INDUSTRIAL WATER USE: WHERE'D IT ALL GO? BALANCING FOR EFFICIENCY

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ABSTRACT

With water critical to many industrial operations, the use, reuse and treatment of the water and wastewater streams throughout a plant can be a large piece of the ongoing operations and maintenance budget. Water uses within industrial facilities vary by industry, and can include cooling water, process water, quench water, cleaning water, boiler water, potable water, and others. Many industrial facilities have changed significantly since they began operations decades ago, and water use throughout the plant can be difficult to evaluate after numerous retrofits and process changes.

A detailed, refined, water balance study can save costs on water use and treatment. By systematically evaluating where water is used, how it gets there, how it is collected, and what water quality is necessary at each process, a working understanding of how best to manage water throughout the plant is produced. A thorough water balance across each process can identify inefficiencies in water use or distribution and in wastewater collection and treatment.

What-if scenarios can then be considered: What if another production line is installed that requires 1,000 gpm of cooling water? Will the existing system be capable of handling it? If so, how can it best be done? If not, what modifications will be necessary? Are there existing water sources that can be used for the cooling water, instead of using potable? With a water balance study in hand, these types of questions and answers are then easily evaluated.

By carefully balancing the water use throughout the plant, inefficiencies can be identified and addressed, and future plant needs can be determined. A step-by-step approach to the water balance and a process for system evaluation will be presented. Plant managers and engineers can then make informed decisions about the most cost-effective use, reuse, and treatment of their industrial water needs.

KEYWORDS

Industrial, water, process flow, wastewater, reuse, recycle, water balance, infrastructure, block diagram, facilities, upgrades, cost effective, efficiency

INTRODUCTION

As evident by a May 29 article in U.S. News and World Report (Lavelle, 2007), the topic of water use and availability are becoming increasingly mainstream, and the dialogue about who will pay the costs for clean water is ongoing. As many of us in the water/wastewater engineering industry are familiar with and have seen increases in wastewater surcharge fees, industrial plants that rely solely on municipal water supplies will likely see the costs for clean water increase as well. These increasing costs are likely to lead to industry management teams looking at new ways to effectively use, manage, and treat their water and wastewater within their facilities. Management focus is typically on production, and rightfully so. But water use is often taken for granted - until there isn't enough of it, or the quality has degraded to the point where production starts to be affected. At that point, a detailed water balance study can add to the overall plant knowledge and understanding of how water is used throughout the plant, and where inefficiencies are within the water or wastewater system(s).

Tracking the water from entry to the plant, through each branch or process, into the collection system, and to the pretreatment or discharge is the first (and sometime overwhelming) step. Investigating flows then allows for a water balance calculation through each branch, including evaporation and process use. Unknowns should then be identified and data gaps filled. Sizes of pumps, piping, valves, control mechanisms (flow control valves, weirs, and orifice plates) can be evaluated to determine pump efficiencies. Technology certainly plays a role in the upgrade of water and wastewater facilities, but the existing infrastructure and available capacity for a particular industrial plant are equally important. Without a solid understanding of the existing infrastructure, use of water and treatment of wastewater, and available technologies for a plant, options for improving plant efficiencies and cost savings can be overlooked. A detailed approach to a facility water balance can be a good decision-making tool for industrial facility management.

INDUSTRIAL FACILITIES

Although the US has seen a significant decline in manufacturing in the last 20 years, there are still significant water users and wastewater generators that are primarily industrial in nature. It has been estimated that nearly 70% of the total wastewater discharged in the U.S. comes from industrial sources like power generation, minerals production, and manufacturing (EPA 1980). Some of the common industrial categories and major contaminants of concern are shown in Table 1.

Each of these categories of industrial user has its own unique, or not so unique, set of difficulties in the use, treatment and reuse of water. Water use within each industry can vary widely, based on production, process requirements, cooling requirements, treatment capacity (if any), permit conditions, regulatory jurisdiction and other, site-specific constraints.

Table 1 – Industries and their Typical Wastewater Constituents of Concern (Corbitt 1990).

