A NEW APPROACH TO LIME SLUDGE DISPOSAL

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Design of lime sludge disposal facilities and programs has gone from stockpiling the problem to now treating the waste material as a resource. This requires the design of waste management facilities that not only concentrates the waste effectively, but also provides an efficient means to adapt it to alternative uses. It also requires the designer to understand the potential uses of the waste. Specifications for contracted disposal must efficiently utilize the material in the agricultural or industrial sector. The markets must be continually protected with quality of end-use in mind. This paper will focus on Des Moines Water Works' effort to design and implement the above concepts.

Historical Sludge Production

Des Moines Water Works (DMWW) has used a lime softening process to remove hardness since 1948. This softening produces .02 m^3/sec (0.5 mgd) of a 3 percent solids lime sludge. The sludge has historically been pumped across the river from the treatment plant to 26.7 hectares (66 acres) of storage lagoons, which are now full and have limited potential for expansion.

In 1991, Des Moines Water Works began a structured approach to evaluate sludge dewatering techniques, research potential sludge markets, and evaluate government regulation of sludge reuse. An inter-departmental team was developed within the utility with varied areas of expertise for the evaluation. The effort culminated in identifying dewatering of the daily sludge production as the solution to our full-lagoon situation.

Establish Criteria For Process Evaluation

Before equipment was researched, a priority was placed on understanding marketable uses for the sludge material. The market value of this material could then be used to offset disposal and dewatering costs. Chemical and physical properties of the sludge at various solids concentrations were analyzed:

Solids Concentration	Physical Description
1% to 3%....................	Decants water to 3% solids concentration
3% to 30%..................	Liquid, thixotropic, minimal flux density
30% to 50%................	Liquid after aggressive mixing, changing to sticky paste when set
50% to 65%................	Paste after aggressive mixing, changing to non-sticking solid when set
65% to 80%................	Remains solid, little dust formation
80% to 100%.............	Increasing dust formation with increased solids concentration

Parameter	Percent on Dry Basis
Calcium Carbonate	80 - 90
Magnesium Hydroxide	4 - 10
Ferric Oxide	1 - 1.5
Silica	1 - 2
Organic Matter	3 - 7

Toxicity Characteristics Leaching Procedure Leachate Testing was conducted on a sample of the sludge. No compounds were above Environmental Protection Agency maximum contaminant levels and one compound, Selenium was found above the reporting level.

Identifying Desired Solids Concentration

Recycling or reuse capability begins with establishment of markets. Des Moines Water Works defined "market" as a value-added price established for the beneficial use of a material. Assigning valuable use for the material also eroded its current designation as a solid waste. Prior to investing time into researching markets for the material, it was decided to let the markets come to Des Moines Water Works. This was accomplished through the use of a "Request For Proposals" (RFP). The resulting bids showed the most cost effective proposed disposal approach was land application. It also showed the need to maximize sludge solids concentrations to minimize transport costs associated with long haul distances to proposed markets.

The focus then switched to providing the residual in the proper form most efficiently and dependably to meet this market. Other less cost effective markets were also identified and dewatering equipment versatility was considered for future adaptation to these markets.

Communication was established during this period with all research shared with local land application contractors. Facilities were visited. Analysis of transport costs, storage versatility, and current land application equipment material requirements justified dewatering the sludge to as high a solids concentration as mechanically possible. The target goal was 65% to 80% solids. The material should be in as solid form as possible, able to flow through equipment easily, with the ability to quickly delump to a size compatible for uniform field application in the 2.3 dry metric tons per hectare (2.5 dry ton/acre) range.

