Paper number e6261

Update on Mt Pleasant WTP Incorporating the MIEX® DOC Process and How it Compares With a Plant Operating in Enhanced Coagulation Mode.

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EXECUTIVE SUMMARY

Natural organic matter (NOM) is a major factor impacting on water treatment processes. NOM is a precursor of disinfectant by-products (DBP), a food source for regrowth of micro-organisms and makes downstream processes such as membrane filtration and activated carbon less efficient. Reducing NOM in conventional treatment plants can be achieved by using enhanced coagulation, whereby additional coagulant is applied at a reduced pH. More recently the MIEX® DOC Process was developed specifically for the removal of NOM in drinking water production. This process has been operating at the Mt Pleasant plant in South Australia since 2001 where it has been applied in two treatment streams in combination with conventional coagulation/filtration and membrane filtration. Plant operation has been closely monitored to ensure that any unforeseen problems are detected at an early stage as this is of particular concern when introducing a new technology such as MIEX®.

The plant has gone through significant changes since early 2004 including replacement of the filter media and nozzles in the Stream 1 coagulation train following a problem with achieving effective filter backwashing. The cause was found to be filter nozzles blocked with sand and normal operation was achieved once nozzles of suitable size were installed. The second upgrade was replacement of the membrane modules of the Microfiltration plant of Stream 2 during December 2004 due to poor membrane cleaning and increasing transmembrane pressure. The cause was attributed to inefficient and infrequent clean in place (CIP) causing increased inorganic fouling. Once the membranes were replaced and a more rigorous CIP strategy put in place, the plant displayed a significant improvement in the resistance values and much lower operating pressures. A new control strategy was established in 2005 which has enabled operators to maintain a stable resin concentration in the contactors despite variable raw water flows.

The impact of MIEX® and coagulation at Mt Pleasant was also compared to a conventional treatment plant employing enhanced coagulation that processes essentially the same raw water from the River Murray. A review of the last two years operating data shows the average coagulant dose at Mt Pleasant MIEX® and coagulation stream was 8 mg/L alum and 0.2 mg/L polyDADMAC compared with the conventional plant under enhanced coagulation conditions of 45 mg/L alum and 0.07 mg/L LT 22 filter aid with pH adjustment to 6.4. A review of both distribution systems indicated the plant product water from Mt Pleasant was of superior quality with regard to dissolved organic carbon (DOC) and total trihalomethane (TTHM) reduction. Pilot plant studies at Mt Pleasant comparing enhanced

and MIEX®/coagulated waters as feed streams to granular activated carbon (GAC) filters showed similar trends in improved chlorine demand and THM reduction. The Mt Pleasant plant has been reliably producing high quality drinking water despite significant seasonal variations in raw water quality and the incorporation of the MIEX® treatment has clearly resulted in reduced chemical addition and improved product water quality with reduced DBP.

INTRODUCTION

The impact of NOM on water treatment processes has been recognised as a major issue for the Water Industry and there has been a concerted world wide effort to develop processes to reduce the levels of NOM in treated waters. The MIEX® DOC Process was developed specifically for the removal of NOM in drinking water production (Morran *et a*l 1996) and has now been successfully installed in water treatment plants both in Australia and America.

The MIEX® DOC process employs an ion exchange resin to remove the dissolved organic carbon in the raw water prior to a second treatment stage for turbidity removal. The Mt Pleasant Treatment Plant, incorporating this process, has been in operation since 2001. The MIEX® treatment stage is followed by two alternative processes for turbidity removal. Stream 1 employs MIEX®/coagulation while stream 2 combines MIEX® and microfiltration.

The Mt Pleasant plant performance has been reported up to 2004 (Morran et al 2004) however, since that time there have been numerous modifications made to the plant which has resulted in further product water quality improvements. In addition the extensive pilot plant trials associated with evaluating the impact of the MIEX® treatment on downstream processes have begun to yield meaningful data. This paper reports on the performance of the plant over 2004 – 2005 together with presentation of some of the pilot plant results. MIEX® and coagulation is also compared with enhanced coagulation for both the pilot plant study and an actual conventional treatment plant practising enhanced coagulation.

RESULTS AND DISCUSSION

Mt Pleasant Treatment Plant Upgrades.

The first major plant modification to improve plant performance occurred in early 2004. Stream 1, employing MIEX® and conventional coagulation and filtration had difficulty achieving effective filter backwashing. While there was some initial concern that MIEX resin carryover from the resin settler stage was having an impact on the filter physical characteristics, the actual cause was found to be that the filter nozzles which were blocked with sand. To address the situation the filter media was replaced and a gravel layer included to assist water and air dispersion during backwashing. The nozzles were also replaced with ones of suitable size to prevent sand penetration. Normal filter backwashing efficiency was immediately achieved and no further problem has been encountered.