Industry	Typical Wastewater Concerns
Chemical and Petrochemical –	Metals, oils, pH, organics, surfactants, organics
Power –	Heat, TSS, coal, metals
Manufacturing –	Metals, FOG, TSS, pH,
Mining –	pH, TSS, metals
Agriculture –	pH, pesticides/herbicides, nitrates, fecal matter
Steel and Metals Finishing –	TSS, oils, toxic metals, heat, pH
Petroleum Refining –	BOD, COD, TOC, pH, TSS, VOCs, FOG, toxic metals
Textiles -	TSS, organics, dyes, pH, metals
Food and Beverage –	BOD, TOC, FOG, TSS, TDS, odor, pH

Regardless of which industry is being studied, several typical water uses include:

- Process use – water as an ingredient or carrier in the manufacture of the end product
- Cooling water – evaporative cooling, cooling tower make-up water, heat exchangers, open or closed loop equipment cooling systems
- Boiler feed/make-up water – to provide steam/energy, make-up for boiler blow-down
- Direct quench water – cooling for product or process temperature control
- Sanitary – clean-in-place systems, toilets, washing, line-flushing, sanitation
- Potable – drinking fountains, kitchens

Depending on the industry, some of these uses may be negligible, and others may be significant. The potential for reduction, reuse, and recycling of these water streams is high in some cases (cooling water and quench water) and low in others (sanitary or process use). In many cases, existing facilities need to know what water is being used, or available to be used, in order to make informed management decisions. Facilities are retrofitting their operations to manufacture different product lines, ownerships change, regulations change, or new processes are introduced. All of these things can cause a facility to modify their operations, and many times those modifications require water or wastewater treatment. An understanding of each of the water uses throughout the plant, and what flow rate, water quality, and infrastructure exists to carry these flows is critical to a comprehensive water balance within each industrial facility.

INDUSTRIAL WATER USAGE

Historically, water has been pretty inexpensive. When compared to other utilities –natural gas, and electricity, for instance – you could argue that water has been taken for granted. That is starting to change. It's getting more scarce, there are more demands on our water resources, and it's harder and harder to get "clean" water. In arid regions, water is not seen as an inexpensive commodity anymore – desalinization plants are becoming more and more common. Water restrictions are common now – only water every other day, or only during certain hours, or both. All of these things translate into water getting more expensive. EPA measures the difference between capital necessary for water/wastewater infrastructure and the funding provided by taxpayers in the hundreds of billions of dollars (EBJ, 2006). Rate increases are inevitable in order to maintain and upgrade water infrastructure (WEF, 2006).

For industry, energy audits are becoming more and more common. Audits often focus on how electricity is used and misused throughout an industrial facility. Given that about two-thirds or more of all industrial water use is for cooling purposes, one relatively new company's business model is to demonstrate that just moving cooling water around costs a significant amount, and that by implementing some capital improvements, industry can save significant costs – up to 50% of current pumping energy costs (Reading, 2006). The interest in reuse of water is gaining more and more momentum, through organizations like the WateReuse Association, and Universities are conducting ongoing studies of the reuse of POTW effluent as industrial process water (Anderson 2007).

The expense of supplying water to industrial facilities has now increased to the point where the economics of water supply and treatment within an industrial facility is getting management attention. Water quality, and quantity are becoming mission critical for production. Not enough water and cooling systems suffer, causing a ripple effect throughout the production line. Insufficient water quality and product quality suffers, or infrastructure is damaged.
Oily wastewater fouls heat exchangers, low or high pH corrodes infrastructure and causes pipe or tank failures, increasing costs, high chlorides can cause quality control issues, TSS build up within pipe systems causes flow restrictions. The list could go on and on. The point is that water, and therefore wastewater, can't be taken for granted anymore. Industry is staring to learn its lesson.

"THAT'S THE WAY WE'VE ALWAYS DONE IT"

One beverage facility had ignored their water use, and their management of the water, for so long, because "that's the way we always do it." So, when asked why all their equipment was just dumping water on the plant floor, they ignored it. The water, as it turns out, had a low pH, which corroded their floor drains and subsequently their pipes. Once the pipes were gone, the water attacked the subgrade on their floor slabs. Once the subgrade started to wash out, the support for their floor slabs weakened and floors started to sink. Sinking floors started to affect their fixed pumps and piping that were mounted on those floors. A pump/pipe that was connected to a 20,000 gallon product tank shifted with the shifting floor slab, causing the piping to crack, and released 15,000 gallons of raw product, which reached a sanitary discharge manhole, and entered the public sewer, which violated their POTW discharge permit.

So, as a result of "we always do it that way," this company faced not just a poor housekeeping program, but in a very real, quantifiable way, they ended up with significant, expensive problems with their infrastructure, supply chain, production capability, and regulatory compliance. If they would have gained a real understanding of their water use (and loss in this case), these problems and the costs that came with them may have been avoided.