Process Management Criteria

The sludge dewatering process would produce approximately 1.8 million liters (.48 million gallons) of high pH filtrate per day. DMWW chose to recycle the filtrate. Differing influent sludge characteristics led to management considerations. These decisions added further criteria for equipment selection:

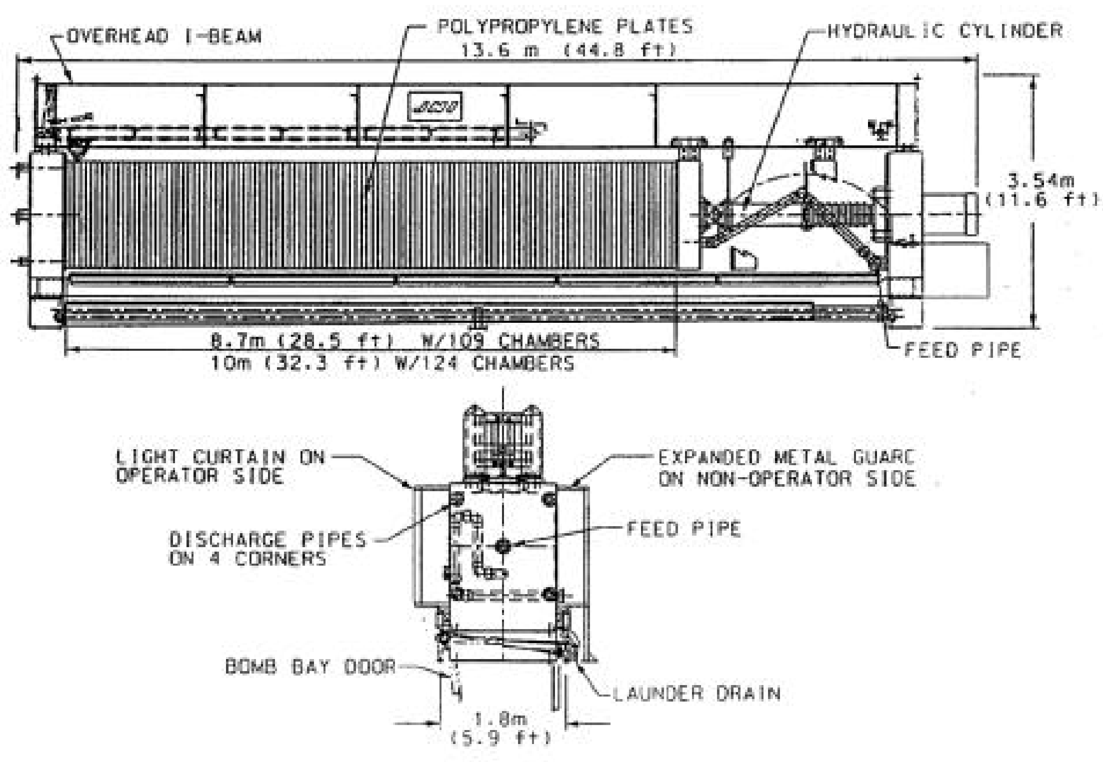
- Dewatering equipment must not use non-potable polymers and minimize use of potable polymers and coagulants, which may affect normal plant processes.

- Dewatering equipment should minimize filtrate solids concentration and provide versatility to filter additional plant waste streams containing microfloc or microorganisms.
- Influent sludge temperature, pH, solids concentration, and floc characteristics may continually change.
- Process sludge flows may vary.
- Changes in coagulants used in the treatment process may cause variations in sludge characteristics.
- Operations and maintenance had to be simple and readily accomplished with DMWW personnel.

Based on the criteria established by DMWW and the relative weighting of the criteria, the recessed plate press system was chosen for the dewatering system design. Equipment selection could easily have changed based on criteria assumptions. This stresses the importance of understanding and communicating the needs of the client in the equipment selection process.

Recessed Plate Press Description

The DMWW recessed plate design consists of a metal frame composed of two end supports rigidly held together by horizontal steel bars and overhead I-beams. Flat polypropylene plates, with recessed ribbed interior surfaces and smooth protruding edges, are supported in a vertical position from the I-beams. Cloths are draped over the plates. When the plates are pressed together, the cloth forms the outer filter surface of a recessed cavity. The pressure to close and hold the press plates together is provided by a hydraulic ram exerting approximately 3.6 million newtons (800,000 pounds) of force into the center of a movable header plate.



