Effluent generated during drinks manufacture can often be a significant volume and have a high pollution load. Greater awareness of the value of water and materials in effluent can encourage the elimination, reduction or reuse of targeted effluent streams to generate significant savings in water usage and effluent disposal charges.
WRAP’s vision is a world without waste, where resources are used sustainably.

We work with businesses, individuals and communities to help them reap the benefits of reducing waste, developing sustainable products and using resources in an efficient way.

Find out more at www.wrap.org.uk
Contents

Contents ................................................................................................................. 3
Introduction .............................................................................................................. 4
Compliance with regulation ......................................................................................... 4
Alternative options ....................................................................................................... 6
Segregating effluent streams ....................................................................................... 8
Barriers to uptake ......................................................................................................... 10
End-of-Pipe Effluent Treatment ..................................................................................... 13
Conclusions .................................................................................................................. 17
Introduction

Effluent generated in the manufacture of drinks can both be high in volume and have a high pollution load. This may be in the form of suspended solids (SS), from material such as orange pulp or yeast, or in soluble form, such as sugars or ethanol, giving rise to chemical oxygen demand (COD). As a result, the effluent may require some form of treatment prior to disposal and any trade effluent discharges may be significant.

This study has shown that there are opportunities for the drinks sector to:
- reduce effluent generation;
- minimise the economic loss and environmental impact of effluent; and
- reduce the overall costs of effluent treatment and disposal.

The methods available to the industry are site/product specific. A common theme is greater awareness of the value of materials in effluent. The elimination, reduction or reuse of targeted effluent streams could generate significant savings in water usage and effluent disposal charges to benefit the environment.

Compliance with regulation

Over 34 billion litres of waste water are discharged by the drinks sector annually. Trade effluent consents or agreements with local water and sewerage companies usually contain limits for flow and pollutants in an effluent discharge to sewer. In the latter case, this typically includes concentration (and possibly load) limits for chemical oxygen demand (COD) and also suspended solids (SS). These limits are necessary to protect the process at the local municipal wastewater (sewage) treatment works and provide the water and sewerage company the means to manage and control the incoming flow and load.

Irrespective of company size, it is a legal requirement to comply with trade effluent consent conditions.

When a site does not have access to a sewer, it may have to install its own effluent treatment plant to treat effluent to a quality suitable for
discharge to watercourse or groundwater, or store the effluent for collection.

Drinks manufacturing plants may find it commercially beneficial to install effluent treatment facilities for discharge to a nearby watercourse. (hence avoiding trade effluent charges). or to pre-treat effluent prior to discharge to sewer as a means of reducing trade effluent charges.

Current practices in effluent treatment within the UK drinks sector are highly diverse, as can be seen for some of those detailed in Table 1.

Table 1: Some effluent treatment options used in the drinks industry.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Observed practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft drinks</td>
<td>No treatment – direct discharge to sewer</td>
</tr>
<tr>
<td></td>
<td>pH control only</td>
</tr>
<tr>
<td></td>
<td>Separation of high COD discharge, sent to anaerobic digestion off site</td>
</tr>
<tr>
<td></td>
<td>Collection in tanks sent off site for land spreading</td>
</tr>
<tr>
<td>Winery</td>
<td>Private soakaway</td>
</tr>
<tr>
<td></td>
<td>On-site treatment facilities</td>
</tr>
<tr>
<td>Distilleries and Spirits</td>
<td>No treatment – direct discharge to sewer</td>
</tr>
<tr>
<td></td>
<td>Land spread</td>
</tr>
<tr>
<td></td>
<td>Onsite treatment and discharge to sea</td>
</tr>
<tr>
<td>Cider</td>
<td>High COD effluent stored onsite and ‘balanced’ then mixed with low COD effluent from other processes to discharge to sewer within correct range</td>
</tr>
<tr>
<td></td>
<td>Wetland treatment systems</td>
</tr>
<tr>
<td>Beer</td>
<td>No treatment – direct discharge to sewer</td>
</tr>
<tr>
<td></td>
<td>Partial treatment (settlement) and sludge disposal off-site</td>
</tr>
<tr>
<td></td>
<td>Full treatment (aerobic processes – eg activated sludge) with sludge disposal off-site</td>
</tr>
<tr>
<td></td>
<td>High COD effluent sent to anaerobic digestion</td>
</tr>
<tr>
<td></td>
<td>Effluent stored on site and mixed with mains water to get in correct range</td>
</tr>
</tbody>
</table>

Source: Oakdene Hollins/Ashact Consulting
In general, these ‘end-of-pipe’ treatment approaches typically focus on compliance and sometimes reduction in trade effluent costs, rather than reducing material or recovering materials from the effluent stream. Frequently, this is not the most environmentally effective approach and can often be costly. For example, some companies were observed mixing discharge with mains water to dilute COD levels, effectively paying for potable water to be sent straight to drain.

