gates;
f) inadequate viewing of the waste stream during transfer;
g) failure of the metal and fabric bellows;
h) constant operator attention required anytime the system was in operation.

GENERAL DESCRIPTION

The new rotary conveyor design utilizes a two concentric pipes to isolate and cool the hot waste and ash as it passes from the kiln and secondary combustion chamber (SCC). Waste is moved by rotation of the rotary conveyor and gravity; the angle of the conveyor is two degrees. The new conveyor will incorporate the same seal design to be used on PREPP's rotary kiln (Figure 3). The Rotary Discharge Conveyor will have an increased cooling capability and will keep the waste stream in constant motion preventing stagnation of the waste, ensuring proper cooling of the waste stream. Accidental contact with the SCC is no longer a consideration due to the rotary design and low kinetic energy of the system. Many radioactive contamination problem areas have been eliminated by simplicity of the design.

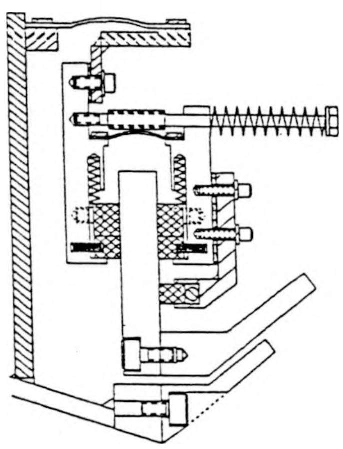


Figure 3 - PREPP Seal Design for the Rotary Discharge Conveyor

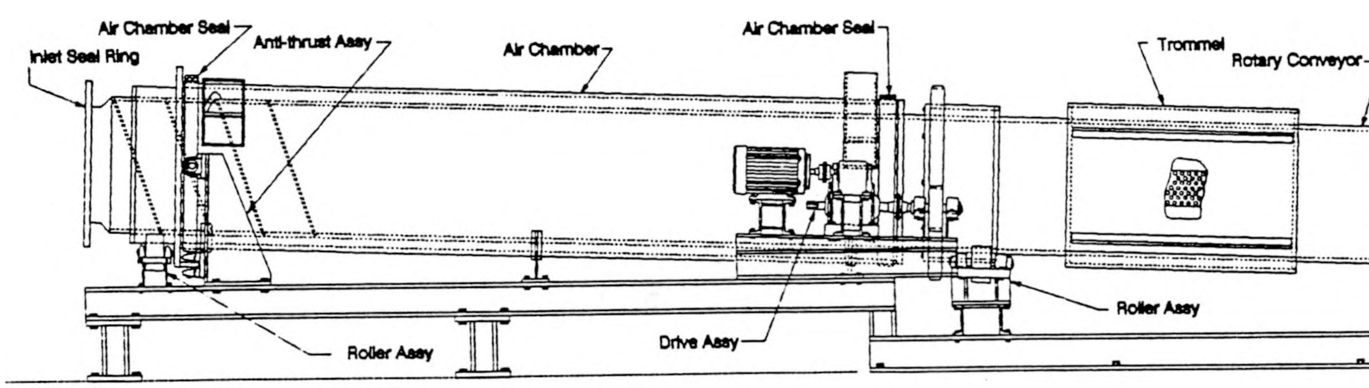


Figure 4 - PREPP Rotary Discharge Conveyor

Operator attention to the system has been greatly reduced. The original vibratory conveyor system required constant attention via closed circuit television stations during waste transfer to control operation of two gates regulating waste flow through the cooling region of the conveyor. Future operation will require operator attention only during start up and shut down of the unit, and occasional routine monitoring during operation.

The RDC design is under construction for mock-up testing, and should be completed by mid-1990. The main components of the rotary discharge conveyor are: 1. air chamber, 2. waste conveyor/trommel, 3. tire roller bearing assemblies, 4. anti-thrust assembly, 5. conveyor inlet seal, 6. air chamber seals, 7. drive assembly, 8. conveyor inlet chute assembly (Figure 4).