When the sludge is pumped into the press through a central hole in the plates, the solids will remain in the cavity and the filtrate passes through the cloth. Filtrate drainage holes on corners of the plates channel the filtrate into the effluent conduit.

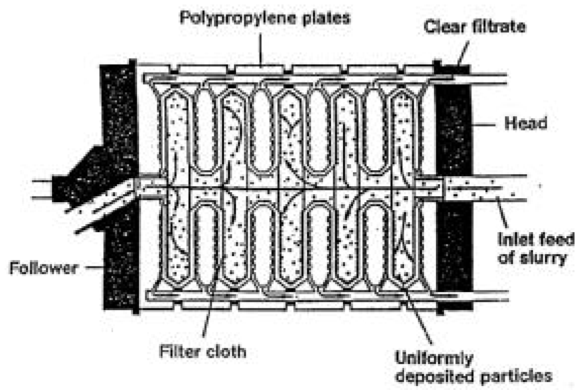


Figure 2

Once the chamber has been filled with cake, the plates are singly separated by a shifting device. Drip trays located under the press to catch any drainage between the press plates, open when the plates are shifted apart and the cake falls directly below the press.

Recessed Plate Press Design

The press design was developed around standard designs pilot-tested with Des Moines Water Works' sludge and customized in the following areas:

- Filtration area compatible to flow requirements
- Cake volume compatible to hauling requirements
- Cloth selection
- Cake thickness selection
- Plate size
- Plate material selection
- Press structural design for maintenance efficiency
- Press closing system design
- Feed pressure requirements
- Dual-end vs. single-end feed
- Hydraulic system components
- Washing system
- Safety system

Presses are positioned within the facility to enable an operator to monitor and control cake discharge from two presses at the same time.

