MINIMISING THE EFFLUENT FLOW
FROM A CANE SUGAR FACTORY

P.G. Wright and K.F. Miller
Sugar Research Institute, Mackay, Queensland, Australia.

ABSTRACT

This paper discusses methods to:

(i) examine existing factory discharge patterns.

(ii) model and modify internal factory water circuits, and

(iii) develop strategies for the reduction of heat, solids, liquid, and atmospheric wastes.

As an example of the use of these methods, a set of data for a factory typical of present Australian practice is taken as the ‘base case’, and feasible modifications are examined. These include the reuse of injection water, alternate choice for hose water, rationalisation of process spillage reclamation, and the operation of a wet scrubber using lightly contaminated water. In most cases the closing of cooling water circuits and reuse of high quality water is found to provide significant savings in fresh water and corresponding reductions in the flow of effluent. Water circuit configurations to minimise water use and reduce water discharge to zero are suggested.

Wet flyash collectors in boiler flue gas circuits are examined to determine their potential for reducing effluent water flow from the factory. It is found that there is indeed a good potential for this technology. Physical systems to clean up final effluent water for reuse either in the factory or for irrigation purposes are also examined. The strategies examined and quantified in the paper should facilitate a reduction in the factory water intake as well as its effluent production and the cost of effluent treatment to Mills.

Keywords: Effluent, Minimisation, Zero effluent, Sugar Factory

INTRODUCTION

Waste minimisation is replacing waste treatment as the preferred environmental management strategy in most industries. Work by the Sugar Research Institute (SRI) in factory energy and water system audits has demonstrated that there is considerable potential for mills to reduce the volumes of waste water discharged, even to the extent of achieving a ‘zero effluent’ status. Recent work, however, has shown that discharges can be kept well within effluent discharge limits presently set by the regulatory authorities.

The term zero effluent is typically used to describe the elimination of factory liquid effluent discharged to surface water. In recent years, the increase in the size of sugar factories, population pressure, and more stringent environmental standards have all contributed to placing pressure on sugar factories to move toward zero effluent status. A zero discharge factory will enhance the industry’s public image and will also reduce operating costs.

This paper describes some general principles that are used to achieve a significant reduction or elimination of factory effluent waters. It focuses on rearrangement of internal factory streams rather than the more traditional effluent treatment or “end of pipe” approach.
Background in cleaner production and zero effluent

The consideration of effluent minimisation and 'cleaner production' is quite topical in the general chemical industries. Many general references are available. Jessen and Kemp (1996) redefine the terms commonly used in waste minimisation technology as:

- Recovery  Water is diverted from discharge as wastewater
- Reuse  Water is used more than once within the plant
- Recycle  Water is recovered and reused within the same process
- Reclamation  Water is recovered and reused in a different process, usually in a less demanding application, which can tolerate water that may not be as clean.

Other chemical engineers stress that the most important parameter in designing an efficient, economical water recycling and reclamation system is the required water quality for reuse. Reliance on wastewater streams as a source of process make-up water often has two advantages, viz, availability and consistency in quality.

Typical problems with attaining a zero discharge include:

- Increased maintenance of water circuits;
- Reduced plant reliability;
- Accumulation of trace chemicals in the internal water circuits;
- Increased likelihood of exceeding the allowable maximum concentrations for that wastewater which is discharged; and
- Lost water rights

Nelson (1990) has stated that the two most common waste reduction techniques are to make less waste initially and to recycle waste products back into the process. He lists waste minimisation procedures, and those associated with process piping include:

- recovery of individual waste streams (stripping, filtering, drying or some other type of treatment may be necessary before re-using the stream);
- elimination of pipe and tank leaks;
- monitoring of major vents, especially for intermittent losses;
- recovery of vented product.

Waste minimisation in the cane sugar industry is also topical, being driven by environmental regulatory authorities. Purchase (1995) recently surveyed cane sugar factory practice in eleven countries with respect to potential pollutants, legislation, standards, quantities, techniques and attitudes. His work mainly focussed on treatment procedures rather than on waste minimisation.

Hsieh et al (1995) show that the water content of the cane is more than sufficient for the internal processing of cane sugar. By recycling and reuse, the consumption of external water can be minimised. A zero effluent scheme is proposed in which the treated water from a facultative-aerobic system can be recycled to the external cooling water circuits, thus eliminating disposal. This not only avoids the harm caused by polluted effluent but also saves precious water resources.
Effluent flows from a cane sugar factory

Cane sugar factories require a supply of water as a sink for the major factory cooling duty, that of heat removal from factory condensers. A minimum flow of around 5000 tAl is required for a 500 t/h cane factory. It can be available from brackish or fresh water rivers, or most commonly in a closed circuit system incorporating air/water contact equipment such as cooling towers or spray ponds. The closed circuit systems are made up with good quality fresh water as necessary and overflow to the effluent drains.