**Alternative options**

While an ‘end of pipe’ approach to effluent treatment may enable compliance, it is likely to do so using processes and equipment with much higher capital and operating costs than necessary. Considerations should also be given to resource efficiency within the process prior to initiating ‘end of pipe’ effluent treatment, particularly segregated effluents.

Although the main perceived benefit of reducing a site’s water consumption and effluent generation are the cost savings associated with water supply and effluent disposal, there are several other potential benefits:

- recovery and reuse of product and/or raw materials;
- reduced loss of product and/or raw materials;
- reduction of ‘hidden costs’ (energy, chemicals, pumping costs, etc);
- reduction of demand on water resources; and
- improved environmental performance, including a reduction of CO2e emissions.

There are many options for securing benefits for segregated effluent streams from specific operations including:

- improving process water use;
- improving process control;
- product recovery techniques;
- improving cleaning operations; and
- improving ancillary water use.
Figure 1 shows the typical approaches that can be adopted ranking eight approaches to effluent management comparing environmental/financial desirability with water efficiency. The top four approaches are considered ‘best practice’, as the value contained within the effluent is recovered.

Many of the effluent management approaches that can be regarded as ‘best practice’ require the segregation of the effluent streams.
Segregating effluent streams

The first step is the identification of existing effluent streams.

Most drinks manufacturing sites are large and complex. A first step before options can be evaluated is to understand the effluent streams that exist.

To understand the site it is necessary to complete a water and effluent survey and use the information to create a water balance.

A water balance shows numerically where water enters and leaves the process and its uses in between. A water balance will help to:

- understand and manage water and effluent efficiently;
- identify the key points of water use and effluent generation;
- identify areas with greatest cost saving potential; and
- detect leaks.

For further guidance see WRAP/Envirowise publications ‘A guide to developing a water balance’ (EN895) and ‘Tracking water use to cut costs’ (GG152R).

Completing a water balance may itself identify immediate water, effluent and cost saving options.

Following preparation of a water balance and identification of key effluent streams an assessment of them, as individual streams, can be made – reviewing water usage and effluent flow and load generation and identifying any actions that can be taken to minimise either.

A number of typical short, medium, and long-term recommendations that can be made to reduce effluent flows and pollution loads by addressing specific segregated streams are shown in Table 2.
Table 2: Some typical effluent minimisation options available to the drinks industry.

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Typical potential benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short-term</strong></td>
<td></td>
</tr>
<tr>
<td>draining and collection of product/raw material</td>
<td>raw material or product savings, reduction of effluent COD/SS</td>
</tr>
<tr>
<td>from pipes and equipment prior to cleaning,</td>
<td>and charges</td>
</tr>
<tr>
<td>with recovery for reuse</td>
<td></td>
</tr>
<tr>
<td>switch off (or fit automatic shut-off valves)</td>
<td>reduction in water (and any added value) consumption, reduced</td>
</tr>
<tr>
<td>to spray bars, belt lube etc when not in use</td>
<td>effluent volume and charges</td>
</tr>
<tr>
<td>ensuring water recovery systems in cleaning</td>
<td>reduction in water (and any added value) consumption, reduced</td>
</tr>
<tr>
<td>equipment (eg CIP or tray washers) are working</td>
<td>effluent volume and charges</td>
</tr>
<tr>
<td>correctly</td>
<td></td>
</tr>
<tr>
<td><strong>Medium-term</strong></td>
<td></td>
</tr>
<tr>
<td>replace one-through cooling water with</td>
<td>reduction in water (and any added value) consumption, reduced</td>
</tr>
<tr>
<td>recirculation (chilled) system</td>
<td>effluent volume and charges</td>
</tr>
<tr>
<td>use water recirculation systems on liquid ring</td>
<td>reduction in water consumption, reduced</td>
</tr>
<tr>
<td>vacuum pumps seal water</td>
<td>effluent volume and charges, increase in pump efficiency</td>
</tr>
<tr>
<td>collection of any hot water (hot liquor) for</td>
<td>reduction in water (and any added value) consumption, energy</td>
</tr>
<tr>
<td>reuse (direct or indirect)</td>
<td>recovery, reduced effluent volume and charges</td>
</tr>
<tr>
<td><strong>Longer-term</strong></td>
<td></td>
</tr>
<tr>
<td>recovery of raw material/product or water using</td>
<td>raw material or product savings, reduction of water use, effluent</td>
</tr>
<tr>
<td>membrane (or other) technology</td>
<td>COD/SS and charges</td>
</tr>
<tr>
<td>use of clean in place (CIP) equipment with</td>
<td>raw material savings, reduction of water use, effluent COD/SS</td>
</tr>
<tr>
<td>final rinse and detergent recovery technology</td>
<td>and charges</td>
</tr>
<tr>
<td>review and improve water treatment to</td>
<td>reduction in water (and any added value) consumption, reduced</td>
</tr>
<tr>
<td>minimise blow down from steam boilers and/</td>
<td>effluent volume and charges</td>
</tr>
<tr>
<td>or cooling towers</td>
<td></td>
</tr>
</tbody>
</table>