UPGRADES

With more and more industry exploring the reuse of former manufacturing plants, upgrades to existing systems are more common than brand new systems. Often, when production changes, the water and wastewater systems don't. Retrofits, equipment changes, production increases – all of these things have potential impacts on the effectiveness and efficiency of water and wastewater systems. Prior to implementing changes, the relevant question that needs to be asked and answered is: How will this change affect water usage, treatment, discharge, reuse, or recycling? In order to answer the question, a detailed water balance for the applicable water or wastewater systems is necessary.

WATER BALANCE

Several good references exist for conducting an industrial water / wastewater balance (Liu/Liptak, 2000; Stevenson/Blackburn, 1998; Dyer et al, 1981). Even so, in practice, a comprehensive look at the use of water and the treatment of wastewater within an industrial facility is the exception rather than the rule. To begin with, taking a hint from Stephen Covey (Covey 1989), "begin with the end in mind," an industrial water balance needs to start with the question of "What is it that we are trying to answer?" Some of the other common questions are:

- Where is all our water going?
- What water could we be reusing?
- How much water can we save?
- What effect will increases (or decreases) in production have on our water needs?
- How much capacity do we currently have for water supply and treatment?
- Are we treating wastewater that we don't need to be treating?
- How much do we spend on "moving water around?"

It's important to note here that the questions above are going to change significantly depending on which industry we're in, where the industry is, and what pain the industry is feeling. For instance, a steel mill in Indiana, directly on the shores of Lake Michigan, and a semiconductor chip manufacturer in arid southern California are going to have vastly different perspectives on how they use and treat their water supply. However, all projections are that regardless of where industry is located, water use and reuse in the next 20 years will be a significant topic of discussion and debate (Maxwell, 2007). Also keep in mind that an effective water balance strategy needn't bite off more than it can chew – if the questions focus on a particular process or section of the plant, focus the water balance there, too.

