THE MC CLARIFLOW

The Ultimate

UPFLOW SOLIDS CONTACT CLARIFIER

by

Arthur C. Schlicht
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Walker Process Equipment
Division of McNish Corporation
840 North Russell Avenue
Aurora, IL 60506-2853

PHONE: (630) 892-7921
FAX: (630) 892-7951

HISTORICAL

Since the late 1930's, upflow solids contact clarifiers have been in use, supplanting traditional separate-basin rapid mix, flocculation and settling basins with a single vessel capable of performing all of these functions.

Walker Process Equipment has produced upflow solids contact clarifiers in various forms since the early 1950's, with units such as the HC ClariFlow and the Mark II ClariFlow, both of which have been successfully used for municipal turbidity removal and softening applications, and many industrial waste streams. Over 600 ClariFlow units have been supplied over the years, capable of treating in excess of 2 billion gallons per day.

Both the HC and Mark II units are configured such that the internal slurry recycle pump draft tube(s), offset from the basin centerline, stops at an elevation that limits maximum recycle of solids, in order to clear the rotating scraper arm. Consequently, these units disqualify with fully complying with specifications that demand 4% solids concentrations within the mixing zone.

Therefore, the MC ClariFlow was developed to answer these requirements. The MC ClariFlow utilizes a slurry recycle pump within the center pier, where raw flow and recycled slurry from the clarifier bottom are intimately mixed and discharged to the mixing zone of the vessel. Typically, the ratio of raw flow to recycled slurry is between 1:4 to 1:6.

PROCESS DESCRIPTION

A solids contact unit incorporates the processes of mixing, coagulation, flocculation, liquid/solids separation, automatic sludge removal, and solids recycle in a single unified vessel. Raw water and chemicals are mixed in the presence of previously precipitated solids. Thus, the chemical reactions are accelerated and colloidal precipitates are avoided. The precipitation occurs on the surfaces presented by the old floc particles.

Mixing at controlled velocity gradients is essential so that floc formation is promoted, and previously formed flocs are kept in suspension. The steps of mixing, coagulation and floc conditioning are accomplished in 15-30 minutes, depending on the treatment employed and the temperature of the water. This period is referred to as the solids contact time, and the results obtained from this period are all-important for the proper performance of a solids contact unit.

The liquid/solids separation, or clarification step, is controlled to a large degree by the settling rate of the precipitates produced. The inherent design of solids contact units makes it convenient to utilize the upflow principle in designing the clarification zone. By proper design of the effluent collection system, uniform vertical velocities can be maintained in the entire clear water zone. This is accomplished by the use of radial launder systems. The size of the clarification area is determined on the basis of the settling velocities of the particles kept in suspension and circulated in the "solids contact" zone.

As far as basic designs are concerned, the only pertinent factors are the time in the solids contact zone, the permissible upflow rate in the clarification zone, and the side water depth of the basin. Total retention time is of no significance, although some states will dispute this and insist on specific minimum retention times.

IMPORTANT DESIGN FEATURES

After building and observing hundreds of solids contact units, Walker Process Equipment concludes that the following are necessary design features of a solids contact unit, if both economy and effluent quality are to be obtained:

1) Rapid and complete mechanical mixing of chemicals with raw water.

2) Mechanical means for constantly recirculating large volumes of liquid containing the solids used for contacting at controlled velocities. The liquid volume recirculated should be of the order of 4 - 6 times the raw design flow. A speed variator (mechanical or electrical) should be provided for any recirculator to accomplish the necessary flow ranges.

3) Means should be provided for readily varying the suspended solids concentration in the contacting zone.

4) The optimum solids concentration should be maintained by automatic discharge of excess solids after proper thickening in concentrators, or hoppers. The sludge discharge should be controlled by an adjustable timer.

5) The clarification area should be of such size that the upflow velocity will be at least 50% below the particle settling velocity.

6) An effluent collection system that minimizes horizontal movement of clarified water and also minimizes vertical velocities in the clear water zone.

All of the above are inherent in the MC ClariFlow.

