AXIUM PROCESS LTD
Membrane Process for treatment of dairy effluent

1.0 Reasons for considering UF and RO Membrane Processes:

1.1 DAF and biological options are both traditionally seen as susceptible to variations in feed and to operating conditions. With the variable nature of effluent it can sometimes be difficult to maintain a stable operating environment ensuring consistent performance of such plants. In the event of a biological problem it can take considerable time to regain full treatment capacity – this can present major difficulties for factories depending on secure 24/7 operation.

1.2 Membranes provide a physical system of solids recovery and the quality of the filtrate is normally independent of feed variations. Membrane systems use no flocculating/coagulation agents or other additives – in this sense the process is certainly seen as "greener". A high COD peak of effluent will have little effect on membrane performance.

1.3 The output from a membrane system is split into two streams, a small stream of "concentrate" flow (containing almost all the suspended and dissolved solids in the original effluent) and a much larger "permeate" water stream which is essentially sterile and which can have a COD level similar to tap water. This water is clean and can be used for many secondary functions on site and need not be sent directly to sewer.

1.4 As no chemicals (aside from pH correction chemicals) are added to the membrane process, the disposal problem is not made worse, i.e. only the solids originally in the effluent need to be taken into account.

1.5 Not having to purchasing input chemicals for DAF or digesters results in reduced direct operating costs and also eliminates purchasing, transport, storage, handling and disposal considerations.

1.6 As nothing potentially harmful is added to the effluent when using membrane processing, other means of disposal can be considered, such as animal feed (for the protein, fats, sugars contained in the effluent has a value if uncontaminated). This route may not be open to a concentrated effluent or DAF sludge containing coagulants and flocculating chemicals.

1.7 Membranes systems are seen as BATNEEC (Best Available Technology Not Entailing Excessive Cost) and currently attract ECAs (Enhanced Capital Allowances).

1.8 If required, the plant can be made to be expandable incrementally, to meet the site processing needs. Additional membranes can be added in small numbers as production expands and further capacity is required. With conventional DAF and bioplants, expansion is not normally an easy option.

2.0 What membrane systems can do practically:

2.1 Dairy effluents in general contain milk proteins, fats, lactose, some ash and small amounts of colours, flavours (and occasionally nuts) together with tiny amounts of packing materials which are picked up during plant operation and effluent transport within the factory.

2.2 Treating this effluent directly by Reverse Osmosis, RO, (normally spiral design) will result in problems due to blockage of the flow channels by small amounts of insolubles picked up in the passage of effluent to the treatment plant, or by heavy deposits of fats or precipitated proteins.

2.3 To get the best from the system, a two stage process is essential, removing fats, precipitated proteins and any suspended materials by means of Ultrafiltration (UF) membranes before feeding the clear permeate (filtrate from the UF) to the RO membranes. The UF permeate will in general contain only amino acids, sugars and soluble minerals.

2.4 The RO system will concentrate any sugars or lactose present, together with colours, flavourings and ash or salts. The RO permeate is almost pure water and may be used for floor washdown or CIP makeup water. The water produced by the RO is clear, commercially sterile, and has a very low COD value (see below). For the very best quality water, which removes even this low level of COD, the RO permeate (Pass 1) can be passed through an RO membrane for a second time (Pass 2).

Material	**Min COD - ppm**	**Max COD - ppm**	**Average COD - ppm**	**Variation in COD – ppm**
Raw effluent	1,200	80,000	25,570	78,800
UF Permeate	17	5,200	1,220	5,183
RO Permeate – Pass 1	5	21	14	16
RO Permeate – Pass 2	5	5	5	0

2.5 The COD values of the effluent to the plant are highly variable, while the permeates are progressively more consistent, as the summary table above demonstrates. The concentrates from the UF and RO are eventually combined and may be disposed of as animal feed, to soil injection, or could be used as part of a composter feed.

2.6 The scale of a similar effluent system designed, manufactured and installed by Axium Process for a large ice cream factory during 2008-9 was 400 m^3/day. Since that time results have been shown to be very beneficial and the UF plant is now being expanded upto 700 – 800 m^3/day. Between 90 and 95% of the effluent can be recovered as good quality reusable water.

3.0 Where are the savings?

3.1 The main operating savings accrue from the reduction in costs incurred by the Mogden formula. If the water is simply sent to drain, without recycling on site, then the volume term is still present according to the Mogden formula, but the suspended solids and the COD terms are essentially zero. If the recovered water is utilised on site the cost situation improves further.

3.2 Re-using the reclaimed water on site reduces the volume of fresh water normally used in factory process offering further significant savings. In certain situations, if water supply is limiting, this recycling process would allow production to expand.

3.3 With membrane systems, no flocculating or coagulation chemicals need to be added to the effluent, making considerable savings on purchasing, transport, storage, handling and disposal costs. As a result, the total volume of effluent (typically 5 – 8% of the original effluent volume) has greatly increased options for disposal. In some instances the remaining effluent has a value and could be sold as animal feed or composted, it is also much easier on the environment.

3.4 Further savings can be made in recovering the heat content of the effluent and using it in CIP make up water or floor washing procedures.

3.5 Membrane systems have a small footprint being relatively light and compact. They do not need very large holding tanks or require civil engineering. Systems can sit on standard industrial floors without re-enforcement. Each of the systems we build is customised and designed to fit within the confines of the environment specific to the application, such as limited head room in existing buildings etc. The lack of any civil engineering makes for a relatively rapid installation.

3.6 The effluent is processed almost immediately it is produced, and is processed before smells can develop.

4.0 Example of costs:

The following are estimated costs for a 700 m^3/day automatic treatment plant using Ultrafiltration followed by double Reverse Osmosis (the UF permeate is passed twice through an RO membrane to provide very high quality water):

Factor	Assumptions	£/day operating costs
Electricity	8p/kWh	237.30
Labour	4 hours/day at £15/hr	60.00
Membrane replacement	3 year life assumed	106.20
Cleaning chemicals	Sodium hydroxide, nitric acid, sodium hypochlorite	28.00
Mechanical maintenance	Pump seals, valve seals	31.30
TOTAL		**462.80**

Cost of effluent treated, £/m^3	**£0.66**