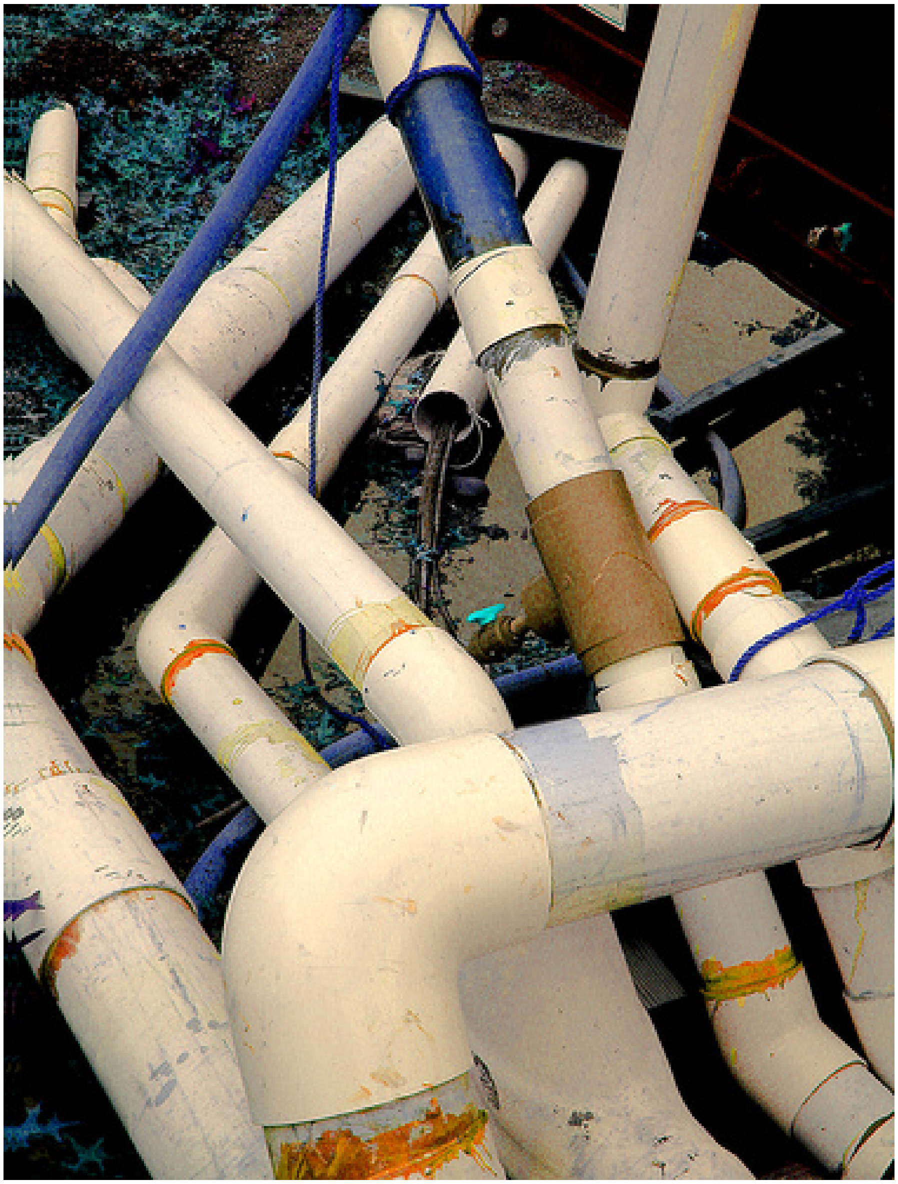
DEFINING THE PROCESS

In its simplest form, a water balance is:

Water in = Water out.

Simple, right? As you can see from this photo, it's not always that simple.

Figure 1 – Industrial Piping



Water can be defined using flows, quality, and temperature, and water can leave a system in both liquid and vapor form. Water can enter a system as supply, recirculation, or recycle loops. Water can leave a system through process use, evaporation, spillage, floor drains, return/recycle, and disposal/effluent. So, a water balance can be simple in concept, but on the other hand, there are many complicating factors to consider when planning the water balance. Therefore, a step-by-step process for conducting the water balance should be followed.

A PROCESS APPROACH

The first step to any process is planning. As Dwight D. Eisenhower once said, "…planning is everything." The plan for conducting a water balance should include the objectives of the water balance, the known or existing data, the unknown, or data collection needs, and the process by which the data gaps will be filled.

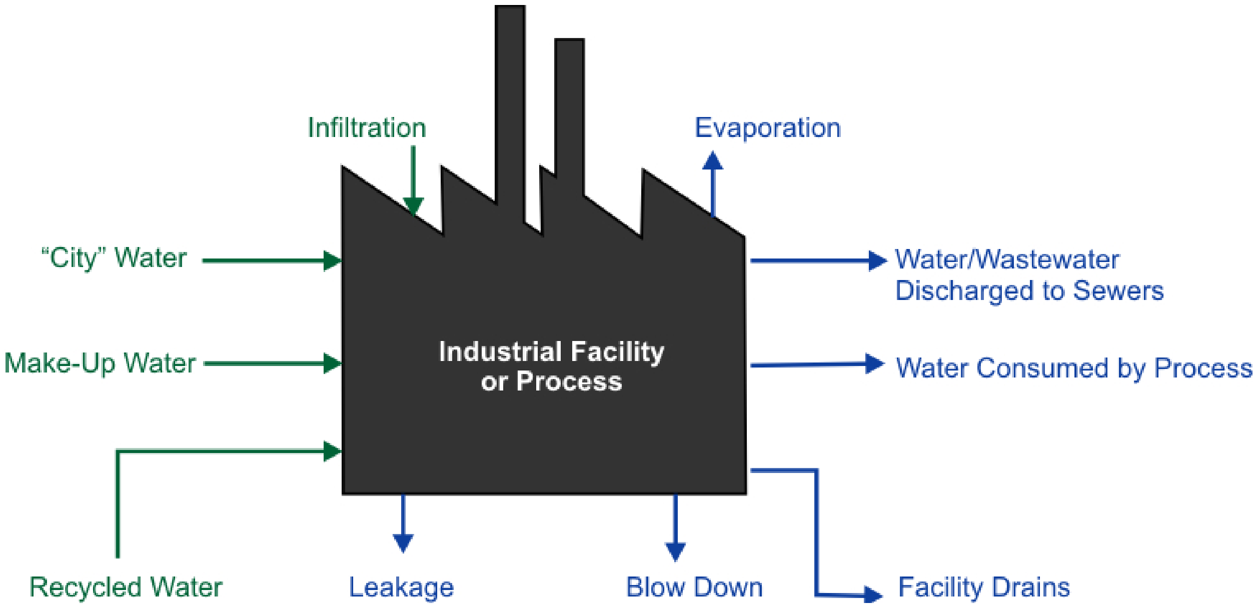
Once the process has been outlined, the existing data ought to be sorted and compiled to determine if data gaps exist, and if so, how big and how important they are. As much information as possible should be filled in at this point – piping sizes, pump nameplates, flow meters, pressure sensors, water quality data, manufacturer's equipment sizing and facility operations personnel are all valuable resources to gather known information about water or wastewater systems. A block diagram can be very useful, simple tool to help conduct the water balance.