APPLICATIONS

Potable Water Treatment
- Softening
- Turbidity Removal
- Iron and Manganese Removal
- Color Removal

Wastewater Treatment
- Phosphorus Removal
- Filter Backwash Reclamation

Industrial Process & Waste Treatment
- Suspended Solids Removal
- Metals Precipitation
- Landfill Leachate
- Boiler Blowdown
- Cooling Tower Makeup
- Coal Pile Runoff
- Many Others

ADVANTAGES

SUPERIOR PERFORMANCE
Low effluent turbidities produced by the MC ClariFlow are a direct measure of its high efficiency which, in turn, results in longer filter runs.

RECIRCULATION
Mechanical recirculation allows the ratio of raw flow to recycled slurry to be varied, in contrast to totally hydraulic, helical, upflow solids contact clarifiers.

CONSTRUCTION COSTS
Generally less than steel shell, field erected, totally hydraulic, helical, upflow solids contact clarifiers, and far less than separate-basin construction.

STABLE OPERATION
The large mass of retained slurry and the flow pattern prevent short-circuiting and resist upsets, particularly when the raw flow is increased.

INTERMITTENT OPERATION
Following a shutdown, the MC ClariFlow is restarted in a matter of minutes. This is critical for small water plants or non-continuous treatment processes.

HIGH CHEMICAL EFFICIENCY
Cost savings are realized from the reduced chemical usage, due to effective solids contact provided by the slurry blanket.

EQUIPMENT DESCRIPTION (See drawing)

1) DRIVE/COLLECTOR MECHANISM

As with all clarifiers manufactured by Walker Process, the MC ClariFlow uses the same AGMA Class 6 precision spur gear drive with replaceable raceways, and which is discussed in greater detail elsewhere. This may seem to be an unnecessary statement, but at least one competitor offers an open chain/sprocket drive that is lubricated with a mop and grease bucket, the drippings from which could easily contaminate the water being treated.

The cages and arms are specifically designed for the torque loadings imposed.

2) AXIAL FLOW RECIRCULATION PUMP

The heart of the MC ClariFlow is the mixing/recirculation pump located in the center pier. This pump must be sized to handle not only the volume of the recirculated slurry, but also the raw water flow, since that total volume passes through the pumping element, the impeller.

The recirculation pump is a product of a major mixer manufacturer, using a special impeller, designed to minimize the breakup, or shear, of floc particles. The impeller is patented, and is characterized by a wide blade and is the most efficient impeller available for high viscosity mixing. Proof of pumping volume is based upon the mixer manufacturer's own test tank research.

Anti-rotation baffles are located within the center pier both above and below the impeller to optimize the pumping capacity. The maximum velocity of raw + recirculated flow within the center pier is to be 2.0 fps.

Unless specified to the contrary, the ratio of recirculation to raw flow is established at 4:1. Also, the recirculation pump drive should be at least 3:1 variable speed to assure the ability of the operator to tailor the recirculation rate to the flow and chemical addition.

3) FLOCCULATION SKIRT

The flocculation skirt is a truncated cone-shaped compartment, with an inward-sloping bottom to direct density currents inward rather than permitting them to establish "rivers" directly to the effluent launders. The slope of the conical portion should be a minimum of 50 deg. from horizontal to prevent settling on the sides of the skirt.

The size of the flocculation skirt is selected to effect retention times of from 15-30 minutes, depending upon the application. Retention times are based on a volume under the skirt to the basin SWD.

Around the top periphery of the flocculation skirt is an effluent collection flume, into which the radial effluent

troughs discharge, and from which the effluent flume emerges.

4) EFFLUENT TROUGHS

The preferred effluent trough system is a series of radial troughs. The number of troughs is based upon the optimum weir rate for the process involved. In no case should the peripheral distance between troughs exceed 25', and, in the case of square tanks, DO NOT position a trough directly into a corner.

Maximum velocity of flow within troughs is to be 2.0 fps.

These effluent troughs may have either V-notch weir plates or submerged orifices. Submerged orifice design is the preferred method.

5) SLUDGE BLOWDOWN SYSTEM
The automatic sludge blowdown valve is provided to remove and control the inventory of sludge within the basin. It is provided with an adjustable timer to permit sludge blowdown to match the sludge production, so that the slurry blanket does not increase or decrease in depth.