GENERAL PROCESS DIAGRAM

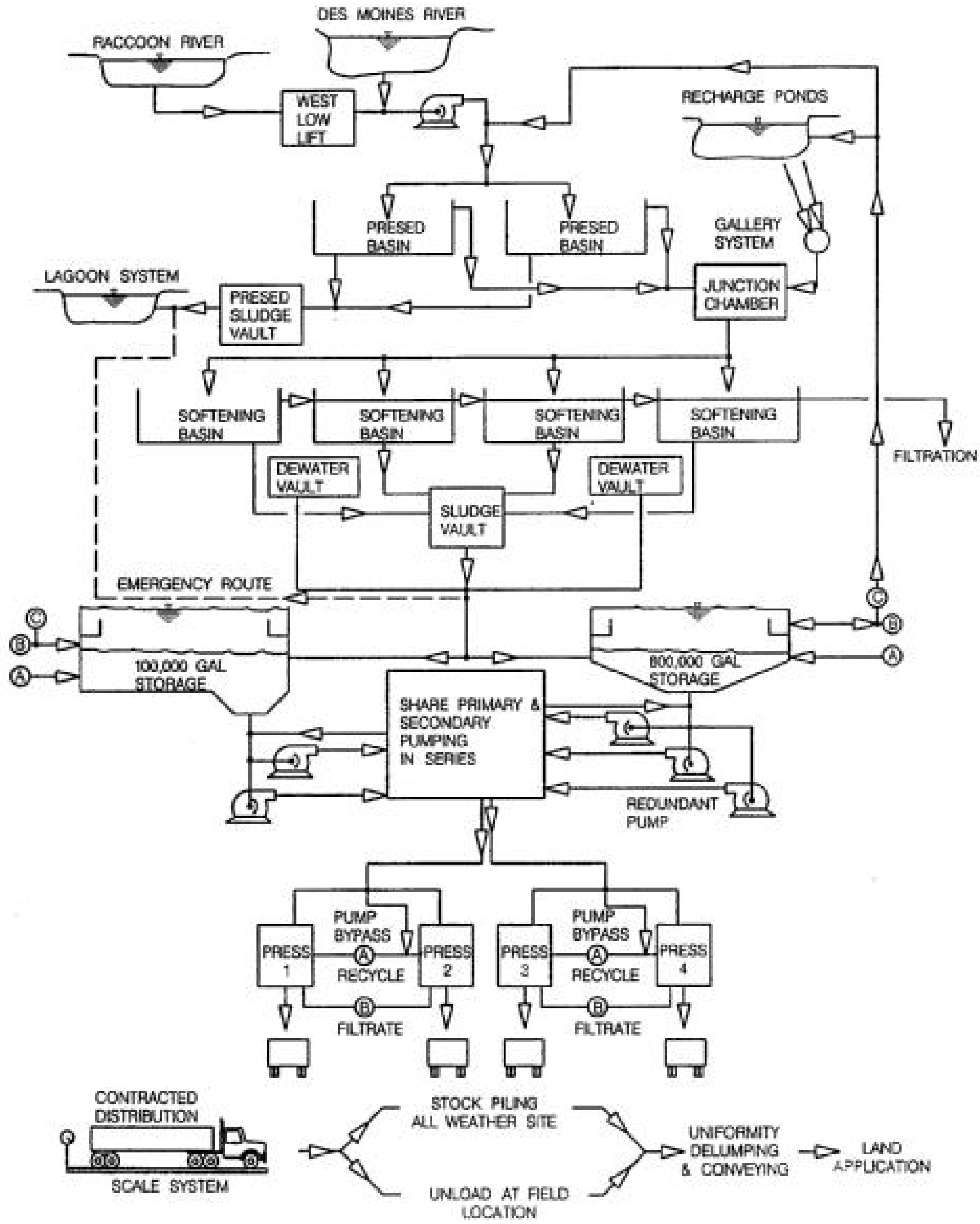


FIGURE 3

Process Design

Use of recessed plate presses requires pumping systems providing varied hydraulic characteristics with an abrasive and alkaline fluid. Initial flow rates of 50.5 L/sec (800 gpm) diminish to 7.6 L/sec (120 gpm) through the press cycle and have to be accurately regulated. Five centrifugal press feed pumping systems were utilized with variable speed control. These systems are connected in series, linking two separately located storage tanks into one integrated pumping system.

Process systems for compressed air, high-pressure pump seal water, recycled sludge delumping and return, filtrate recycle, and high pressure washing are provided. Redundancy was designed into all systems. The sludge handling systems between the treatment basins and the dewatering building were also renovated. Orifice plates were utilized throughout the sludge handling system to allow six similar sludge transfer pumps to meet differing hydraulic constraints, allowing standardization of maintenance items.

Programmable Logic Controller (PLC) Functions

Control for the system is automatically handled through PLCs. This allows the ability to change system operation parameters easily and integrate the system with a future SCADA system. PLC control is in the following areas:

- Preprogrammed pump acceleration, deceleration, start-up, and shutdown for coordination of series and parallel pump interaction.
- Operation of pump discharge valving.
- Feed cycle termination based on weir plate flow metering of individual press filtrate discharge flows.
- Interaction with press PLC that defines plate shifting and valve operation during the five press cycle segments.

Process Sludge Cake Storage and Hauling

Market research and building maintenance desires indicated sludge storage should allow for dumping of material directly into trailers or stockpiling for later loading by the contractor. Building design was adapted to allow both trailer loading schemes. Press design allows for two production cycles of sludge to provide an efficient hauling weight under current Iowa laws. Additional drying and processing equipment were also researched to fit into this area. The resulting 2-story building design allows ten days interior storage capacity, open clearance, and structural integrity for maneuverability of large loading equipment below the presses. Four tractor/trailers combinations can back into a room directly below the presses. The first floor also has a 450,000-liter (100,000 gallon) redundant sludge storage tank, pumps, and piping. The second floor houses the control room, shop area, and press room. The ventilation system is designed to minimize exhaust infiltration into upper rooms and maximize lower level ventilation, exhausting air through an energy recovery system.