BLOCK DIAGRAM

A simple, yet useful tool for the water balance, a block diagram can be used to set-up a process flow that illustrates water in and water out, to be used during calculations. Most times, it is invaluable to interview and discuss the water balance approach with existing (or sometimes better yet – former) facility personnel, that have information not reflected in facility records or drawings. A block diagram can be a simple way to show facility personnel what answers are trying to be answered, and the right areas to look at within the plant in order to answer them. Figure 2 is a simple block diagram of an overall industrial facility, and some of the more common categories of "water in" and "water out."

Keep in mind that the block diagram should show the known data as well as the unknowns, such that it can be used to set-up equations for determining water use or potential for reuse at the facility. The unknowns then illustrate the data gaps, and a determination of which unknowns to concentrate on can be made. Sometimes, a data gap, although unknown, can be a minor source of error in the overall water balance, and it's not worth chasing down. Other times, data gaps account for the majority of the water or wastewater flow through a system – like when numerous flow meters have been neglected, and VFD pumps run at full speed because there is no more flow pace control on them. Sound familiar?

Figure 2 – Example Overall Industrial Facility Block Diagram



UPDATE DRAWINGS

A complete set of thorough, recent, accurate pipe layout drawings and process flow diagrams is a good place to start. Many industrial facilities have no such thing. In these cases, again, an interview with experienced personnel can go a long way to understanding current water and wastewater systems. Even so, it always pays to verify the accuracy of someone's memory. Therefore, one of the common up-front tasks is to walk through the system with the most recent drawings to find out where changes have been made, and how current flows operate. A plan-in-hand walk-through is the best way to find discrepancies, identify areas of concern, and verify that what is shown on the drawings is really there.

During the walk-through, the engineer(s) should map out piping, pumps, equipment, meters, gauges, valves, branch flows, drains, cooling towers, heat exchangers, filters, treatment units, and any other significant equipment that may affect water flow, quality, or temperature. Careful consideration should be given to every process that uses or discharges water or wastewater.

The end result of this effort should be an up-to-date piping layout and process flow diagram, which can be used throughout the water balance effort and beyond. More time is usually spent on this updating step, and in gathering the right information from the right sources, than any other piece of the water balance process. Without accurate information up front, the rest of the balance information will be suspect.

WATER QUALITY

Existing water and wastewater streams should be defined in terms of flow rate, water quality, temperature, contaminant loading, or any other relevant parameters (TSS, BOD, chlorides, pH, etc.). If the relevant parameters are unknown, the water balance project team needs to evaluate what the important parameters are. Cooling towers typically require analyses of chlorides or conductivity, heat exchangers may require analysis of pH, TSS, TDS, and FOG. Individual unit processes may also require analyses of various chemical constituents, depending on the process and the suspect contaminants of concern in the water or wastewater. Changes over time in plant processes can also lead to new analytes or parameters of concern.

Existing chemical analyses can be used to evaluate the water quality, as long as the analyses are recent and representative. The project team should also consider collection of grab and/or 24-hour composite samples, even if only to verify the existing analytical data. Regardless of which type, location or frequency of samples are planned, the team should ensure that the sampling program represents the typical range of water quality expected for each of the sample points. If production changes necessitate a change in water quality, the sampling program ought to make certain that these changes are sampled by staggering sampling across the process changes, or sampling during different shifts, or both. It may be necessary to collect many different samples, especially from segregated flow streams, to reflect actual water quality conditions within each stream. Any comprehensive sampling program ought to have clear goals and objectives, locations and rationale for selecting them, sampling procedures and analytical requirements, and chain-of-custody protocols (Stephensen/Blackburn 1998).

FLOWS

Measurement of flows can be a daunting task – configurations of pipes, lack of space, intermittent flows, operational concerns, and antiquated equipment can all be obstacles to obtaining accurate flow readings. Many facilities have older systems that are over sized for current operating conditions, or have malfunctioned over time, and were never repaired. The determination of accurate flows is critical to the water balance. Garbage in = garbage out. It is worth the extra time, cost, and effort to collect the necessary flow measurements by "bucket tests," clamp-on flow meters, insertion flow meters, flumes, weirs, or pump/pressure relationships, or whatever reasonable means necessary. Again, it is important to relate changes in operations or production to flow changes, and to represent these changes over time when measuring flows.