Source: Ashact Consulting

Financial savings from any of these actions can also be significant:

- One drinks manufacturing site had vacuum pumps using water for cooling and forming the ‘seal’ – (the liquid ring). Instead of using water on a once-through basis it was decided to recover this water and re-use it by recirculating the seal water via chillers. The first recirculation system was installed and has been operating successfully saving >75,000 m3/y water and over £52,000/y2.
Barriers to uptake

Some of the barriers perceived to limit the uptake of effluent segregation are given in Table 3.

Table 3: Barriers to change in effluent management.

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>Uncertainty about financial benefits of implementation</td>
<td>Effective metering and cost benefit analysis will allow for a better understanding of economic feasibility</td>
</tr>
<tr>
<td></td>
<td>Lack of resources to invest in process innovation</td>
<td>Clarify financial benefits, look at incentive schemes like the enhanced capital allowance water scheme (ECA¹)</td>
</tr>
<tr>
<td>Product quality and safety</td>
<td>Perception that water reuse affects product quality and safety</td>
<td>Increase awareness that these issues can be overcome with technological advances and by keeping streams separate to those used in product</td>
</tr>
<tr>
<td>Decision making</td>
<td>Lack of data on which to base decisions</td>
<td>Process mapping and effective water metering</td>
</tr>
<tr>
<td></td>
<td>Lack of awareness of technically feasible options</td>
<td>Site dependent; stimulate disposition to ask for expert advice²</td>
</tr>
</tbody>
</table>

Source: Oakdene Hollins based on Environment Agency 2009

¹ http://www.eca-water.gov.uk
² An initial step may be contacting the trade association for the water industry supply chain, British Water http://www.britishwater.co.uk/Default.aspx or for technical assistance with water efficiency sign up to the Federation House Commitment www.fhc2020.co.uk
Case study - Effluent segregation at Adnams brewery

Adnams Brewery (at Southwold) has invested in order to minimise discharges to sewer and recover value from its effluent.

Liquid waste, including out of date stock, tank sediment and ullage (returned and/or spoiled stock and cask sediment), is segregated at point of arising and tankered to a separate vessel for storage. Tank sediment includes the yeast, beer and protein sediment remaining at the base of the tank fermentation vessel. The initial pull through of beer is also segregated because it includes excess sediment. This liquid has a high level of COD and suspended solid, and if discharged within the general trade effluent would require treatment or dilution for disposal to foul sewer.

The stored liquid has a high organic content which makes it ideal feedstock for a newly created anaerobic digestion (AD) plant (see image), which converts the matter into biogas and fertiliser. The AD plant also takes hospitality waste from Adnams’ pubs and hotels in the vicinity.
"With energy and fuel prices rising, the reality of being able to convert our own brewing waste and local food waste to power Adnams' brewery and vehicles, as well as the wider community is very exciting. The industrial ecology cycle is completed when the fertiliser produced from the anaerobic digestion process can be used on farmland to grow barley for Adnams beer."

Andy Wood
Chief Executive Officer

In addition to effluent separation, Adnams have implemented several water recycling programmes within the brewing process. Steam from the kettle is recovered, capturing both the heat to heat an energy recovery tank and the liquid to rinse the Lautertun (a vessel used in the early stages of brewing, for separation of wort from grain). Notably, when Adnams transfers from vessel to vessel in the brew house they incorporate the rinse water in the next stage product, to retain the valuable product collected.

Investment in sustainable brewing equipment has been significant, but not unmanageable. With equipment ready for refurbishment anyway, rather than replace like with like, Adnams decided to incorporate best available technology, paying slightly more than otherwise, but offering significant savings over the coming years -

"Water bills have been reduced significantly. Sustainability is a priority for Adnams, but it just so happens that in this case, it makes excellent financial sense also."
End-of-Pipe Effluent Treatment

When all that can be done to minimise water use and water and material losses from production processes through segregated stream treatment has been implemented the remaining effluent has to be discharged. Often treatment is required to meet standards set by the controlling authority or to minimise trade effluent charges associated with discharge to sewer.

Effluent treatment processes can be categorised into five main areas each of which is discussed below.