DETAILED DESCRIPTION

AIR CHAMBER

The stationary air chamber is the outer shell of the rotary discharge conveyor. The air chamber is a 3.66m (12 ft.) long, 34 in. O.D. SCH 20 carbon steel pipe. It is supported by three cradle assemblies bolted to the floor. The air chamber has a duct at both the inlet and discharge ends to accept cooling air supplied by the original discharge conveyor supply blower at a nominal 1.18 m^3/sec (2500 SCFM) and 18.3°C (65°F). 5.1cm x .64cm (2" x 1/4") sectional flighting attached to the outside of the waste conveyor makes one revolution every .91 meters (3 feet) for the entire length of the air chamber. The air passing between the waste conveyor and the air chamber is redirected by the flighting causing turbulent mixing of the cooling air stream, thus increasing the effective cooling area.

WASTE CONVEYOR/TROMMEL

The waste conveyor/trommel is a 6.7m (22 ft.) long, 28 in. O.D. SCH 20 carbon steel pipe. The inlet of the waste conveyor interfaces with the bottom of the SCC via a stainless steel delivery chute. Waste entering the waste conveyor inlet is moved toward the discharge end by another area of sectional flighting in the first four feet of the conveyor. The internal surface will contain a section of 2.54cm x 1.27 cm (1" X 1/2") ribbon flighting designed to move the waste away from the sealing area as quickly as possible. The remainder of the conveyor's internal surface will have angle iron welded its entire length along four quadrants. This will ensure the waste does not stratify, and ensures adequate ash separation at the Trommel section of the conveyor.

The trommel section of the conveyor contains screening .64cm (1/4 in.) holes on .95cm (3/8") centers that allows the ash and fines to be separated from the coarser waste. The outer trommel separator of the conveyor is a 1.22m (48") long, 34" O.D. SCH 20 carbon steel pipe welded to the outside diameter of the rotating waste conveyor. The outer separator of the trommel has axial slots cut into it to allow fines to drop into the trommel hopper located directly below it. The combination of the inner screening and the outer drum will not allow any items bigger than .64cm x 6.4cm (1/4" X 2 1/2") through the trommel and into the fines transfer/storage system. The fines and ash are deposited into the trommel hopper, and the coarse waste continues on into the Drum Fill Enclosure (DFE).

TIRE ROLLER BEARING ASSEMBLY

The rotating section of the conveyor will be supported on two sets of rollers, and ride on raised, floating tires. These tires are located at the feed end, and near the drive assembly. Each tire is a 32 in. O.D. SCH 20 carbon steel pipe assembly that is supported off of the conveyor by 3.8cm (1 1/2") square carbon steel bar spacers. The tire near the drive assembly is "locked" in place by identical steel bars welded to the outside diameter of the rotating conveyor. The tires are raised off of the conveyor to allow for expansion and contraction of the pipe during heatup and cooldown, and to allow the tires and rollers to compensate for any misalignment of the drive assembly or seals.

ANTI-THRUST ASSEMBLY

The anti-thrust assembly mounted behind the front tire allows the rotary discharge conveyor to rotate at a two degree incline while maintaining the air chamber and inlet seal surfaces. A thrust ring is mounted on the conveyor against the inlet end floating tire. A support assembly mounted around the lower 180 degrees of the air chamber supports three stationary roller bearing assemblies that accept the force of the rotating thrust ring.

CONVEYOR INLET SEAL

The conveyor inlet seal provides a dynamic seal between the process stream and the outside environment. A rotating stainless steel disc is bolted to the inlet end of the waste conveyor pipe. Two stationary seal housings containing 18 overlapping carbon bars each, are suspended from the SCC support structure. These carbon bars form both the primary and secondary seal, and are spring loaded with a minimum 34.5 kPa (5 PSI) against the rotating disc. A third set of smaller carbon bars running just inside the secondary seal, will form the tertiary seal. Negative pressure will be applied between the primary and secondary seals, and a slightly positive pressure will be maintained between the tertiary and secondary seals. This will ensure the alpha barrier is maintained even during non-rotation. These pressures will be provided by tapping into the kiln seal pressure systems. The discharge end seal will be attached to the Trommel enclosure. These seals are a duplicate of the proposed Kiln seals, but reduced in size to fit the RDC.