The production of effluent depends on the type of factory cooling system installed. The outflow from factories with 'single pass' injection is very large (at least ten times the factory cane crushing rate) but is technically an effluent of low BOD. The reduction of the injection cooling water requirements of the factory is important, but has already been considered in some detail in a recent paper (Wright, 1992). However, it is the factory floor effluent, including the overflow from recirculating cooling water systems, which is of most environmental concern, since it is the effluent type which has to be stored and treated.

The focus in this paper is on factories with fully closed (cooling tower or spray pond) injection water systems, as these are becoming quite general.

The amount of water discharged to designated high BOD effluent streams varies quite widely among Australian sugar factories. The volume of this type of effluent ranges from as little as 5% to over 60% on cane. Higher discharge rates add extra cost to effluent treatment systems, reduce the residence time in treatment ponds, may cause short circuiting in lagoons and ponds, and can cause problems in the operation of activated sludge treatment plants due to low BOD levels. High effluent discharge levels may also cause compliance problems with the individual licences issued by the environmental authorities.

Much is currently being done in Australian factories to lower effluent production, using a number of techniques developed by experience. Sometimes they may risk the use of poor quality injection water on some process cooling duties. This paper describes some of these techniques and, where possible, quantifies the flows and benefits involved. The discussion assumes that factories operate with adequate reclamation drains for returning high purity spillages to the process stream either into the mill juices or the remelt tank. The discussion is limited to operations during continuous crushing, and does not deal with the effluent discharged during factory shutdown operations.

Water requirements of the cane sugar factory

The term ‘fresh water’ is used to describe the water inputs to the factory that are obtained from river water, local catchments and bores, and from local municipal supplies. Fresh water is used because of its generally low solids content, low temperature and (mostly) ready availability. A fresh water source has been considered essential to a sugar factory, though factories can vary widely in their requirements of fresh water. An abundance of good river or bore water promotes its lavish use on process cooling duties in ‘once through’ mode, with the result that excessive prime effluent can be generated.

Condensates produced by the factory heat transfer equipment including the multiple effect evaporators are usually more than sufficient for steam boiler feed and the factory processes involving extraction, clarification, filtration and crystallisation (Wright and de Viana, 1993). There is usually an excess of this condensate water to be utilised or discarded as effluent. Often this excess is directed to the recirculatory injection system and then displaces some injection water to effluent.

Apart from the main condensation cooling duties, there are a number of smaller cooling duties which require appreciable water flows. The method of solving these smaller cooling duties can have a large influence on the amount of make-up fresh water required and the amount of effluent discharged from the factory. The major portion of effluent flowing to factory treatment facilities is from factory drains, overflow from cooling towers or spray ponds, and excess condensate. The latter can appear directly in mill drainage or can be incorporated in the injection water overflow stream.
When the main cooling water flow is recycled through a cooling tower or spray pond system, the excess condensates are usually diverted to the main cooling circuit. Water drift losses, as well as the loss of vapour to ambient air by evaporation in the cooling tower, usually almost balance the inflow of vapour condensation from the factory evaporators and vacuum pans. There is therefore an overflow from the main cooling system, with its quantity approximately equal to that of the excess condensates and any fresh water inputs diverted to it. Where the cooling system is not well managed the situation can be as shown in figure 1, where all the small cooling duties are serviced with fresh water and subsequently flow to the effluent drain, and all the excess condensate flows directly to the effluent drain. The quantity of treatable effluent flows can amount to 40% on cane in this case.

Figure 1 Production of effluent from the factory with poor water management

With better water management there is an opportunity for substituting main cooling water for fresh water in some of the small cooling duties in the factory. This situation is reflected in the schematic of figure 2, where the treatable effluent flows can be contained to below 20% of the cane rate.
Selection of the cooling water streams appropriate to the duty, and the use of small cooling towers largely to close some of the previously-open small cooling water circuits can greatly reduce the factory need for fresh water. As well, the hot fresh condensates can be flash-cooled and treated to improve their quality to allow substitution for fresh water. This arrangement reduces both the factory need for fresh water and its production of effluent.

