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INDUSTRIAL WASTEWATER ZERO DISCHARGE; A CASE HISTORY

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Background

Zero discharge is a desired goal for many generators of industrial process wastewater. It reduces costs for makeup water, permitting, and monitoring, and completely eliminates wastewater disposal charges. It is also the best possible solution for reducing water usage in water-short areas such as the desert Southwest, and eliminates any possible environmental problems connected with discharge of insufficiently treated wastewater.

ProChemTech International, Inc. (PCT) was contacted by Pure Carbon Company, Inc. (Pure) St. Marys, PA, to design and build a true zero discharge water treatment system. Pure manufactures seals for pumps and jet engines from various carbons and silicon carbide. The parts are finished to extremely fine tolerances by a wet grinding process. This process generates a substantial wastewater flow containing containing many submicron size particles which is very difficult to treat using standard sedimentation techniques.

Past practice had been to treat this wastewater by gravity separation and discharge to a stream under an NPDES permit. A decrease in the NPDES limits, plus an increase in fresh water costs prompted Pure to investigate the feasibility of treating this wastewater stream for process reuse.

Evaluation of Reuse Options

The systems most commonly evaluated for reuse of treated wastewater in an industrial operation are the cooling towers and the process systems. The reuse of treated wastewater as process or cooling tower makeup water is considered a high value use, in contrast to a low value use, such as landscape irrigation or dust control. The replacement of potable water used for process and cooling tower makeup with treated wastewater makes the potable water available for other high value uses. With proper planning, there is the potential to totally eliminate the discharge of process wastewater from an industrial facility. The key word is "planning".

A major consideration is that the wastewater generating process and the subsequent treatment process must be included in the design of the water reuse program. The program design must account for both the wastewater and the treated wastewater chemistries, and the potential for upsets that could cause major problems in either process or cooling tower reuse.

The first step in the design of a wastewater reuse program is a plant wastewater survey.

A. SUPPLY - This is to determine what wastewaters are available for reuse, and their present quality. Once these sources are located, the following information should be developed:

1. Where does the wastewater originate, what process produces it, and how is it disposed of now?

2. At what rate is the wastewater treated and how does the treated wastewater flow rate and quantity vary with time? Both short and long term changes should be considered.

3. What is the present raw and treated wastewater quality? This should include the range of variation for each parameter, and the reason for the variation, if possible.

4. What is the specific wastewater treatment chemistry in use, and what are the target parameters? It may be necessary or desirable to evaluate alternate chemistries.

5. How is the wastewater treatment process controlled? Are chemical reagents added proportional to set flow rates, or are wastewater parameters such as pH measured, and reagents added to obtain specific set points?

6. Any existing problems with the wastewater treatment process should be evaluated.

7. A wastewater treatment system block flow diagram should be prepared.

B. USE - Once a potential supply of treated wastewater has been located and evaluated, the potential uses of the supply must also be evaluated. A complete survey of the target process and/or cooling tower systems must be made.

1. What is the present makeup water use rate and amount used over time?

2. How does the makeup water use vary with time? Both short and long term changes should be considered.

3. What is the present makeup water quality? All relevant parameters such as pH,dissolved solids, hardness, alkalinity, chlorides, and sulfates should be determined.

4. Is there any chemical treatment being done on the present makeup water prior to use, such as softening, corrosion inhibitors, or biocide treatment?

5. What chemistry control systems are presently in use, such as blowdown, chemical inhibitor addition, and biocide feed control?

6. If cooling towers are being considered as a use for treated wastewater, various cooling tower parameters must be considered, such as water temperatures, minimum and maximum flow rates, metallurgy of the system with special emphasis placed on potential galvanic couples, and the use of by-pass filtration.

C. ECONOMICS - Once a source of treated wastewater has been established, and a potential use has been found for this source, then the next question to be answered is, "will the reuse of the treated wastewater pay for itself?" The costs of fresh water, sewerage disposal, and the present water management program must be established. Once established, it is a simple matter to calculate the potential cost savings from elimination of fresh water purchases and disposal of "one pass" treated wastewater. The savings must be balanced against the capital and operating costs of any equipment, such as filters, tanks and pumps needed to reuse the wastewater.