The second main overhaul was replacement of all the membrane modules in the Microfiltration rig during December 2004 due to increasing transmembrane pressure and poor recovery of membrane performance after membrane cleaning (clean in place (CIP)). Again, resin carryover was suspected of having an impact on the membrane but autopsies of the membrane filaments indicated the problem was due to a build up of inorganic salts (eg alumina silicates) on the membrane, most likely caused by inefficient and infrequent clean in place (CIP). Once the membranes were replaced and a more rigorous CIP strategy put in

place, the membrane plant showed a dramatic improvement in the resistance values (Figure 1) and much lower operating pressures.

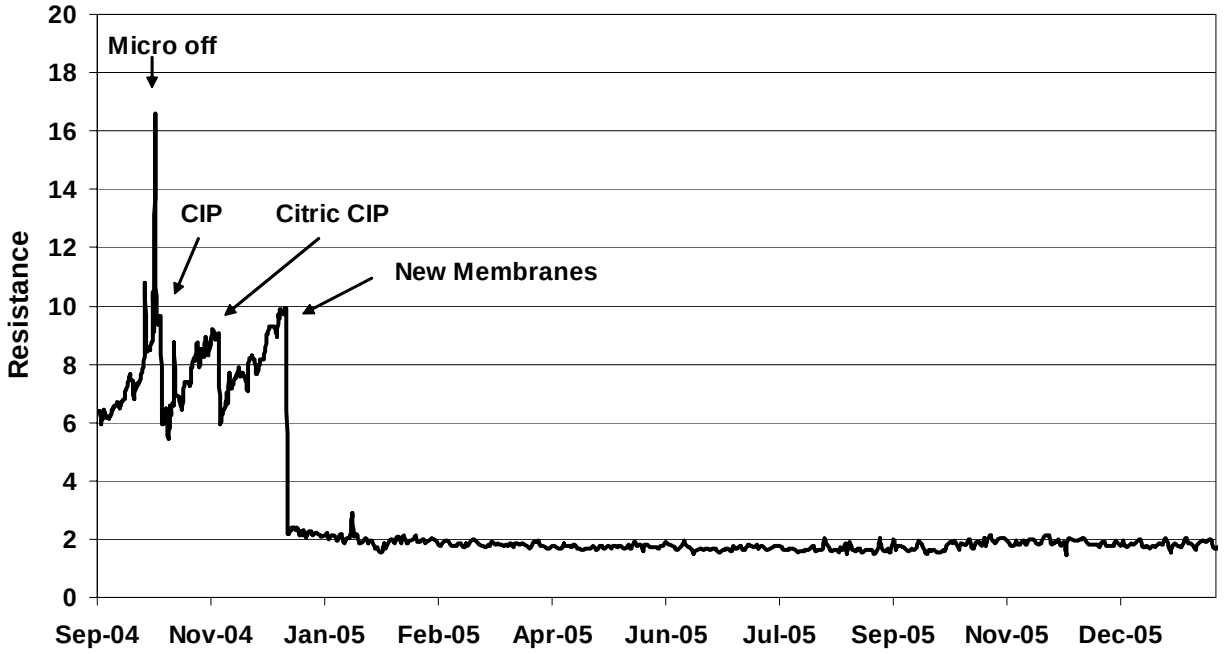

Figure 1 Mt Pleasant Treatment Plant Membrane Performance

Another significant change in the plant operation was to establish a new strategy to control the resin concentration in the contactors which was previously manually controlled and variable, particularly during changes in flows. A control loop was established incorporating the resin concentration in the contactor, as measured with suspended solids meters, with the fresh resin feed pump and take off flow to the regeneration section. The results (Figure 2) show a clear improvement in Stream 1 while further changes to the control system in late 2005 have begun to have an impact on Stream 2.