AIR CHAMBER SEALS

The air chamber seals provide a mechanical HVAC seal to reduce cooling air leakage from the air chamber. The inlet seal at the thrust collar is a braided silica rope with a maximum operating temperature of 982.2°C (1800°F). The rope is spring compressed against the thrust ring, and the entire seal assembly is secured to the air chamber with a stainless steel bolted band around the circumference of the air chamber. The air chamber outlet seal provides the mechanical seal at the end of the conveyor near the drive assembly. This seal is a braided silica tape, spring compressed against a seal ring welded to the rotating conveyor. This seal is also secured by a similar stainless steel bolted band assembly.

DRIVE ASSEMBLY

The RDC will be driven by a 3.73 kw (5 Hp), 3 phase, 480 volts, 1800 RPM variable speed motor, through a 400:1 reducer, and finally to the pinion gear: a 8.89cm (3 1/2 in.) wide, 25.4cm (10 in.) diameter spur gear. A 102.87cm (40 1/2 in.) spur gear will be attached to the rear tire assembly, and will be driven by the pinion gear. The speed of the conveyor will be variable from 0.5 RPM to 1.0 RPM.

CONVEYOR INLET CHUTE ASSEMBLY

The inlet chute assembly conveys waste from the kiln discharge to the inlet of the rotary conveyor. The discharge chute is 1.27cm (1/2 in.) 304 SS formed plate. The chute provides the transition from the rectangular SCC outlet, to the circular conveyor inlet, at an angle of approximately 33 degrees. A vibrator is attached to the underside of the chute and will operate periodically during waste incineration to ensure waste movement in the chute area.

MISCELLANEOUS EQUIPMENT/INSTRUMENTATION

Temperatures of the waste stream will be monitored by a remote operated infrared sensor that looks up the length of the conveyor from the DFE. A remotely operated closed circuit television (CCTV) system will be installed to allow the operator to view the waste stream as it moves down the conveyor. Another infrared system may be installed to monitor shell temperatures of the conveyor as an indication of cooling capability, heatup and cooldown effects, and for monitoring variations in waste stream heat loads and their effects.

A gate will be provided in the DFE to seal the conveyor from the DFE in the event of an abnormal or emergency event, and in order to facilitate maintenance in the DFE during operations.

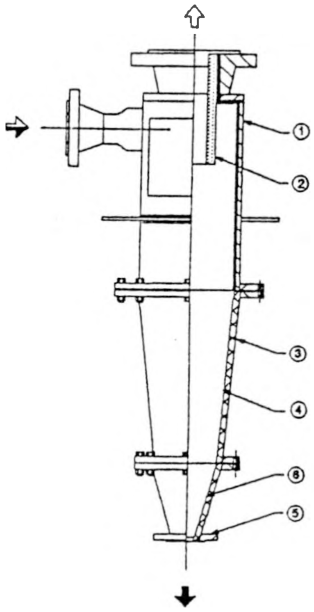
The RDC will be controlled from CDAS in the PREPP control room with speed indication, waste stream temperatures, shell temperatures, and motor status supplied on the control room workstations. On-station monitoring of the conveyor by operators will be required only during start up and shut down of the system. Continuous monitoring of the waste stream will be possible via the control room CCTV system.