Case History

At Pure Carbon, the economics of the wastewater centered on a decrease in allowed NPDES pollutant discharges, and an increase in the cost of potable city water. The grinding process required 160 gallons per minute of potable water which was being discharged after one pass through the system. The existing pretreatment plant consisted of a settling basin which was inadequate to meet the new NPDES limits. Therefore, Pure had to either install a treatment facility to meet the discharge limits, or treat the one pass wastewater sufficiently to reuse in their facility. The cooling tower capacity at the facility was too small to utilize the volume of wastewater being generated, so reuse in the grinding process was investigated.

Following review of various technologies and laboratory treatability testing, ProChemTech determined that the optimum treatment process would be a dual organic polymer train for coagulation/flocculation of the fine particles. PCT 8502 is very high molecular weight cationic polymer supplied as an emulsion, while PCT 8727 is an ultrahigh molecular weight anionic polymer supplied as a powder. Both polymers require makedown systems.

After mixing and adding the polymers in series, the wastewater passes through an inclined plate clarifier. Clarified wastewater, which would meet the standards imposed by Pure for their grinding process, would be completely reused in the process. Sludge would be thickened in a gravity thickener and dewatered in a recessed plate filter press.

To confirm the treatability test results, Pure commissioned a pilot study on-site using a 5 gpm PCT Mark V inclined plate clarifier. After two weeks of pilot operation, in which the wastewater was successfully treated to reuse standards, Pure decided to proceed with a full scale system. The system was specified to be capable of treating 160 gpm of wastewater to a final maximum turbidity of 1 NTU, without increasing the dissolved solids content of the wastewater.

Because of size limitations imposed by an existing building, door demensions, and inside ceiling height, the 160 gpm inclined plate clarifier was custom designed and constructed by PCT in three parts to fit the alloted space. Another unique design feature of the system is the elimination of any type of final filtration. This reduced the initial cost, operating cost, and eliminated many potential operating problems.

Product grinding and finishing is a continuous process and loss of grinding water flow would result in product damage, and cause a major economic loss to the company. To minimize any product damage due to failure of the wastewater treatment system to supply treated water to the grinding process, the system was designed with dual supply pumps featuring automatic pressure loss switchover, a large clear well, several automatic pump and level alarms, and a city water backup in the event of total system failure. Attached is a Wastewater Treatment System Schematic, and pictures of the inclined plate clarifier and "before" and "after" examples of the untreated and treated water.

Results

The wastewater treatment and reuse system was brought on-line in October, 1993, by PCT technicians and Pure plant personnel. Operations have been continuous since that date. Pure has eliminated all discharge of industrial process wastewater from the plant facility. Chemical costs for operation are less than $0.25/1000 gallons and the system has proven to be easy to operate and very reliable. Various parameters of the untreated and treated wastewaters are shown in Table 1.

Pure Carbon Company, an ISO 9000 manufacturer, has reported no product quality problems with reuse of treated wastewater in their production process. The company has reduced their use of fresh water by approximately 30 million gallons per year, and has substantially reduced plant costs for environmental monitoring. Redundancy and automatic alarms provided in the design have proven sufficient to prevent any production losses from system operational problems.