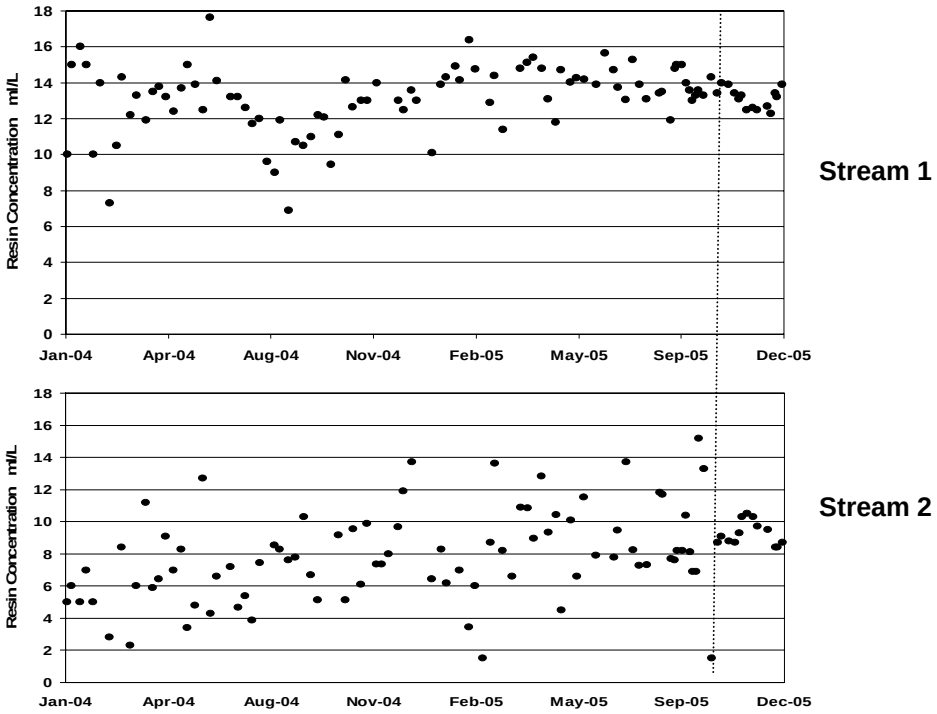

Figure 2 Mt Pleasant Treatment Plant Contactor Resin Concentration

Plant Performance

The raw water turbidity averaged 43 NTU over 2004 -2005 and both treatment streams have proved to be very effective at turbidity removal producing water with turbidity consistently below 0.2 NTU and averaging 0.09 NTU over 2004-2005 (Figure 3).

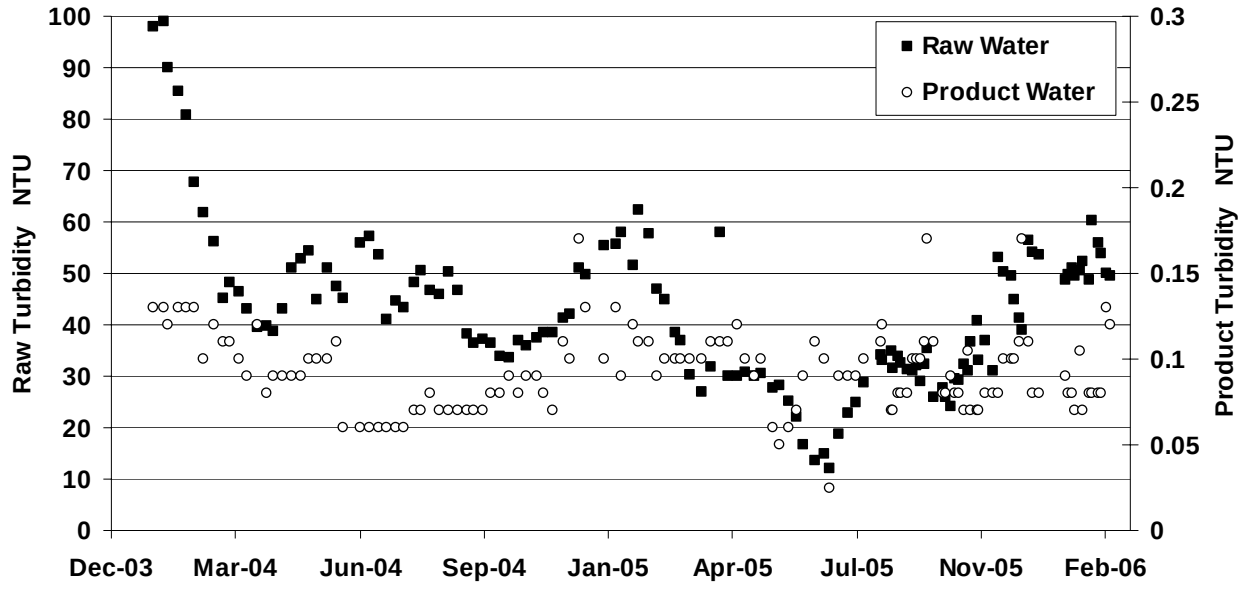

Figure 3 Raw and product water turbidity for 2004 – 2005.