Factory cooling circuits

In order to implement proper management of the factory cooling circuits a good understanding of the cooling duties and the associated water requirements are required, both for water quantity and quality. The major process cooling circuits in Australian raw factories have been described by Wright and de Viana (1993). A summary of the circuits, giving approximate water flow rates, heat loads, input and output temperatures, water sources and sinks, water quality and approximate cost of package cooling towers suitable for the duty were listed there, and are reproduced here as table 1.
Table 1. Typical process cooling circuit flows and heat loads for a 500 t/h raw sugar factory

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Condenser Injection Water</td>
<td>6 000-12 000 (15 Cool tower) (64 Spray pond)</td>
<td>30</td>
<td>46</td>
<td>River Cooling Tower</td>
<td>Cooling Tower Spray Pond</td>
<td>Proof</td>
<td>Three options</td>
<td></td>
</tr>
<tr>
<td>Mill Bearing</td>
<td>25 (2)</td>
<td>250</td>
<td>32</td>
<td>40</td>
<td>Cooling Tower Fresh</td>
<td>Cooling Tower Drain</td>
<td>Good to Poor</td>
<td></td>
</tr>
<tr>
<td>Mill Turbines</td>
<td>25 (2)</td>
<td>250</td>
<td>32</td>
<td>40</td>
<td>Cooling Tower Fresh</td>
<td>Cooling Tower Drain</td>
<td>Good to Poor</td>
<td></td>
</tr>
<tr>
<td>Power House Turbines</td>
<td>25 (2)</td>
<td>250</td>
<td>32</td>
<td>40</td>
<td>Cooling Tower Fresh</td>
<td>Cooling Tower Drain</td>
<td>Good to Poor</td>
<td></td>
</tr>
<tr>
<td>Crystalliser Cooling</td>
<td>100 (6)</td>
<td>700</td>
<td>37</td>
<td>Injection Fresh</td>
<td>Injection</td>
<td>Injection</td>
<td>Good to Poor</td>
<td></td>
</tr>
<tr>
<td>Final Molasses Cooling</td>
<td>40 (1)</td>
<td>100</td>
<td>30</td>
<td>32</td>
<td>Injection Fresh</td>
<td>Injection</td>
<td>Good to Poor</td>
<td></td>
</tr>
<tr>
<td>Vacuum Pump Cooling</td>
<td>80 (80)</td>
<td>1000</td>
<td>40</td>
<td>Injection Fresh</td>
<td>Injection</td>
<td>Injection</td>
<td>Good to Poor</td>
<td></td>
</tr>
<tr>
<td>Boiler Feed WP Bearing Cooling</td>
<td>3 (3)</td>
<td>15</td>
<td>30</td>
<td>33</td>
<td>Fresh</td>
<td>Drain</td>
<td>Good to Poor</td>
<td></td>
</tr>
<tr>
<td>Boiler ID Fan Bearing Cooling</td>
<td>20 (20)</td>
<td>120</td>
<td>35</td>
<td>Injection Fresh</td>
<td>Drain</td>
<td>Drain</td>
<td>Good to Poor</td>
<td></td>
</tr>
<tr>
<td>Boiler Ash Handling Circuit</td>
<td>300 (30)</td>
<td>NA</td>
<td>65</td>
<td>Injection</td>
<td>Evaporation</td>
<td>Drain &amp; Wet ash</td>
<td>Poor Recycle from clarifier or pond Large evaporation loss</td>
<td></td>
</tr>
<tr>
<td>Crystalliser Reheater System</td>
<td>50 (2)</td>
<td>300</td>
<td>65</td>
<td>60</td>
<td>Fresh</td>
<td>Good</td>
<td>Controlled steam injection</td>
<td></td>
</tr>
<tr>
<td>Small uses (Once-through)</td>
<td>10 (NA)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Fresh</td>
<td>Drain</td>
<td>Good Laboratory Lime Preparation wash basins Amenities</td>
<td></td>
</tr>
</tbody>
</table>
The injection water cooling circuit.

The main injection water circuit encompasses the factory condensers and has the present options of (i) straight-through use, (ii) spray ponds or (iii) cooling towers.

The main injection water circuit has some outflows to the process (e.g. fire supply, cold water tank emergency make-up), some inputs (e.g. condensed vapour, fresh water, condensate water), and some losses due to evaporation, drift, seepage and overflow to the main effluent drain.