Biographies

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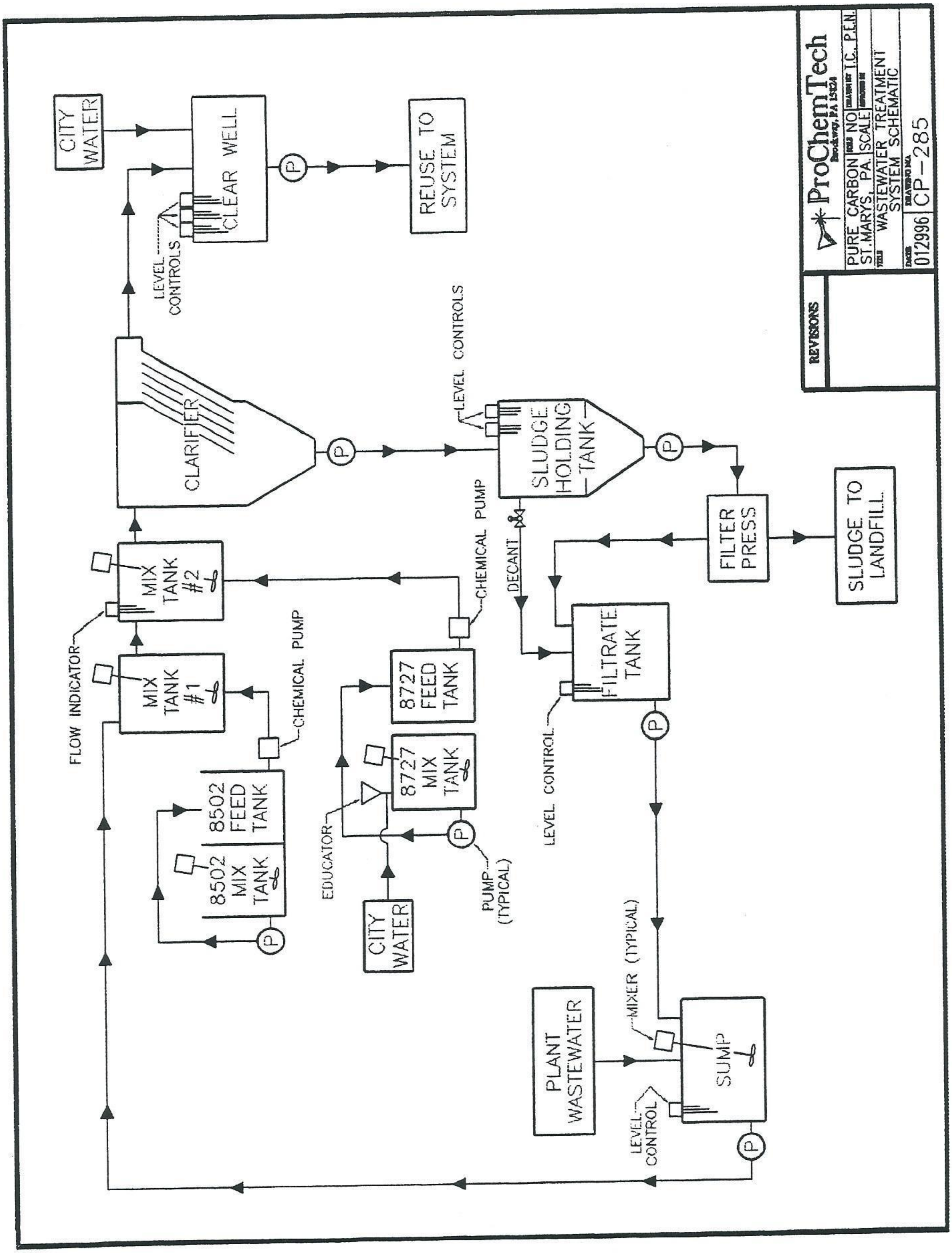
Timothy E. Keister, President, ProChemTech International, Inc., Brockway, PA; B.Sc. in Ceramic Science; former Section Head, Water/Wastewater Control, Brockway, Inc.; Fellow, American Institute of Chemists.

Reference

Wei, Eugene, and Timothy E. Keister, 1995, Recycling Treated Wastewater Through Cooling Tower or Process Systems. Northern California Plant Engineering Conference, Santa Clara, CA. Sponsored by the American Institute of Plant Engineers, September 21, 1995.

Table 1

Parameter	Untreated	Treated
pH su	7.87	7.83
Total Alkalinity, mg/l	122	100
Conductivity, mmhos	886	853
Suspended Solids, mg/l	2764	ND
Turbidity, NTU	7000	0.5
Chemical Oxygen Demand, mg/l	60	18


CITY WATER
CLEAR WELL
P
REUSE TO SYSTEM
LEVEL CONTROLS
CLARIFIER
P
LEVEL CONTROLS
SLUDGE HOLDING TANK
P
FILTER PRESS
SLUDGE TO LANDFILL.
DECANT
MIX TANK #2
CHEMICAL PUMP
FLOW INDICATOR
MIX TANK #1
CHEMICAL PUMP
8727 FEED TANK
8727 MIX TANK
FILTRATE TANK
LEVEL CONTROL
P
8502 FEED TANK
8502 MIX TANK
EDUCATOR
P
PUMP (TYPICAL)
CITY WATER
P
MIXER (TYPICAL)
PLANT WASTEWATER
SUMP
LEVEL CONTROL
P
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