DEVELOPMENT OF A ZERO DISCHARGE PROCESS FOR MDF EFFLUENT TREATMENT

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Conventional processes for the treatment of effluent arising from the manufacture of MDF panels fail to comply with increasingly stringent environmental requirements. Recent advances in polymer chemistry combined with membrane technology have enabled both water recovery and, more recently, solubilised organic compound recovery. The result is that a ZERO DISCHARGE system is now a reality.

This case study of the first commercialised system at an MDF mill outlines the shortfalls of conventional systems, and how the benefits of the membrane system have resulted in it being viewed not as an effluent treatment plant but as process technology incorporated into the refining process.

INTRODUCTION

The mitigation of environmental effects has become increasingly important during the design and operation of MDF mills. A range of technologies such as "wet scrubbers", "wet electrostatic scrubbers" or "thermal oxidisers" can treat emissions to air from the drier and the press. Whilst these systems meet increasingly stringent environmental standards, conventional systems for the treatment of effluent are coming to the end of their product life cycle, as in many cases they no longer satisfy the demands of works managers, company accountants or Environmental Agencies.

Effluent is generated in many processes during the manufacture of MDF, typically in the refiner, the glue kitchen, the boiler and the air treatment systems discussed above. This article concentrates on the main source of effluent arising during the refining process.

Most European MDF mills include a chip-washing system in the refiner process to remove gross extraneous debris such as sand and grit. Efficient washing of the chips improves the quality of the MDF and also extends the operating life of the refiner. Following washing, the chips are steam-heated to soften the fibres, excess water is removed in a screw press, the chips are cooked to further soften the fibres, and then refined.

The quantity of excess water generated during this process depends on the moisture content of the raw wood and the temperature at which the refiner is operated. As the moisture content of the raw wood increases, the pre-steam requirement increases and consequently effluent production increases. As a rule of thumb, approximately 400 litres of effluent is generated per tonne of bone-dry wood processed. Operating experience in two MDF mills suggests that during the winter up to 600 litres of effluent may be generated per tonne of bone-dry wood processed.

HISTORICAL TREATMENT OPTIONS

Tankering off site / sewer disposal is expensive and is not a sustainable solution

Biological treatment has a high capital cost associated with the solids removal, biological oxidation, clarification and filtration stages. Performance is inconsistent as a result of toxins, pollutant overloading, adverse temperature and low nutrient levels. Resource recovery is limited due to the poor quality of the treated effluent and the production of biological sludges, thus there also exist continued waste disposal and water supply charges.

Evaporators are also expensive with high operating costs (£10 to 15 per m^3) unless there is a cheap source of heat locally available. In addition, there are high maintenance requirements (4 hours cleaning per day plus 1 day maintenance per week) and resource recovery is limited as up to 50% of evaporator condensate is used for cleaning. As evaporators can only operate at constant rate, they are inflexible for use as supplementary steam generators. There will always be an excess of steam generated than can be recycled back into the refiner system so the disposal of contaminated steam has to be considered, particularly during periods of low steam demand. Risk of corrosion is high due to the combination of high chloride concentration, high temperature and acidic conditions.

ENVIRONMENTAL PRESSURES

With the onset of environmental quality standards such as BS 7570, ISO 14000 and the EU equivalent, EMAS, there was an industry need to improve environmental performance. Typical environmental mission statements are "to satisfy environmental and financial expectations by optimising the recovery and reuse of waste streams".

RECENT ADVANCES IN EFFLUENT TREATMENT TECHNOLOGY

Recent advances in effluent treatment technology include the development of high performance polymers, which can efficiently coagulate high strength effluents. In addition, membrane technology is now well established in the fields of filtration and fluid separation, increasingly replacing conventional filtration and separation technologies. Since the development of membranes 40 years ago, applications have progressively become more challenging with both inorganic and organic feeds being successfully treated. Initially, industrial applications were limited to the desalination of seawater (removal of inorganics) and then the removal of colour (organics) from surface water. Over the past 30 years membranes have been developed to meet new industrial demands such as the requirement for ultrapure water in the manufacture of semiconductors, the concentration of protein in the dairy industry and product concentration and recovery of pharmaceuticals. Membrane systems for the treatment of effluent have matured over the past 10 years.

Criteria for Success

1. Low capital cost with rapid investment payback
2. Optimum product / water recovery
3. Effluent reduction, recycle and re-use
4. Long term environmental compliance
5. Easy to upgrade modular systems.