The automatic sludge blowdown valve may be actuated electrically, or with either air or water at a minimum of 50 psig pressure.

6) EXTERNAL SOLIDS RECIRCULATION

For lime softening and some industrial waste treatment processes, especially when the unit operates on a start-stop basis, an external solids recycle pump may be required. The primary use of this external recycle is to resuspend the sludge blanket and prevent the sludge blowdown line from plugging during and/or after an "off" cycle.

CASE HISTORIES

The following pages describe case histories of three (3) recent installations with differing treatment regimes, verifying the broad range of applicability and efficiency of the MC ClariFlow.

- Beaux Bridge, LA
- Grand Prairie Regional Water Distribution District, Stuttgart, AR
- Trinity River Authority of Texas - Huntsville Water Treatment Plant

CONCLUSION

The MC ClariFlow is a definite improved offering to the marketplace when compared to the earlier versions of the ClariFlow offerings by Walker Process, as well as others. We now have MC ClariFlow installations, which can be pointed to as success stories of operating installations in lime softening, iron removal and turbidity removal. There should be no reason why the MC ClariFlow cannot be approved against the competitive offerings of any other manufacturer.

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Case History

Beaux Bridge, LA

In March, 1998, the first Walker Process MC ClariFlow in a lime softening application went on line at Breaux Bridge, LA, a 30' dia. MC-RS ClariFlow. Data from this unit is as follows:

Raw Water Characteristics:

Source:	Wells
Total Hardness:	380-400 mg/l (as $CaCO_3$)
Flow Rate:	Design flows of 104 GPM min. – 1,042 GPM max.

Iron removal (in conjunction with a tray aerator upstream of the MC ClariFlow) is also an objective, and the iron content is in the class of 5-10 mg/l. The raw water flow rate is maintained at, or slightly above, the design maximum when the plant is in operation.

Treatment:

pH adjustment:	Lime
Coagulant:	Alum

Both the lime and alum are fed through chemical feed piping located inside the center pier. The lime feed trough is routed through a bridge platform beam, with the feed pipe from the trough discharging inside the center pier.

The effluent total hardness is about 100 mg/l (as $CaCO_3$), which requires a pH of 9.5-9.6.
This plant does not recarbonate.

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Case History

Grand Prairie Regional Water Distribution District, Stuttgart, AR (Lonoke Water Treatment Facility)

In the spring of 1998, the first Walker Process MC ClariFlow in a strict iron removal application went on line in a 66' dia. unit at this site. Data from this unit is as follows:

Raw Water Characteristics:

Source:	Wells
Field pH:	6.2-6.3
Total Hardness:	160 mg/l as $CaCO_3$
Alkalinity:	170-180 mg/l as $CaCO_3$
Calcium Hardness:	100 mg/l as $CaCO_3$
Magnesium Hardness:	40 mg/l as $CaCO_3$
Carbon Dioxide:	150 mg/l as CO_2
Flow Rate:	2,100 GPM design, 2,100 GPM max.
Iron:	5 mg/l

Iron removal (in conjunction with a forced draft aerator upstream of the MC ClariFlow) is the main objective.

Treatment:

Oxidant:	Chlorine and Potassium Permanganate
Coagulant/Flocculent:	Aluminum Sulfate/Polymer Blend

The above treatment chemicals are fed into the aerator effluent line.

The MC ClariFlow effluent contains 0.5-1.0 mg/l of iron, which is all in particulate form such that the filter effluent has zero iron content!

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Case History

Trinity River Authority of Texas - Huntsville Water Treatment Plant

A high-profile Walker Process MC ClariFlow on a turbidity removal application is a 65' dia. unit at the Trinity River Authority of Texas' Huntsville, TX facility. This unit was started in 1998, after which two more were purchased, installed and placed into operation in late 1999. Data from this unit is as follows:

Raw Water Characteristics:

Source:	Trinity River
pH:	7-8
Turbidity:	30-40 NTU
Total Alkalinity:	100-120 (as $CaCO_3$)
Flow Rate:	390 GPM min., 2,780 GPM design, 3,680 max.

The above analyses are normal values, but during rainfall events the turbidity is over 100.