Preliminary or pre-treatment
Gross solid material in the effluent (factory debris such as lids, gloves etc) will need to be removed prior to the main treatment processes to protect pumps and other equipment. But drinks manufacturing sites may also discharge or ‘dump’ tanks of high-strength effluent (e.g. syrups) necessitating load balancing prior to further treatment (or discharge). Also, some effluents may also be highly acidic (e.g. orange juice) or alkaline (e.g. CIP detergent) such that they require pH control prior to further treatment (or discharge). Therefore, it is often necessary to undertake one or more of the following:

- screening to remove gross solids (inclined raked screen or rotating brush screens often used);
- balancing to balance the flow and/or load (which should be mixed to prevent solids settlement); and
- pH control to control the pH to meet discharge standards and/or protect plant and processes downstream (biological processes are usually most efficient when operated in the pH range 6.5-8.0).

Primary treatment
Primary treatment is generally understood to be the removal of insoluble material (suspended solids) from the effluent stream to reduce loads on downstream processes and/or final discharge.
Figure 3: Balancing of effluent prior to further treatment

Typical primary treatment processes suitable for a drinks manufacturing site may include:

- gravity settlement in a settlement tank or clarifier; or
- dissolved air flotation (DAF) to remove suspended solids (often with chemical coagulant/flocculant assistance).

**Secondary treatment**

Following preliminary/primary treatment it may be necessary to reduce the organic pollution load using some form of biological treatment system. By using naturally occurring bacteria the biochemical oxygen demand (BOD) and chemical oxygen demand (COD) can be reduced and removed as a biological sludge from an effluent.

Biological treatment usually involves either a ‘fixed film’ system, such as biological filters or a ‘suspended growth’ system such as the activated sludge process. Either system can be one of two main types:

- aerobic (in the presence of oxygen); or
- anaerobic (in the absence of oxygen).

For strong, warm effluents, anaerobic treatment can be particularly attractive since methane gas is generated which can then be used as a source of energy.
In general, biological systems are costly to operate and great care must be taken in the selection of the optimum process, or series of processes, in order to minimise cost.

![Figure 4: High-rate biological filtration (with compact lamella settling in background)](image)

In order to minimise the risk of odour, retention in pre-treatment units should be kept to a minimum attendant with process needs and secondary treatment should be designed with odour risk in mind - for example biological filters are more likely to cause odour than activated sludge. Anaerobic processes and sometimes sludge storage/thickening facilities are also prone to odour problems and they may have to be equipped with odour control systems. This is practicable but will affect both capital and operating costs.

**Tertiary treatment**

Tertiary treatment is used to describe the ‘polishing’ of the effluent following primary and secondary treatment to a required standard. It may comprise further solids removal, microbiological disinfection or removal of specific chemicals e.g. nutrient removal.

Tertiary treatment techniques are many and varied and include:
- macro filtration (e.g. microstrainers, sand filtration);
- membrane techniques (e.g. reverse osmosis, ultra filtration);
- sterilisation and disinfection (e.g. UV or chlorination); and
- chemical removal (e.g. activated carbon, specific ion-exchange).
Sludge treatment
Sludge will be produced from both primary processes and from the secondary (biological) treatment stage. Disposal of this sludge has to be considered and some form of dewatering is usual to reduce total sludge volume prior to disposal.

Mechanical dewatering is widely practised, for both primary sludge alone or for combined primary/secondary sludge following blending in a stirred tank; pre-thickening by gravity in batch or continuous-flow tanks. There are a variety of mechanical dewatering processes include centrifuges, filter-belt presses, rotary-vacuum filters, screw presses and filter-plate presses.
Conclusions

Disposing or treating the total combined effluent on site can be a significant cost and give rise to undocumented product and ingredient losses. To reduce these costs and losses effluent segregation and treatment is often overlooked. This need not be expensive or involve substantial retro-fit of equipment, with many options available to eliminate, reduce or reuse effluent.

To identify the best route forward it is always necessary to ensure effluent streams are well understood and mapped, with costing and characteristics evaluated.

Effluent costs are often undervalued, with hidden costs (treatment, heating, product loss equating to loss of potential sales) not taken into account in addition to cost of water and effluent disposal charges. Once the true value of effluent is realised it may be that payback of a particular option may be sooner than expected.

The key considerations in improving effluent management are:
- Map the site water and effluent process streams;
- Locate the effluents with high flow or high COD or SS content within the process which may potentially offer the greatest benefit for elimination or reduction;
- Maximise production yields to decrease COD and SS in effluent (from product and ingredient loss during processing) and make treatment easier and less costly;
- Attempt to eliminate, recover and reuse any loss where possible;
- Reuse waste product. Loss of finished product is probably the highest value loss, due to embedded raw material, labour and energy costs – this loss is compounded when effluent treatment and disposal costs are taken into account; and
- Find the optimal use for the segregated effluent streams. This may include collection, storage and direct reuse, installing a membrane treatment process to separate and recover sugars and water for reuse or sending high COD effluent to anaerobic digestion for energy recovery.