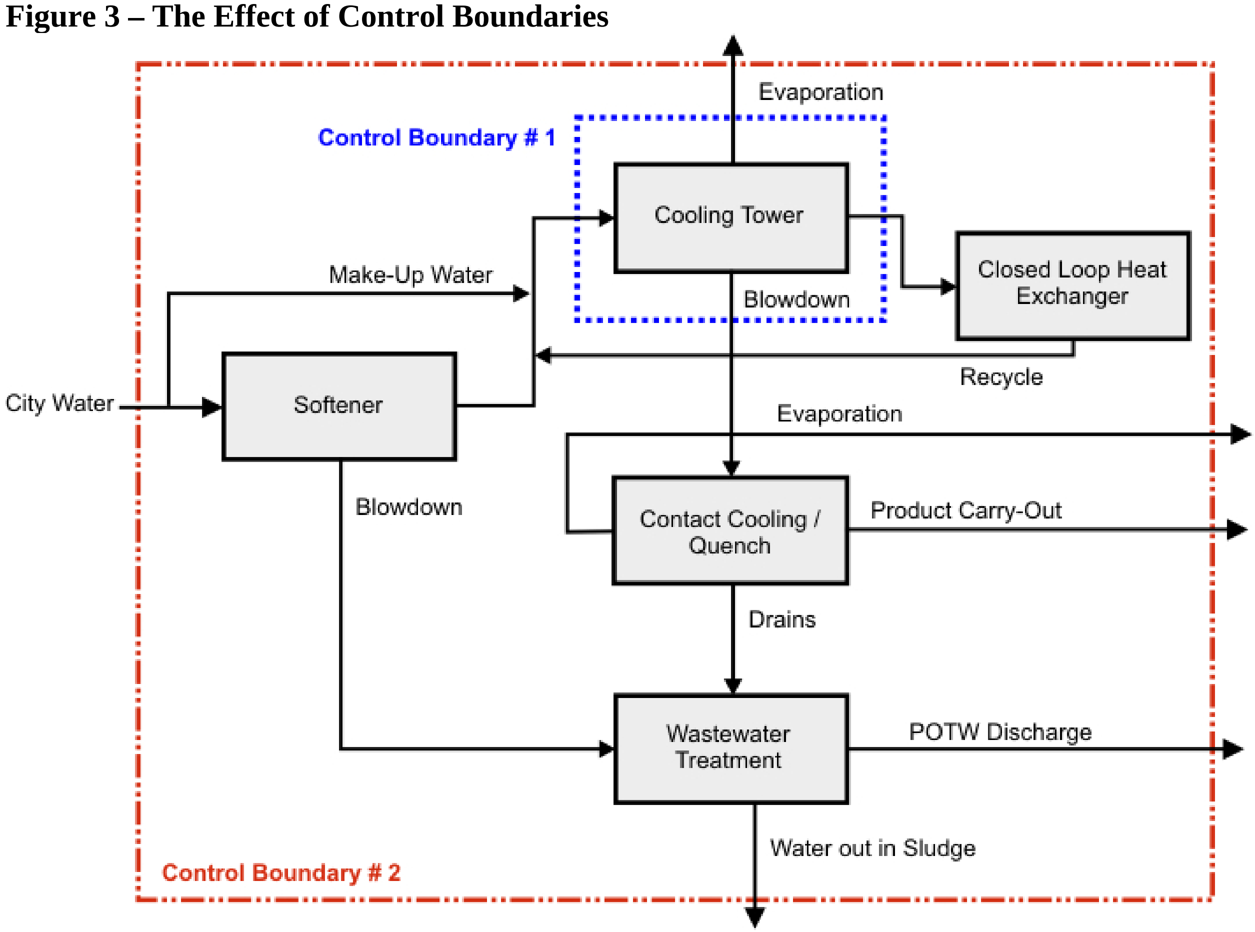
Once the flow measurements have been collected and compiled, a realistic accounting of the relevant water and wastewater flows throughout the facility should be entered on the Block Diagram, so that well-defined water balance equations can be set up and solved.

CONTROL BOUNDARIES

Once the process is well understood, and the data gaps have been filled as much as possible, the water balance proceeds to the evaluation stage(s). By drawing control boundaries across processes or equipment, the unknowns at the control boundaries can be discovered and solved for. Where is the control boundary going to be? Depends on what questions are trying to be answered, and there may frequently be more than a single control boundary in each water balance effort. Draw a control boundary around the process or plant that you are interested in. For instance, you might have a control boundary around a single cooling tower (including water supply, evaporation, blow-down and make-up), or the boundary might be drawn around an individual plant process that utilizes cooling towers, heat exchangers, water treatment units, and facility drains.

