ENVIRONMENTAL TECHNOLOGY BEST PRACTICE PROGRAMME

MEMBRANE TECHNOLOGY TURNS EFFLUENT INTO COST SAVINGS

A NEW PRACTICE CASE STUDY AT KRONOSPAN LTD

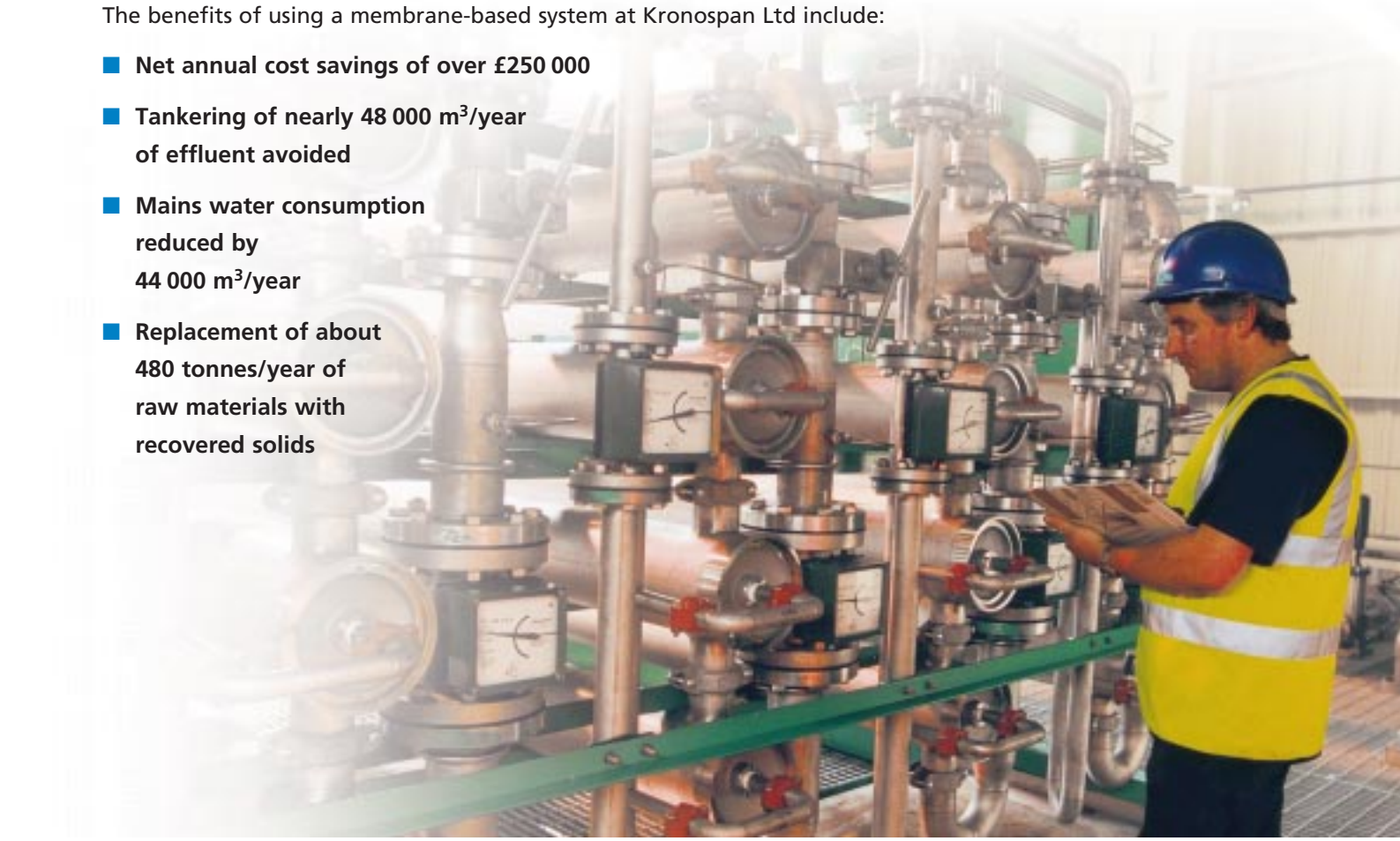
NC259
FINAL RESULTS

This Case Study demonstrates the economic and environmental benefits of using membrane technology to recover re-usable water and fibres from effluent generated during wood fibreboard manufacture.