The injection water flow is augmented in the factory by the condensation of factory vapours, estimated for a 500 t/h factory as 156 t/h, and by the addition of any fresh water or condensate water into the circulating stream.

Injection water is lost to the main drain after its use in some factory cooling processes and in some boiler auxiliaries. However, the major outflow of water is in the form of vapour removed or released from the spray pond or cooling tower. Normally the vapour and drift loss from a modern water cooling system in a sugar factory is approximately equal to that of the vapour condensed by the injection water in the factory condensers, in this case 156 t/h.

A well designed tower has a drift loss of about 0.2% of the circulating flow, but spray ponds have no drift eliminators and can lose much more, say 1% of the flow, estimated here as approximately 60 t/h at the crushing rate of 500 t/h.

From the difference between the total loss and the vapour condensed it would be expected that a completely closed cooling tower system would require a small top-up (~15 t/h) of water, and a closed spray pond system would require more (~64 t/h). However, it is usually organized to have the closed injection water circuit augmented by excess condensates and/or fresh water so that there is an appreciable overflow; this provides the benefit of keeping the concentration of total solids in the recirculating injection water below the maximum tolerable level.

The mill brass bearing cooling system

The cooling system for individual mill brass bearings often incorporates a manifold box for monitoring the heat output of the bearings at each mill, and recirculation and heat removal by flushing with cold fresh water or by some type of individual air contact cooling tower.

As seen in table 1, this is a small recirculating flow of tepid water, topped up with fresh cold water. It is subject to contamination of oils, greases and cane juice, but is well suited to the incorporation of a mini packaged cooling tower including a grease trap. Closing the circuit can reduce the requirements for fresh water, as well as the amount of overflow (typically this would be directed to the effluent drain).

The mill turbine bearings cooling system

The mill turbine and gearbox (oil coolers) cooling circuit can be a straight-through flow or a closed circuit (incorporating a dedicated cooling tower with a small makeup of cold fresh water). As well, it sometimes is a closed circuit combined with the mill brass bearing cooling circuit. The application involves little risk of contamination.

Often cool fresh water is used for this cooling duty. The incorporation of a dedicated mini cooling tower enables the cooling water circuit to be almost fully closed, with very little fresh water top-up.

The power house turbine bearings cooling system

The power house turbo-alternator bearing cooling circuit is commonly fitted with an individual small air/water contact cooling tower, with some make-up from cold fresh water and some outflow to the effluent
drains. This was the first application of the dedicated mini cooling tower in the mills. The conditions of operation are very similar to those of the mill turbine cooling system above; in fact these two systems could be combined except for the fact that they are located in the factory an appreciable distance from one another.

The low grade crystalliser cooling system

Cold water is required for massecuite crystalliser cooling. In some factories this is provided by including the crystallisers in the injection water circuit, although this may promote problems with excessive cooling coil corrosion. Other factories use a closed circuit system fed by fresh water and including a small cooling tower.

Crystalliser cooling is normally the third largest water load (~100 t/h, as seen in table 1). There is some risk of contamination of this water with massecuite. Where the injection water is not too brackish or corrosive, factories incorporate the crystallisers into the main injection water system. Otherwise the system uses ‘once-through’ fresh water, delivering into the injection water circuit, or the system is closed with a dedicated cooling tower. The once-through technique demands excessive amounts of fresh water and generates excessive effluent overflows. The cooling tower is superior as regards effluent reduction, though it has disadvantages in costs and in the fact that massecuite leaks can cause rapid rises in water acidity and bad crystalliser coil corrosion. The closed circuit cooling system has the advantage that chemicals can be added to the water to minimise corrosion in the crystalliser coils.

Final molasses cooling systems

Cold water is required for final molasses cooling. This is often arranged by including the molasses coolers in the injection water circuit, although there can be problems with excessive corrosion, especially with the steel/brass vertical ‘shell and tube’ type coolers. A closed circuit system made up by good quality fresh water and including a small cooling tower is also in use.

Molasses cooling constitutes a substantial use of cool water (40 t/h, as seen in table 1), and there is some risk of contamination of this water. Molasses coolers (plate or ‘shell and tube’ types) are frequently located remote from the factory e.g. at the molasses storage tanks, and it is convenient that the water circuit of the system be closed with a dedicated cooling tower, as only a small quantity of fresh top-up water is then required.

Cooling and sealing water on vacuum pumps.

Good quality cold water is required for ‘water ring type’ and reciprocating type vacuum pumps.