SLUDGE HANDLING SYSTEM

The PREPP Scrub Solution System contains incinerator ash in the form of suspended solids. The sludge handling system is designed to concentrate the suspended solids into a sludge (up to 38 wt%). The present system uses a sintered metal cross flow filter to concentrate the solids. The filter has experienced fouling problems, and the equipment associated with the filter (valving, pressure and flow controllers, etc.), failed to perform as required and precluded any successful attempts at placing the system in service. Considering the problems encountered with the filter, and the anticipated difficulties associated with operating a maintenance intensive system with fluids containing alpha radiation emitting solids, a hydrocyclone unit is being installed to replace the filter unit (Figure 5). A modified sludge tank will be mounted below the hydrocyclone to accept the "underflow" from the outlet of the hydrocyclone (Figure 6).

The hydrocyclone is predicted to control the concentration of suspended solids in the scrub solution below 0.5 wt% and be free of the operation and maintenance problems associated with the original cross flow filter. The basic operation of the hydrocyclone entails introducing scrub solution into the cyclone which forces the flow along the inner wall, causing the mixture to rotate at high angular velocity. The kinetic energy of the feed stream is in this manner converted to centrifugal force. Coarser and heavier solids are concentrated and discharge as "underflow" out of the bottom of the cyclone. Most of the feed liquid and a part of the very fine solids discharge through the vortex finder out the top of the cyclone as "overflow." Depending upon the physical characteristics of the solids, "underflow" concentrations of 50 to 70% solids by weight can be attained, and solids discharging with the "overflow" can be as fine as 10 microns.

As compared with centrifuges and filters, the liquid cyclone is a very simple device with no moving parts. Because cyclones very efficiently convert the energy of the feed stream into centrifugal force of great magnitude, a cyclone

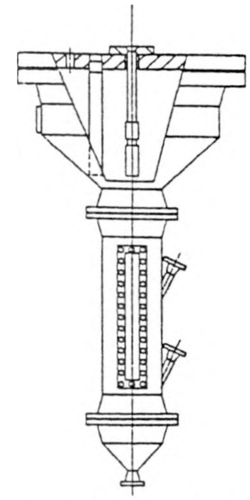


KREBS Cyclone

Model D6B-T138-XZ

Part No.	Description
1	Inlet Head Section with 2 1/2" Inlet And 4" Overflow 150# Flange Connection Neoprene lined, Sandvic #2205
2	Vortex Finder, Neoprene Lined, Sandvic #2205 1 3/4" Size
3	Cone Housing, Sandvic #2205
4	Cone Liner, Silicon Carbide
5	Apex Housing, Sandvic #2205 with 1 1/2" Standard Flange Connection
6	Apex Insert, Silicon Carbide

Figure 5



PREPP Sludge Tank

Figure 6

of small physical volume can be used to replace a filter or clarifier of much greater volume. The involuted feed entry configuration minimizes turbulence and provides a higher solids removal efficiency. Sectionalized construction facilitates replacement of worn components and permits changing cyclone separating characteristics.

Once the desired density sludge is collected in the sludge tank, scrub solution will be directed to another sludge tank and hydrocyclone separator, and the sludge in the original sludge tank will start a sparging cycle. Nozzles located in the top and the sides of the tank will be cycled to agitate the solids back into suspension using the tank's twin diaphragm pump. Once the solids are in suspension, the sludge tank will be put into a recirculation mode using the sludge pump to keep the solids suspended. At the discretion of the operator, the system can be lined up to recirculate through the grout mixer fill lines, making sludge available for grouting in the solidification system.

Three sludge handling systems will be installed in the PREPP facility. One system will be in service, one in recirculation mode, and the other available for sending sludge to the grout system, or empty. This ensures an adequate surge volume for the sludge handling system while continuing incinerator operations.

Instrumentation to be installed in the sludge handling system includes flow, pressure, temperature and density measurement devices. All instrumentation is being designed to be nonintrusive to the pressure boundary to prevent contact with the liquid system. The flow measuring devices being considered are ultrasonic flowmeters and are currently in testing in a mockup of the sludge tank. Pressure measurement devices are to be isolated by the use of a diaphragm, and temperature instruments will be housed in thermowells. Density measurement devices will also be ultrasonic, and are being tested on the sludge tank mockup.