

DERRYLIN WWTW – KEE FIXED FILM TECHNOLOGY PROVIDES A HIGH STANDARD OF WASTEWATER TREATMENT IN NORTHERN IRELAND

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PRODUCT / TECHNOLOGY: RBCs have been accepted by Water Utility Companies for many years for treatment of medium sized flow for average less onerous discharge consents. For tighter consents Water Utility Companies have traditionally used activated sludge process and possibly membrane reactors (MBR). These technologies are high in capital cost, high in energy demand and require extensive operational input. Increasingly Process Engineers are now looking at technologies which provide the reliable solution and low lifetime cost, with the simple operation, maintenance and servicing requirements. For their site at Derrylin, Northern Ireland Water (NIW) had consent from Northern Ireland Environment Agency to achieve a final effluent with BOD < 5mg/l, Suspended Solids < 5 mg/l, NH₄-N < 5 mg/l and 6 < pH < 9 all on a 95 percentile basis. NIW Project Managers and Process Engineers were tasked to find alternatives to using MBR technology as required by their process matrix selection. Having worked with KEE Process as their Framework Partner for Western & Southern Division RBC Framework, the Project Team asked KEE Process to produce a design that would be capable of consistently providing the consented effluent standard. It was also necessary to design the system for flows and loads for the 2010 horizon and ensure that this could be further expanded to account for almost 50% increase in flows and loads for the 2030 horizon whilst maintaining the performance objectives.

KEE Process applied their well tried and tested Managed Flow Fixed Film RBC technology to provide their clients, NIW, with the robust solution that offered simplicity and robustness and also reduced BOD and NH₄-N to very low concentrations. To ensure that the process was low in energy needs and simple to operate, the team decided to use slow sand gravity tertiary filters to reduce the solids in the final effluent.

BENEFITS: NIW Design Brief.

- a. Simplicity in design and operation reducing capital expenditure.
- b. Minimal on-site construction to save time and costs.
- c. Reduced power consumption to lower carbon footprint.
- d. Lower operating and maintenance labour costs.
- e. Lower on-going spares and replacement parts costs.
- f. Robust and consistent performance to maintain the treatment objectives for discharge to a watercourse.
- g. Mitigation of the effects of extreme weather conditions on the process stability of the plant.

- h. Capital equipment design life longevity and assurances.
- i. Reduction or elimination of noise and smell nuisance.
- j. Minimal visual impact on the surroundings.

All the above needs of the client were addressed by effective and reliable process design and innovative application of prefabricated GRP settlement tanks and RBC fixed film technology packaged into GRP tanks with sectional insulated covers, with the option of being able to locally heat the space under the covers. RBC technology is simple in operation and has extremely low power consumption. The fixed film process is self-regulating and therefore reduces day-to-day operational labour input. Benefits achieved were:

- specification ensured 30 years+ design life for the components and reduced planned preventative maintenance requirements to bi-annual lubrication change;
- structural components have 20 years warranty; this together with low power requirements and labour demand enabled the client to minimise the 20 years lifetime costs;
- prefabricated factory built equipment reduced site work and CAPAX costs.
- insulated covers on the RBC biological stage with the optional undercover heating mitigated the effect of extreme weather conditions on the process stability; covers also eliminated the noise and smell nuisance;
- substantial underground installation of the equipment with covered RBCs minimised the visual impact on the local surrounding environment;

Process control is further aided by the innovative 'Flow Control Mechanism' fitted to each RBC.

INNOVATION: There are a number of innovative concepts included in this project to ensure the process robustness and minimal operational costs.

The RBCs are fitted with managed flow technology to enable "plug" flow conditions in the biological stage and to unify the wastewater character to be treated downstream in the subsequent RBC stages. The innovation also enables the process to cope with hydraulic and organic peak loads and to maintain process stability when concentration of inhibitory substances exceeds threshold values. This innovation has been in commercial use for 16 years, although until now, the technology had not been used to achieve the high degree of treatment required at Derrylin.

With the high degree of treatment, oxidation of all $\text{NH}_4\text{-N}$ results in loss of alkalinity. To recover the alkalinity and maintain the effluent within consent with respect to pH, KEE introduced the second innovation of anoxic stage. The first RBC stage was designed to be oxygen deficient and included internal recycle from the end of the RBC to the front of the RBC. The biological treatment in a fixed film reactor such as RBC takes place in the biofilm; the substrate and the nitrates diffuse into the film where the environment is ideal for anoxic process to thrive. This enables the nitrates to be reduced and the alkalinity recovered.

For the process to operate satisfactorily at all times with respect to nitrification, it is necessary to maintain a minimum temperature of 6°C in the biomass. The biological process is exothermic and is normally self-sustaining with respect to heat. However, when the ambient temperatures are sub zero

it becomes necessary to provide supplemental heat to the process. KEE have achieved this by controlling the space temperature under the covers around the aerobic biological process by building in the option to introduce warm air into the space for the nitrification process to remain at its optimum.

COMMERCIAL IMPLICATIONS: The KEE RBC plant with tertiary slow gravity sand filter provided the clients with more than 30% saving in capital and construction costs. Some of the cost benefits are associated with prefabricated equipment housed in corrosion-proof lightweight GRP housing designed for underground installation and fitted with insulated lightweight GRP covers, whereas some of the CAPAX cost savings relate to simplicity and inherent robustness of the equipment.