Roads to the facility are designed to minimize interaction with other plant traffic, yet maintain plant security. A scale system made active by the sludge haulers and monitored by Des Moines Water Works security personnel complete the facility design. A general process diagram is shown in Figure 3.

Des Moines Water Works' Responsibilities During Project:

- Pilot testing of equipment
- Process design, specification, and equipment purchase
- Facilities layout
- Design and construction management
- Inspection
- Hauling specification

Benefits From In-house Design:

- Customization of equipment to DMWW's needs
- Post project operational expertise
- Understanding of equipment versatility for future residual market shifts
- Effective operator and local hauling contractor design input
- Renovation of existing processes to optimize the dewatering concept
- Immediate expertise available for initial start-up question/problems

Current Project Status

The sludge dewatering facility began operation in September 1994. It has handled the sludge dewatering needs of the DMWW effectively since. It is currently operated by 80% of one operator's labor per shift. A repair shop was established in the building for other water production operations to efficiently utilize extra time. Operation of the facility averages 16 hours per day, six days per week. During cleaning of the softening basins, it effectively handles the extra loading with a 24-hour-day operation.

An acid wash system has been added to the design since start-up because of calcium carbonate build-up on press cloths. Additional plates are being ordered to increase the presses to full capacity.

Sludge End-Use Status

Contractors were reluctant to bid end-use contracts without having the material to try on their equipment. This material was not available. To provide a competitive bid environment, the Des Moines Water Works also bid contracted end-use of the material. The utility's contract consisted of hauling the material to the local solid waste landfill as a component of daily landfill cover, hauling to a composting facility as a conditioning component for fill and further marketing; and hauling to an ag-lime distributor for field application. The ag-lime distributor received the entire contracted end-use bid.

The ag-lime distributor has responsibility for complete management plans operating within guidelines of federal, state, and local regulations. He is held accountable for location of all material distributed and rates of application. The ag-lime distributor also owns a manufacturing facility that allows fabrication of innovative lime sludge handling equipment. Field compaction has been minimized with a four-wheel-drive track machine. Bridging of material during distribution has been minimized with collapsing equipment beds and hydraulically repositioning central feed augers. Distribution efficiency is maintained through large capacity equipment and self-propelled conveying systems for discharge directly into field equipment.

The dewatering design provided for a consistent product that comes close to meeting the needs of the market equipment, but additional management is necessary. The material currently has the option to be hauled directly to field distribution equipment, all weather storage sites, or small stockpiles at spreading sites for later field application. The ag-lime distributor continually renovates his equipment as he is learning about the product. When confronted with frozen sludge during cold weather application, a grinder that delumps all the material to a 16mm (5/8 in) particle size and is linked to his conveying system was developed. Maintaining uniformity of particle size and placement during distribution is still a concern that is continually being addressed. Larger pieces of the material break down quickly when in contact with rain and are easily blended with soil during conventional tillage techniques. Minimum tillage conditions require closer management of the material.

Public Perception

Public perception of the material is also being managed. A videotape educating the public about the entire lime softening process from production of the calcium oxide to distribution of lime softening residual onto the field was presented at the Iowa State Fair and continues to be used for other audiences.

Names such as “Slime lime” have been replaced with “Lime Softening Residue” or other end user trade names. Des Moines Water Works’ product is currently handled under the name of “Kelderman Lime”. A name linked to the contractor’s ag-lime distribution market and also his agricultural equipment line.

Des Moines Water Works is currently working with other Iowa municipalities on a state water treatment residuals committee to help draft regulations that will maintain a positive, efficient environment for future use of this material.

Des Moines Water Works currently produces about half of the municipal lime softening residue in the state of Iowa. The utility believes strongly in the lime softening process for good microbiological disinfection as well as water conditioning and must recycle approximately 163 wet metric tons (180 wet tons) of this material each day to keep the lime softening process in operation. Des Moines Water Works is committed to a long-term market for the material and is continually looking at new ways to use it.