DOC levels in the raw water have been low in comparison to historical levels, averaging 4.53 mg/L over the 2004 – 2005 period. MIEX® treated water averaged 2.61 mg/L over this period representing a 42% removal, with a further 14% removal achieved by the coagulation stage. Typically the highest turbidity and DOC levels occurred over the summer period (Figures 3 & 4) with changes in raw water quality reflected in the MIEX® treated water while the Stream 1 DOC removal rate was relatively consistent.

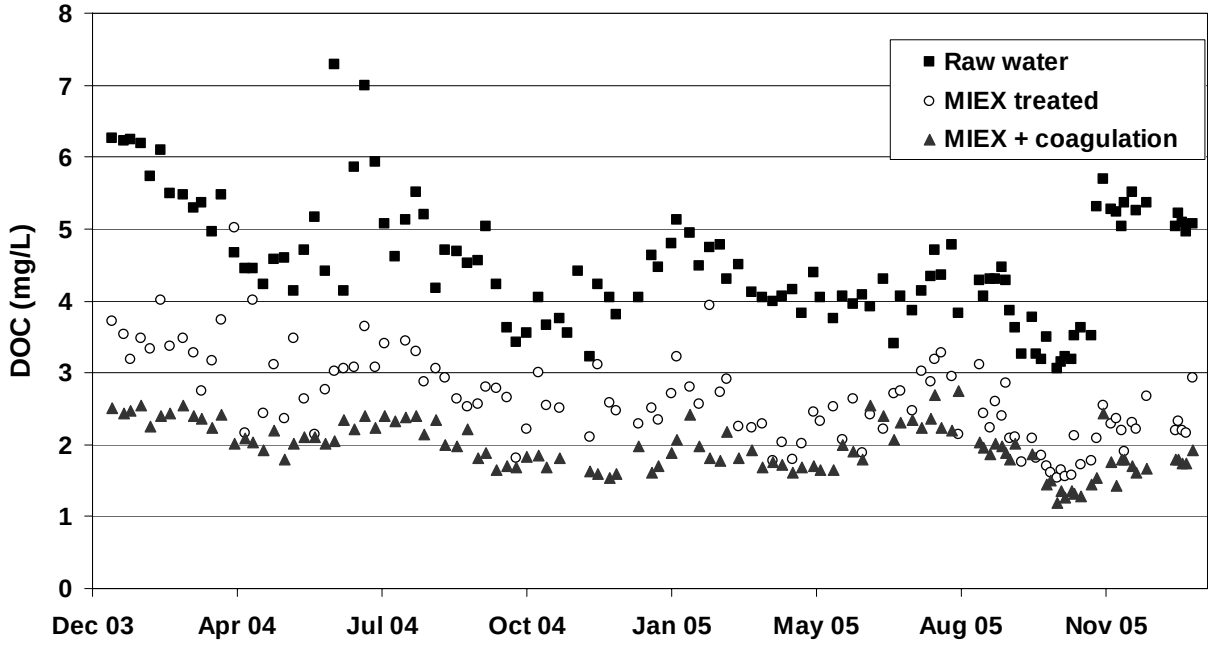

Figure 4 Raw and Stream 1 DOC levels for 2004 – 2005.

Stream 2, the MIEX® and microfiltration treatment train, yielded slightly lesser overall DOC removal as the membrane did not remove any additional DOC, unlike the coagulation stage of stream 1.

Prior to February 2005 the raw water feed to the Mt Pleasant plant was chlorinated at the Mannum pumping station to achieve microbiological quality for users with offtakes before the treatment plant. After that time the chlorination was stopped and the THM reduction in the raw water resulted in an immediate 40-50% reduction in product water THMs at Mt Pleasant (Figure 5) with total THM levels now averaging 72µg/L in the product water.