As seen in table 1 the demand of cooling water for the factory process vacuum pumps is quite appreciable. Most of this is taken by the water ring design of pump, where the seal water may be required to condense water vapour passed by the process condensers. This results in a substantial heat loading on the water stream, especially if the operation of the condensers is poor. Water ring type pumps benefit by having the coolest available water (a water temperature of less than 25°C is desirable), and so fresh cold water is often supplied. Most factories deliver this water once-through to the injection water circuit. Several mills use injection water, risking corrosion in the pump and causing a loss of pump capacity due to the higher temperature (28 to 32°C) of the water.

One problem with the introduction of a circuit for the vacuum pumps is that, with high ambient air wet bulb temperatures, a typical cooling tower would often not reduce the input water temperature below 30°C for a high heat load. One suggestion to improve this is an evaporative chiller or a mechanical heat pump refrigerator incorporated in the water circuit after the cooling tower.

Where the reciprocating type of vacuum pump is used, the cooling water supply need not be as large and its temperature and quality is not so critical, as the water is confined to a cylinder sleeve and does not come into contact with the vapour.
**Hot water reheating circuits.**

Hot water flows are required for the crystalliser and massecuite reheater systems. These circuits are heated by steam and made up with hot condensate water. These duties universally involve closed water circuits and thus should not be significant users of fresh water.

**Ash handling systems**

Boiler ash removal systems often use submerged belt conveyors flushed with injection water. These deliver to a settling pond or clarifier with overflow to the effluent drain.

In one type of system the dry ash falls from the boiler and is quenched in injection water on a submerged ash conveyor. Ash dewatering occurs when the ash is scraped above the water level. The water use of this system is relatively small, with any overflow going to factory effluent. The overflow rate can be lowered by proper regulation of the injection water supplied.

In another type of system a large injection water flow is used to cool the flue gases after incineration. In the process fly ash is collected. Water is also used to flush furnace ash from the boilers. The water flow is larger than that of the ash conveyor system and is treated in a clarifier, with recycle of the overflow and filtration of the underflow to obtain wet ash for removal from the factory site. In this type of system there can be an appreciable loss of water by evaporation in the flue, providing an opportunity for effectively lowering the factory effluent load.

**The boiler feed water pump bearing cooling system.**

The boiler feed pumps can use some (3 t/h, as seen in table 1) cool fresh water to cool mechanical bearings and seals. This water is often discarded to the drain, but some could be reclaimed to the injection water circuit with a suitable piping installation.

**The boiler fan cooling system.**

The large boiler ID and FD fans operate in a hot environment and require a continuous (~20 t/h) flow of fresh water (or injection water). This water is often discarded to the drain, but some could be reclaimed to the injection water circuit with a suitable piping installation.

**Condensate flows.**

Prime (LP steam) condensates with some #2 effect condensate, are monitored by a system of conductivity sensors and directed to the main boiler water feed tank. Condensates from #3 to the final effects, together with the remaining condensate from #2 effect, are fed to hot water tanks and used to top up the maceration tank and to the pan stage hot water tanks for use in pans, high grade centrifugals and process finish-off. Excess hot water overflows from these tanks to the injection water circuit or to the effluent drain.

**Minor uses.**

Other minor ‘once-through’ uses of fresh water include such items as tap waters around the factory, water for cleaning around the lime preparation system, water for hosing, laboratory, amenities, and water for the sugar drier auxiliaries. The total of the minor uses of fresh water is quite small (10 t/h), except for annual hosing around the factory. Hosing can represent an appreciable loading both to the process system (in reclaim areas of the factory) and directly to the effluent drains. Hosing should be minimised and hot condensate should be used for hosing to reduce fresh water intake and effluent outflows.
Principles of effluent reduction

It is obvious that much is currently being done in some factories to lower the production of effluent to be treated, but it is only recently that the techniques have been described in the sugar industry technical literature (Wright and de Viana, 1993).

The smaller cooling duties require appreciable water flows, and the method of solving them has a large influence on the amount of make-up fresh water required and the amount of effluent discharged from the factory. The major portion of effluent flowing to factory treatment facilities is from factory drains, overflow from cooling towers or spray ponds, and excess condensate. The latter can appear directly in mill drainage or can be incorporated in the injection water overflow stream to boost the overflow from these systems.

This paper does not address the problem of the reduction of solids and BOD in the effluent streams. Rather, it focuses on the management of the flows which contribute to the quantity of effluent, a major factor in the sizing of effluent treatment plants and in licensing negotiations.