As you can see from the following example block diagram, Control Boundary #1 is specific to the Cooling Tower, and the balance requires four quantities: water in, evaporation, blow-down, and water out. Control Boundary #2, on the other hand, is for the overall system, and the balance requires water in, evaporation (from 2 sources), product water carry-out, POTW discharge, and water out in sludge production. By breaking down the overall system into its various components, fewer variables are introduced, and solving for unknowns gets easier.

Figure 3 – The Effect of Control Boundaries



WATER BALANCE CALCULATIONS

Finally, when the flows, water quality, and temperature are known, water balance calculations can be carried out. Water and wastewater flows should be included in the equations, including calculations for evaporation, make-up water, losses to production and spillage. Back to the simplest form of a water balance, the water put in has to equal the water (or wastewater as the case may be) taken out. A simple spreadsheet listing water inputs (potable, industrial or process water, make-up water, recycled water, DI water, rainwater, infiltration) and water discharges (process wastewater, sanitary, water "absorbed" or used up in the process or end product, evaporation, blow-down, leakage) can be used to help organize the known data, and will also help to discover the unknowns and the sensitivity of the balance on those unknowns.

Unknowns within the control boundaries can be solved for. Imbalances within the control boundary should be investigated, and the whole water balance process may need to be iterated to narrow uncertainties. Some references suggest that a balance within 10% should be considered acceptable (Corbitt 1990). However, when looking at specific systems with relatively few unknowns, and narrow bands of uncertainty, balances on the order of 3% or less should be achievable.

USES OF THE WATER BALANCE

Although typically implemented as part of a production-specific analysis, the results of the water balance can be used to evaluate "what-if" scenarios, too. What if the flow to the production process was increased by 10%? What if we increase number of cycles in a cooling tower? What if we eliminate an open loop cooling process and replace it with a closed loop? These and other production, financial, or treatment-driven questions can be answered through the use of a detailed water balance approach.

Aside from serving as an analytical tool for facility management, the water balance allows a plant to look at water conservation, wastewater segregation, waste minimization, regulatory compliance, automation control, and ways to improve operations and maintenance. By using the water balance results to evaluate options, management can assemble alternatives to serve production needs, such as (Stephensen/Blackburn 1998):

1. Reduce or Eliminate wastes by changing operations
2. Recycle wastewaters to other processes
3. Segregate wastewaters for off-site disposal
4. Source treatment of water or wastewater
5. Combined flow treatment

COSTS

Once the water balance has been determined, potential changes to the process that will serve production needs or save costs, can be evaluated. Although many times industrial cost estimates focus only on capital costs, of particular importance when looking at modifying processes for efficiency are the total lifecycle costs for process changes. A detailed cost estimate should be prepared that defines the additional costs associated with each process option. Since the cost estimates will most likely be used to make informed decisions about which options to pursue or not, the estimates should have a firm basis in reality. Wherever possible, real equipment and materials quotes should be obtained, and conservative estimates should be used for contractor costs. Every attempt should be made to estimate realistic costs for system upgrades or installations, and the costs to be considered at a minimum, should include those shown below.

Table 2 – Life Cycle Costs to be Considered

Design engineering costs
Permitting (environmental and building) costs
Capital costs for upgrades
Site work –
Utility Relocations / Installations
Demolition
Earthwork
Foundation / Concrete Work
Building expansion
Equipment –
Pumps
Tanks
Cooling Towers
Heat Exchangers
Filters or other treatment components
Mechanical changes – piping, valves, controls, instruments, HVAC
Electrical changes – conduit, cables, VFDs, motor controls
Ongoing Operations Costs
Additional labor costs
Waste Disposal Costs
Chemical costs
Maintenance Costs (Preventative, Routine and Non-Routine)
Power consumption costs
Replacement of expendables (membranes, filter media)
Start-Up and training costs

On the other side of the cost equation, savings can also be realized with careful consideration of changes in process. For instance, VFDs save energy costs by running pumps at variable speeds, based on need. Membrane technologies can be applied to concentrate oils or other contaminants, reducing disposal costs and/or offsetting costs through revenue created by more valuable oil byproducts (IWW 2007b, Hildebrandt 2007). New technologies from automated chemical feed systems to remote operating systems can be applied to save chemicals, disposal, maintenance, and labor costs. Outsourcing of water and wastewater systems can often times lead to cost savings (and headache reduction) for industrial treatment plants.

The costs and cost savings should be reflected in a comprehensive estimate, and from there, costs should be reflected as an annualized cost, using a capital recovery factor approach, or a current cost, using a net present worth factor approach. Which method gets used is often dependent on corporate policy or purchasing requirements. Either method, when using the same project life and the same interest rate, will yield the same total costs.