The manufacture of medium density fibreboard (MDF) at Kronospan Ltd's site in North Wales generates large amounts of effluent with a high chemical oxygen demand (COD) and suspended solids content. Previously, this was tankered off site for treatment and disposal. However, this was expensive and interrupted production if the tanker was late. The Company, therefore, investigated various alternatives, finally installing a membrane-based system that allows virtually 100% material recovery and re-use of treated water. This hybrid plant uses coagulation/ flocculation followed by filtration to remove virtually all the suspended solids from the treated feed-water before it passes through reverse osmosis, cross-flow membranes. Kronospan opted for a low-risk option, negotiating a lease-purchase agreement under which the supplier operates the plant for a monthly fee that is about half the cost of off-site effluent disposal.

The benefits of using a membrane-based system at Kronospan Ltd include:

- **Net annual cost savings of over £250 000**
- **Tankering of nearly 48 000 m^3/year of effluent avoided**
- **Mains water consumption reduced by 44 000 m^3/year**
- **Replacement of about 480 tonnes/year of raw materials with recovered solids**



NEW PRACTICE: New technology and techniques for profitable environmental improvement

MDF Production at Kronospan

The process involves a number of simple, but large-scale, steps. Forest 'thinnings' and sawmill residues are de-barked and chipped before being washed to remove sand, grit, etc. The fibres are then softened in a pre-steam process. Excess water is removed by a screw press before the chips are 'cooked' at 70 - 80°C. The chips are then 'refined' between two flat plates and passed through heated cyclones to drive off most of the remaining moisture. The light and aerated fibres are poured on to a conveyor and premixed resin (prepared in the site's glue kitchen) is added. During the forming/pressing stage, the heated mix is passed between two moving steel belts to compress it to the desired thickness. The formed boards are then cut to the desired dimensions and stacked to cool.

Water is used in large quantities for resin make-up, in chip washing/refining, to raise steam and in air pollution control equipment. Most of the 47 800 m^3/year of MDF effluent is from the chip washing and refining stages. The variable moisture content of the wood changes both the quantity of steam required for softening and the volume of effluent generated. Effluent quality (eg pH) also varies considerably. The effluent typically has a chemical oxygen demand (COD) of over 15 000 mg/litre and a suspended solids content of over 5 000 mg/litre. Organic components include celluloses, lignins and resin acids.

Kronospan's Previous Approach to Effluent Disposal

The high COD and suspended solids content of the effluent mean that it cannot be discharged to sewer without treatment. Evaporating the effluent in the site's driers had been tried, but proved too expensive in terms of energy and maintenance requirements (capacity was also inadequate). The Company, therefore, began tankering effluent off site at a minimum cost of £9.80/tonne. As well as the high cost, Kronospan was concerned about interrupted production if the tanker failed to turn up (the holding tanks being able to hold only a day's worth of effluent). The Company, therefore, decided that it needed a low-risk, low-cost solution that provided maximum wastewater re-use and material recovery.

More Sustainable Effluent Treatment Options

In 1993, Kronospan began evaluating various effluent treatment options including conventional/biological systems, mechanical systems and a membrane-based, reverse osmosis system[1]. Following pilot trials, most of the systems were rejected as being either too costly or inadequate in terms of reliability or final effluent quality. However, the high technology membrane system performed well and offered the potential for water recirculation and material recovery, and hence significant cost savings. The proposed solution also allowed the Company to meet some of its own environmental improvement goals and respond to increasing customer pressures. The only remaining problems were the capital cost and the lack of experience in the UK of successfully using the technology with fibrous effluents.