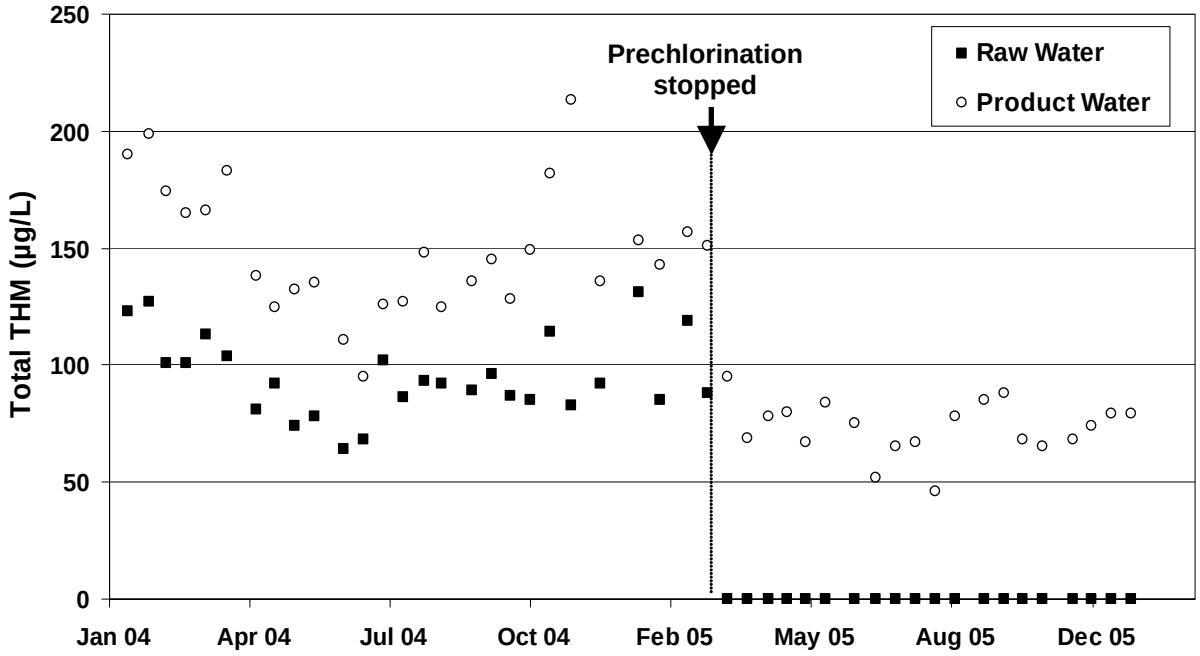

Figure 5 Raw and product water total THM levels for 2004 – 2005.

MIEX impact on coagulation.

The impact of MIEX® treatment on coagulation has been studied both at the lab (Drikas *et al* 2003) and pilot plant scale (Singer *et al.,* 2005). To determine the impact of the MIEX® treatment on coagulation at Mt Pleasant the plant performance was compared with an actual conventional treatment plant practising enhanced coagulation that was for the most part treating water from the same source. A review of the last two years operating data shows the average coagulant dose at Mt Pleasant was 8 mg/L alum and 0.2 mg/L polyDADMAC compared with the conventional plant under enhanced coagulation conditions of 45 mg/L alum and 0.07 mg/L LT 22 filter aid with pH adjustment to 6.4. The conventional plant operated with two different raw water sources, either separately or as a blend, which made comparison of water in the distribution systems difficult however, the overall conclusion was the plant product water from Mt Pleasant was of superior quality with regard to DOC and total THM reduction.

To achieve a clearer comparison, a conventional pilot plant was constructed at Mt Pleasant and operated under coagulation conditions for enhanced coagulation as determined by the "mEnCo" model (van Leeuwen, 2001). Results of three day chlorine demand and THM formation potential are reported in Table 1. MIEX® treatment alone gave similar reduction in chlorine demand and THM formation potential to the coagulation pilot plant output, with the final Stream 1 product water after MIEX® and coagulation displaying additional reductions. When this water was further treated through a pilot plant GAC filter (empty bed contact time

of 20 minutes) the resultant water had a 3 day chlorine demand of just 0.8 mg/L with a THM formation potential of 11µg/L.

	Chlorine Demand mg/L (3 days)	THMFP* µg/L
Raw water	7.7	151
Stream 1 - MIEX	2.4	86
Stream 1 - MIEX – Coag.	1.8	35
Enhanced Coag. PP	2.9	85

(* Sample reacted at 35^{o} with 20mg/L chlorine for 4 hours)

Table 1 Comparison of Mt Pleasant stream 1 product water with an enhanced coagulation pilot plant.

CONCLUSION

The Mt Pleasant Treatment Plant incorporating the MIEX® DOC Process generated product water with an average turbidity of 0.09 NTU with low DOC and reduced chlorine demand yielding low disinfection byproducts exemplified by an average total THM level of just 72ug/L and always below 90ug/L.

In this study the incorporation of MIEX® treatment into a conventional coagulation and filtration process results in reduced chemical addition and improved product water quality with reduced disinfection byproduct formation. The plant is producing high quality drinking water superior to all other conventional treatment plants in South Australia and this should continue as a result of further upgrades that have occurred in 2005.

ACKNOWLEDGEMENTS

Edith Kozlik and Miriam Nedic of the AWQC Water Treatment Unit
Mt Pleasant Water Treatment Plant operators Nick Nedelkov and Ken Bray

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