Zero Discharge Process Philpsophy

Each plant comprises modular process units, therefore facilitating easy upgrades to mirror changes in effluent volume, composition and water quality requirements. The 'standard' treatment process is illustrated in Figure 1.

Wood pulping effluent leaving the refining process is dosed with polyelectrolyte, mixed and then flocculated in a dedicated tank. Flocculated effluent is then pumped in to a plate-type filter press, which produces a filter cake with a dry solids content in excess of 50%. Filtrate is then fed through a dual media sand-anthracite filter. The filtered effluent is fed onto the RO membrane and finally an optional carbon filter. Concentrate from the RO membrane is stored in a dedicated holding tank prior to recycling. All dirty backwash/ cleaning waters from the filter press, dual media filter and RO membrane system are recovered and returned to the head of the works, being combined with the incoming MDF effluent. All solid and liquid phase outputs are recoverable thereby resulting in a zero emission plant.

The plant can be substantially automated and an operator fully trained within a matter of weeks. Routine operation, depending on the degree of automation, involves process monitoring, supervision of dry filter cake discharge from the filter press and initiating automatic backwash/ cleaning cycles on the dual media filter and the RO membrane plant.

The first plant worldwide applying this process to the MDF effluent was installed in Kronospan's Chirk factory in North Wales. Construction with full process commissioning was completed over a period of seven months. Further effluent treatment and recovery plants were subsequently installed in Luxembourg, Poland, Scotland, Wales, Germany and France.

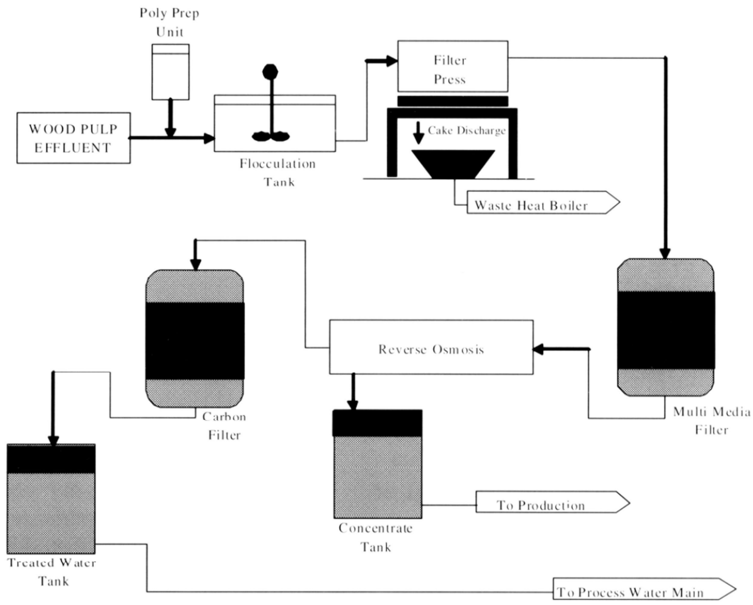

Figure 1: Schematic of the standard Esmil MDF effluent treatment process.

LOW CAPITAL COST / RAPID INVESTMENT PAYBACK

The Esmil plant is mechanical with few process stages thereby reducing the capital investment requirements compared to other systems such as evaporators and biological systems. Operating costs are substantially lower than historical treatment technologies as outputs can be recycled or re-used thereby reducing the volumes and deriving financial benefits from reduced effluent disposal costs, reduced towns water/ natural water intake requirement. In addition, there is no generation of treatment by-product, such as waste activated sludge.

Reduce, Recycle and Reuse

- Process water recovery: 90 to 95% is recycled for use as general process water, chip-wash water or boiler feed water.
- RO concentrate recovery: The remaining 5 to 10% of flow is re-used for chemical make-up water.
- Solids recovery: 100% is recovered as filter cake and re-used as feed for the waste recovery boilers.

Environmental Legal Compliance

The regulatory authorities, in particular the Environment Agency, are increasingly demanding that during the consent process, industry specifies manufacturing and resource management procedures with a view to minimising waste (Integrated Pollution Control).

Under the Environmental Protection Act, preferred environmental solutions are based on Best Available Technology Not Entailing Excessive Cost (BATNEEC). With zero discharge and a fixed physical barrier through which the effluent must pass, membrane systems guarantee long-term confidence of environmental compliance not obtainable by alternative treatment processes.

The Esmil process for MDF effluent treatment has been awarded both the Queens award for environmental achievement and the DTI award for best environmental practice.