The Least-cost, Zero-risk Solution Adopted by Kronospan

To minimise initial capital outlay, the plant was acquired under a lease-purchase agreement. Kronospan now pays a fixed monthly fee to the equipment supplier to operate the plant. To further reduce the risk to Kronospan, the supplier-operator agreed to pay the costs of tankering away effluent if the plant failed to work satisfactorily.

The plant, which was installed in June 1995, is a hybrid system combining conventional physicochemical treatment and high technology membrane systems (see Fig 1).

The first stages of the treatment process (conventional coagulation/flocculation followed by filtration) remove almost 98% of the solids greater than 5 µm in diameter (typically 10 kg/m^3), including colloidal material. This

Fig 1 Flow diagram of effluent treatment plant

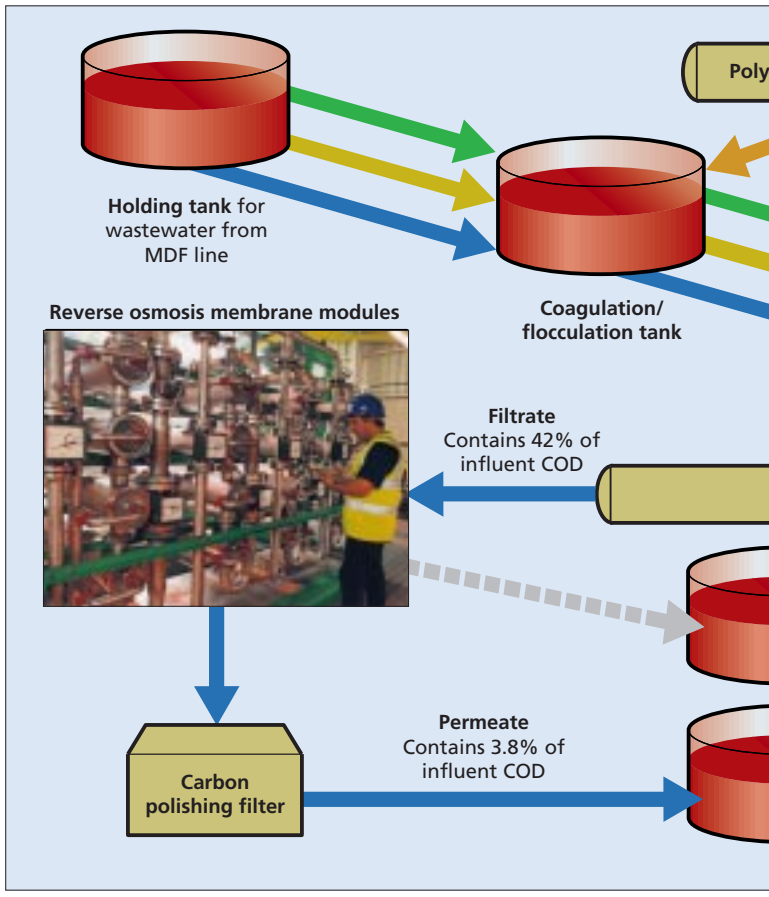


Table 1 Average plant performance (1997/98)

	Water (tonnes/day)	COD (mg/litre)	Suspended solids* (mg/litre)	(tonnes/day)
Feed-water (holding tank)	129.6	16 220	5 870	0.77
Filter cake	1.6	N/A	N/A	0.75
Filtrate (pre-membrane)	128.0	6 880	130	0.02
Concentrate	7.0	Not measured	130	0.02
Permeate	121.0	610	negligible	negligible

* Suspended solids measurements do not detect colloidal solids. An estimated 0.56 tonnes/day of other solids are removed from the wastewater in the filter cake.