One of the major CAPAX cost benefits relates to the cost of equipment and the ongoing costs associated with replacing parts over the lifetime of the plant. The OPEX cost savings relates to the labour costs associated with plant operation and maintenance but a major component relates to the electrical energy demand of the other compatible technology.

However, lower CAPAX and OPEX costs savings are in themselves not enough to embrace the technology if it fails to deliver the functional objectives documented previously. The plant supplied by KEE for Derrylin has delivered consistent plant performance, low lifetime costs, low carbon footprint and substantially lower capital cost. Compared to other nearest compatible process technology, the 20 year lifetime **power saving** with using KEE RBC plant with tertiary slow gravity sand filter is **£317,185**, maintenance and operational labour, sludge disposal costs, and spares costs saving is **£272,420**; making a total **20 years Operational lifetime saving of £589,605**.

There are further latent cost savings, which were not included by the client in the costings, but can now be capitalised as follows;

1. In case of power failure at site, some treatment of the wastewater will still be available. The emergency standby generator does not need to be of a large capacity and therefore relatively easily moved onto the site.
2. In case of mechanical breakdown, there is ample redundancy available in the equipment arrangement and therefore there will be no need to cater for temporary plant for the repair period.
3. The KEE design does not require a major overhaul of the equipment during its lifetime whereby the client needs to cater for temporary treatment facility to facilitate such overhaul of the plant.

ADOPTION: The performance results for Derrylin plant as documented below, gave the Client confidence in RBC technology as applied by KEE Process Ltd.

Client Quote: "The RBC offers very robust process achieving good consistent discharge standards requiring little operational and maintenance input and low power consumption. This gave me the confidence to accept the RBC process for Derrylin where consistent and tight effluent quality was stipulated by the NIEA".

With the benefit of the experience of the consistent plant performance, low lifetime costs,

low carbon footprint and substantially lower capital cost, the Client has endorsed this technology into their selection matrix. The technology has also been adopted for use in a framework for small flows packaged plants with built-in tertiary filter and internal recycle to achieve high quality final effluent for discharge to sensitive receiving water.

The Derrylin project team has now put together a business case for using the same simple RBC concept and process design approach for a much larger municipal wastewater treatment plant (some 295% larger than the Derrylin plant) to deliver similar final effluent concentration with respect to BOD and SS, but with much tighter consent for $\text{NH}_4\text{-N}$ at 1mg/l, all on a 95 percentile compliance basis.

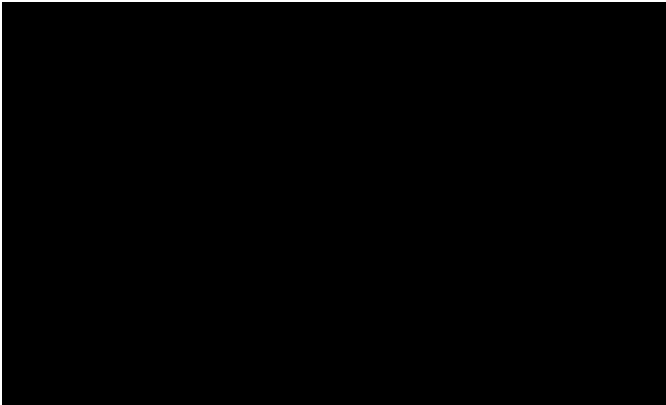
Compared to other process technologies, the 20 year lifetime **power saving** with RBC is **£947,200**, Maintenance & Operational labour, sludge disposal, and spares saving of **£813,520** making a total **20 year Operational lifetime saving of £1,760,720**. KEE Process Ltd has already started work on the new project which is due to be constructed during 2011 for commissioning during early 2012.

SUSTAINABILITY BENEFITS: It is now common for the environmental Regulators to issue tighter consent for discharge, particularly when the receiving waters are sensitive or are of special scientific interest or have shellfish and do not have adequate dilution to reduce the impact of treated wastewater discharge. Technical solutions are already on offer to the Water Companies or Developer, or for sites with no mains drainage, to treat wastewater to a high standard but these solutions are complex, expensive and require much more energy to operate. KEE's solution to use a simple to operate fixed film RBC technology coupled with a simple low energy tertiary filter gives the end users further options to choose from.

To enable the application of the simple and low energy RBC technology for treating small flows to a high standard KEE have also developed a simple physical biological filter that is available as an integral unit in a small packaged plant or as a stand-alone prefabricated modular system to follow a medium sized modular plant configuration to provide tertiary treatment for high quality discharge.

In areas where clean water is a precious commodity, the technology offers a simple low energy solution for the treated wastewater to be re-used for irrigation or non-portable uses such as toilet flushing, general outdoor washing etc. In the Caribbean, Middle East and Africa, KEE have already supplied package systems to treat small flows where the plants also include UV disinfection system after the tertiary filter to enable safe water re-use.

The most salient features are simplicity of the process plant operation and low energy demand. KEE tertiary filter is simple and includes aerobic and anoxic stages for treatment of fine complex and high molecular weight organic particles. This negates the need to use high-pressure back wash pumps with blowers for scouring the filter medium.



5 No. RBCs with 3 No. Final Clarifiers and Slow Gravity Sandfilters in the background



Schematic Flow Diagram of PST, RBC and FST.