Treatment:

Oxidant:	Chlorine dioxide
Alkalinity Adjustment:	Lime
Coagulant:	Alum
Flocculent:	Cationic Polymer

The above are fed into the raw water via a motorized in-line mixer.

The MC ClariFlow effluent is consistently less than 1 NTU at the design flow rate.

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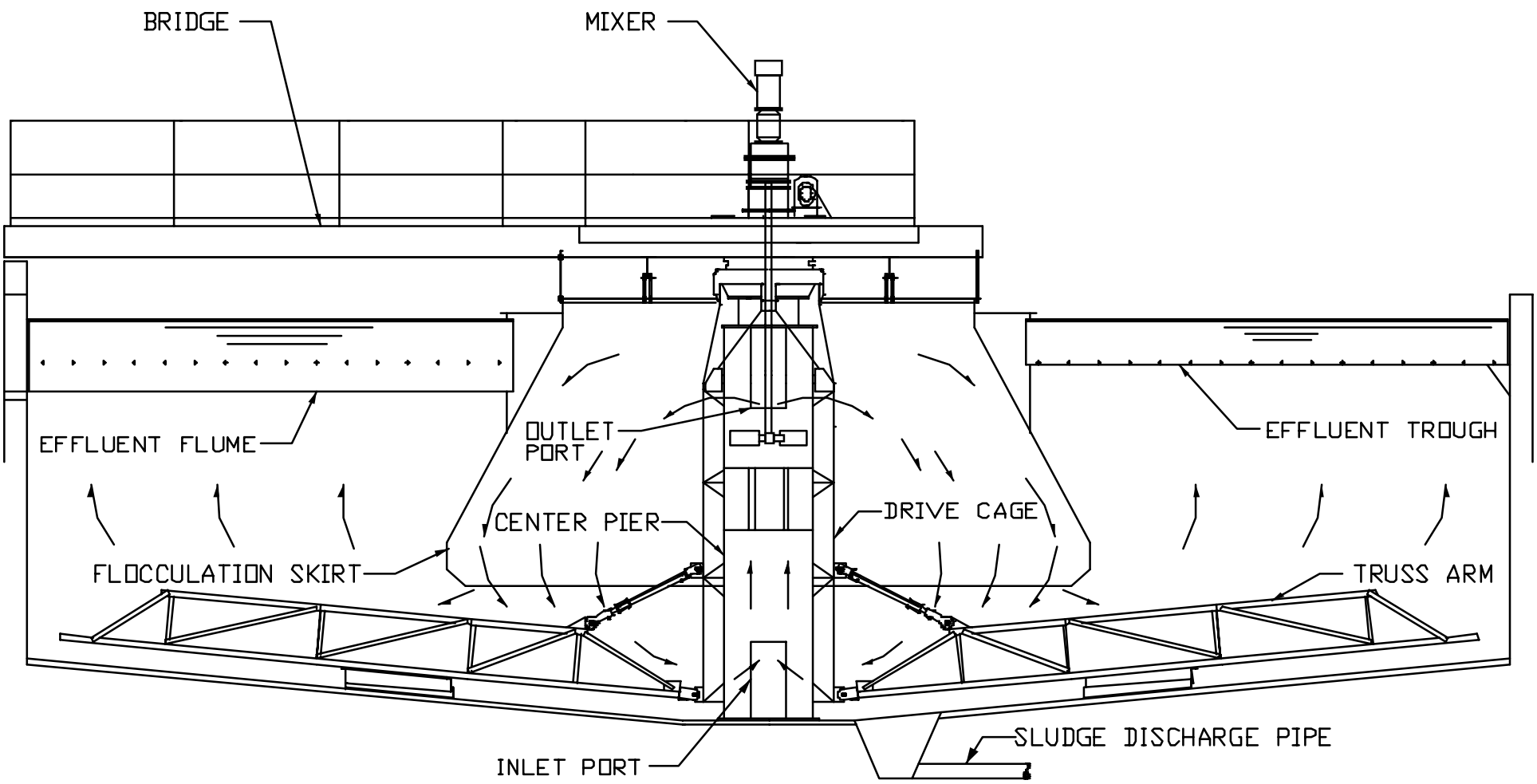

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