[1] An overview of membrane technologies is given in Good Practice Guide (GG54) *Cost-effective Membrane Technologies for Minimising Wastes and Effluents*, available free of charge through the Environment and Energy Helpline on freephone 0800 585794.

protects the membranes and reduces the need for backwashing. The three-stage, cross-flow reverse osmosis membranes then remove most of the dissolved organics, thus reducing the total COD to less than 10% of the raw influent value. Suspended solids are reduced to virtually zero. To achieve the quality needed for re-use, the membrane permeate is 'polished' in a final carbon filter. The whole system is computer controlled. Average performance data for 1997/98 are given in Table 1. Performance has improved since then. COD levels in the permeate are now typically as low as 200 mg/litre and rarely greater than 300 mg/litre.

The spiral-wound, multi-layer, thin-film composite membranes have a smooth finish to reduce surface build-up. They are chemically robust to allow high temperature cleaning at low and high pH to remove surface build-up when it occurs. A valve protects the membranes from hydraulic shock and thus prevents damage to end seals.

Approximately 92% of the feed-water ends up as 'clean' permeate and is used to provide some 60% of the boiler feed water requirement. The 'dirty' concentrate contains

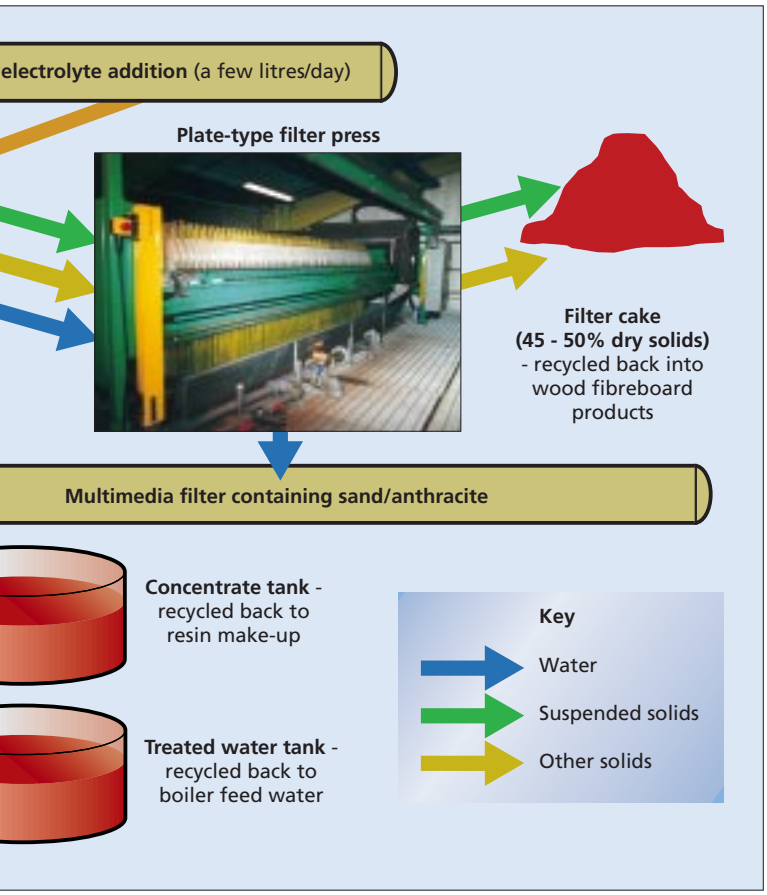
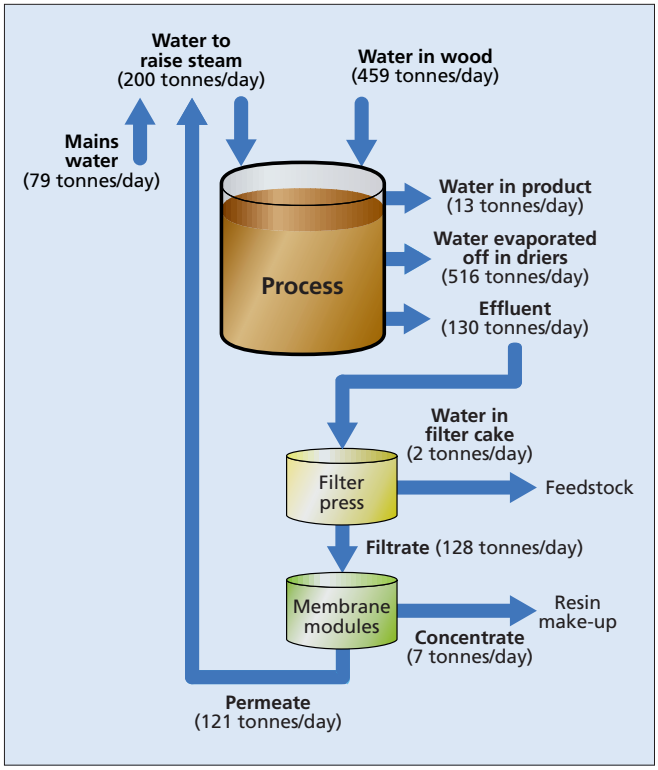