Once the costs and potential savings are calculated, a benefit/cost analysis can be applied to each option or scenario. Then, using a relative scoring approach, the various options can be evaluated against each other and against the "do nothing" option, to give management a useful analysis of the lifecycle costs to implement any of the operational scenarios.

IDENTIFYING INEFFICIENCIES

As a result of a thorough water balance, opportunities to save costs may become evident. There are lots of typical inefficient uses of water throughout an operating facility. Several areas that are normally suspect when looking at industrial water uses:

1. Using potable water sources for industrial water
2. Using once-through cooling instead of closing loops
3. Not running cooling towers with enough cycles
4. "Dumping" clean water into wastewater collection facilities
5. Combining wastewater flows that are relatively clean with those that really need treatment
6. Operations personnel leaving water "on" at all times
7. Discharging treated effluent instead of reusing it for industrial uses
8. Failing infrastructure including leaky pipes and inefficient pumps

All of these inefficiencies, and dozens more, depending on specific facility infrastructure (or lack thereof) or water needs, should be considered when assembling potential options for making the industrial water or wastewater systems more efficient.

REDUCE, REUSE, RECYCLE

Although a bit cliché, looking at the "3 R's" is a great way to explore the potential for improving a particular plant's industrial water use efficiency. Zero Liquid Discharge, or ZLD, systems take the common mantra of reduce, reuse, recycle, to the extreme. ZLD systems that reuse all wastewater within a facility back into the process are increasingly being used to eliminate regulatory risks associated with POTW or NPDES discharge permits (Dennis, 2006).

Some potential opportunities to increase efficiency at industrial facilities, categorized into the 3 R's, are shown in Table 3:

Table 3 – Opportunities to Increase Efficiency

Reduce:
Increase cycles on cooling towers
Close cooling loops
Fix leaks in pipes
Educate and train operations personnel
Eliminate cross connections
Reuse:
Cascade water from process to process
Use “once-through” water for wash-downs
Use treated effluent instead of potable water as cooling fluid (IWW, 2007a)
Recycle:
Use technology to concentrate oily contaminants for energy or resale (IWW, 2007b)
Treat blow-down and use for make-up water
Collect rainwater and use within industrial process

Reuse is a reality – it is estimated that 1.7 Billion gallons of wastewater is reused in the U.S. each day (EPA, 2004). Although resistance to reuse of treated wastewater effluent as a potable water source is high, the technology exists to do just that. Economics and resistance to change are huge barriers that still need to be addressed, but at the industrial plant level, reuse of effluent (although not for potable) is becoming a reality. A recent article in Industrial Wastewater illustrated that by reusing what had been wastewater, a pharmaceutical company will guarantee they have enough water for production, will reduce their reliance on public water supply, and will be good stewards of the water resources they do have. Equally important was that the benefit/cost analysis showed a payback of less than 4 years (Cleary, 2007).

The ability of an industrial facility to recycle a portion of their wastewater back into their process is dependent on many site-specific factors, including infrastructure demands, water quality requirements, and applicable regulations, among others. This is another sign that as the supply of clean water is reduced and cost rise, the potential to recycle is becoming a reality. In the extreme, Queensland, Australia, is considering recycling their POTW effluent back to their drinking water supply (WWPN 2007).

SUMMARY

Many aging industrial facilities are being retrofitted and reused for purposes different than their original intent. The use of water and the treatment of wastewater within these industrial facilities is a growing concern, as the costs of obtaining and maintaining clean, usable water get higher. These increasing costs are causing industries to look at improving the effective use, management, and treatment of the water and wastewater within their facilities.

Opportunities for cost savings through reduction, reuse, and recycling of the water and wastewater throughout a plant often go unnoticed. Even if known, evaluation of these opportunities can be complicated because water use throughout the plant can be difficult to evaluate after numerous retrofits and process changes. Facilities that are being consolidated, added-onto, retooled, reconfigured, or updated need to be able to make informed decisions about how to smartly use their water and treat or discharge their wastewater. In order to gain the knowledge necessary to make those decisions, a step-by-step method and process for conducting a water balance throughout the facility should be explored.

A thorough water balance across each process can identify inefficiencies in water use or distribution and in wastewater collection and treatment. By conducting a systematic water balance that includes updates of existing drawings, existing data compilation and evaluation, flow monitoring and water sampling, and a detailed balance of water and wastewater throughout the plant, inefficiencies can be identified and addressed, and options for improving plant efficiency and cost effectiveness can be determined.

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