Effluent reduction can chiefly be achieved by reducing the net input of cold fresh water flowing through the factory processes to the drain. Drain and sluice outflows from the factory are increased by fresh water usage, and by the excess of hot condensates, less any evaporation. When the input fresh water flows are reduced drastically, some problems might arise with soluble and insoluble solids build-up in the closed circuit water systems. Sufficient flush should be retained through these systems to prevent this.

Three options for lowering the quantity of effluent are recognised. The first and foremost option is to reduce the outflows by reducing the need for fresh water to enter the factory. A second option is that clean water entering the drain should be diverted to the injection water system. A third option is that processes of evaporation and irrigation can be used to reduce water outflows to the main drain.

The first option can be implemented by actions such as:

- Closing the cooling circuits in various regions of the factory using air contact coolers within the circuit. This acts to lower the requirement for fresh water and consequently reduces the overflow to the effluent drain.

- Substituting excess hot condensate for fresh water in utility operations such as hosing. The effectiveness of such operations may actually improve as a result. Provision would have to be made for a return to cold water when condensate is not available. Mechanical cleanup methods could also be used to reduce the need for hosing.

The second option can be implemented by actions such as:

- Trapping and scavenging clean waters from portions of the drain for return to the injection system. Alternatively, scavenged water could be pumped to displace some of the water required for the boiler ash disposal system. In this instance some lesser quality reclaimed water could be tolerated.

- Diverting any excess hot condensate from the floor drain to the nearest torricellian leg sump. The estimated average flow of 60 t/h would place an extra evaporative load of 4.5% on the cooling system.

- Using the lowest quality water that is satisfactory for the duty, bearing in mind aspects of temperature, corrosion and maintenance, will generally assist in the reduction of effluent levels.

The third option can be implemented by actions such as:

- Evaporating some of the cleaner effluent or excess hot condensate by spraying it into the boiler stack.
To 74°F saturated, scrubber water could be evaporated at the rate of approximately 10% on cure. The determination of the rate of evaporation and the rate of condensation can be extrapolated from the data of various experiments conducted in the laboratory. The effectiveness of the scrubber's design can be determined by comparing the amount of water condensed and the amount of water evaporated.

The scrubber's effectiveness can also be estimated by measuring the temperature and humidity of the gas leaving the scrubber and comparing it to the gas entering the scrubber. This comparison can also be made by calculating the difference in the temperature and humidity of the gas before and after the scrubber.

While the scrubber system is used for collection performance of scrubbers, the system is also used for the collection of other low-level water uses.

Another problem with waste and collection of waste clean water is that contamination with oils, fats, and greases, and the related odors, can be a serious problem. This is particularly true in many of the cooling water systems. The exposure to fresh water does not influence the quality of the scrubber water.

The scrubber water is collected in a separate layer over (flowing or non-flowing) the scrubber's clean water to prevent contamination and cross contamination. However, the system's design and the cross contamination of the scrubber water create high risks of cross contamination. Therefore, the exposure to fresh water must be minimized in the classification.

Decreeing quality levels for cooling water can be classified as:

- Unmixed effluent water
- Ash clean water
- Primarily treated waters
- Utility water
- Secondary treated waters
- Mill process water
- Induced water
- Indi-purification set
- Cooling clean waters
- Primary
- Secondary
- Hybrid
- Mixed water contaminants

Pumping some of the clean effluent to refill the mill's system

In selecting factory water for use, a consideration of other factors is necessary. In order of preference:

1. Quality
2. Availability
3. Efficiency
4. Cost
5. Environmental impact

Selecting the best water source for the specific application is crucial. Each factor must be carefully evaluated to ensure the best possible outcome.
Conclusions

From an examination of the major factory water sources and sinks it is concluded that:

- A 'process water audit' study should be carried out prior to action to reduce effluent flows in the factory. The particular circumstances within factories vary greatly, and a good understanding of the quantity and quality of the water available, and of the process water circuits would facilitate an informed selection from the many options available to reduce effluent flows.

- Effluent quantity can be reduced by closing the individual cooling circuits using dedicated cooling towers, or by incorporating selected circuits into the injection water circuit.

- Rearrangement of factory process waters can often reduce effluent rates.

- Strategies involving reclamation of water from drains for use in some processes, and of disposal of effluent by evaporation offer good possibilities for effluent reduction.

- Lower effluent discharge quantities should assist in compliance with water discharge licenses, and should also reduce the cost of installation and operation of effluent treatment systems.

REFERENCES