Fig 2 Water mass balance for the MDF plant (1998 data)



useful dissolved organics - including cellulose and lignins - and is added to the MDF resin binder. The filter press cake provides around 480 tonnes/year of dry solids as a substitute feedstock for the wood fibreboard plant, thus allowing a corresponding reduction in wood use. As shown in Fig 2, Kronospan has achieved zero effluent discharge from its MDF manufacturing plant.

Cost and Environmental Benefits

Under the lease-purchase agreement[2], Kronospan made an initial payment of £200 000 in February 1996 and a final payment of £200 000 in February 1999. The supplier-operator charges a fee of £22 000/month, but the net cost savings are over £250 000/year (see Table 2). The annual cash flow is always positive[2] and the payback period for the cost of the initial capital payment was less than ten months.

The new technology has eliminated the need to tanker effluent off-site for disposal and reduced mains water use by 44 000 m^3/year. All parts of the effluent are re-used in the process; using the concentrate as an additive in the resin binder has actually improved product quality. The supplier-operator takes care of day-to-day operation and maintenance, employment and training of operators. The plant has recently been extended to take effluent from a new, higher capacity MDF line.

Table 2 Savings summary for the new plant (1998 costs and production)

Item	Amount/year	Cost savings (£/year)
Avoidance of need for tankering effluent off site	47 800 m^3	468 500
Reduced mains water consumption	44 000 m^3	29 480
Replacement of raw materials with recycled fibre	480 tonnes	17 760
Subtotal of cost savings		**515 740**
Less cost of fees to supplier-operator of new treatment plant	N/A	264 000
Net annual cost savings		**251 740**

[2] Information about investment appraisal and sources of finance is given in Good Practice Guide (GG82) *Investing to Increase Profits and Reduce Wastes,* available free of charge through the Environment and Energy Helpline on freephone 0800 585794.

Kronospan Ltd

Kronospan Ltd manufactures chipboard, medium density fibreboard (MDF), high density fibreboard (HDF), melamine-faced board, sawn timber products and a range of value-added products at its factory in Chirk, North Wales. The site, which employs over 500 people, uses around 1 million tonnes of primary and recycled wood each year. The Company is part of the Austrian-owned Kronospan Group, which has 22 factories in 12 European countries. Kronospan Ltd was one of the members of the Dee Waste Minimisation Project.

Comments from Kronospan Ltd

We were looking for a sustainable and low-risk solution at minimum cost. This is what we have got through the lease-purchase arrangement. Having the supplier to operate the plant has proved cost-effective and trouble-free. As well as the significant cost savings and environmental benefits, the project has been the catalyst for further profitable waste minimisation work and has led to better understanding of the process in general. The Group has also benefited: the same technology being installed at factories in Luxembourg, Poland and Germany.

Mr T Hackney
Works Director
Kronospan Ltd

"As well as the significant cost savings and environmental benefits, the project has been the catalyst for further profitable waste minimisation work..."

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* There may be other suppliers of similar equipment. Please consult your trade directories or contact the Environment and Energy Helpline which may be able to give you more details on request.

FOR FURTHER INFORMATION PLEASE CONTACT THE ENVIRONMENT AND ENERGY HELPLINE ON

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