Case Study on High Manganese Removal from Mine Run Off Waters

Application: Removal of High Manganese from Mine Run Off Water

Requirement: Remove 3mg/L Mn to <0.05mg/L

Case Study: Ulan Coal Mine, Mudgee New South Wales Australia.

Description of the Application:

Ulan Coal Mines Limited (UCML, the Principal) operates the Ulan Mine located near Mudgee in NSW. The mine includes underground and open cut operations. This requires the extraction of large volumes of water. The on-site water treatment facilities need to be able to produce sufficient permeate to blend with other on-site waters to generate up to 30 ML/d of blended water of suitable quality for environmental river discharge.

A reverse osmosis (RO) plant and Ultra-Filtration (UF) pre-treatment system provided by Osmoflo currently treats water from East Pit, which is a large capacity surface dam. This enables the water to be recycled back into the ecosystem along with on-site irrigation.

Water requiring treatment includes water that has been accumulated on-site (East Pit) and water pumped from underground and open cut mine workings, as well as surface run-off from rainfall that makes its way to East Pit from the site catchment. The mine water, including that from East Pit, is generally very high in dissolved manganese (approximately 3 mg/L). Some raw water streams from individual pump stations can exhibit manganese levels significantly above 3 mg/L. (e.g. The pump station E20 generates mine water containing approximately 9 mg/L of manganese.) High Manganese concentrations similarly to iron have a tendency to foul up ultrafiltration and reverse osmosis systems with a black sludge that can restrict the flow and performance.

Osmoflo are now using the water filtration media technology known as DMI-65, a catalytic filter media that is designed to remove high concentrations of manganese from the feedwater supply when operated in the presence of chlorine. Experience to date has found that DMI-65 is best available catalytic material for removing high concentrations of manganese and iron to pre-treat and protect UF and RO technology.

Osmoflo have commissioned a DMI-65 system upstream of RO. The feed water for the DMI-65 filters has been oxidised via potassium permanganate, aerated with air and filtered with UF. The free chlorine on the outlet of the DMI-65 has been 0.1-1.0ppm. Fine Polishing of Mn and Fe removal through the DMI-65 filters.

See below the tables for the results. Osmoflo analyse the Fe and Mn using a Hach DR900 colorimeter. These results are also similar using the Hach DR2700 spectophotometer. The target is to get below 0.05pm Mn and Fe

	Raw Feed	Oxi Tank Product [a]	DMI Inlet	DMI Outlet	Pretreated water tank
Time	7:30 PM				
Mn (mg/L)	2.6	0.089	0.077	<0.05	0.078
Fe (mg/L)	0.3	0.04	0.06	<0.05	
Turbidity (NTU)	3.63	14.8	0.08	0.09	0.24
pH	6.5	8.08	8.01	7.78	7.58
ORP (mV)	389	346	686	743	660
Temperature (Deg C)	12.3				
KMnO4 dose	**4ppm**				
Single UF train running					

[a] = 14.8 NTU, 8.38 pH, 480 ORP, 12.3 deg C (values from the field instrument)

	Raw Feed	Oxi Tank Product[b]	DMI Inlet	DMI Outlet	Pretreated water tank
Time	10:30 PM				
Mn (mg/L)	2.6	0.068	0.069	<0.05	0.097
Fe (mg/L)	0.28	0.04	n/a	<0.04	
Turbidity (NTU)	3.16	13.4	0.13	0.09	0.18
pH	6.86	7.95	7.91	8.2	
ORP (mV)	195	215	699	692	
Temperature (Deg C)	12.1				
KMnO4	**5ppm**				

[b]= 13.4 NTU, 8.07 pH, 385 ORP, 12.1 deg C (value from the field instrument)

This customer has implemented a large DMI-65 filter as pre-treatment to RO.

The are trying to polish 0.07mg/L – 0.1mg/L Mn to undetectable levels.

The Filters are horizontal filters with a 650mm bed depth, at an LV of 12.6m3/m3/hour backwashing at LV30m3/m2/hour.

There is also about 100mm of 2mm filter gravel + 100mm 1.2mm gavel + 100mm 0.8mm sand as a mixed media with 650mm DMI-65 on top.
Prior to the DMI-65 the client is oxidising up to 3ppm Mn with permanganate in a holding tank, then removing the TDS and TSS and residual permanganate through a UF unit. The quality of water coming into the DMI-65 is listed on page 3.

Raw Water Quality

Item. No	Parameter	Design Envelope		
		Minimum	Maximum	Maximum+10%
1	TDS mg/L	N/A	1820	2002
2	Turbidity (NTU)	2.5	8.80	9.68
3	Manganese (dissolved) mg/L	2.15	2.90	3.19
4	Iron (dissolved) mg/L	<0.05	0.20	0.22
5	Barium mg/L	0.017	0.03	0.0363
6	Aluminium mg/L	<0.01	0.07	0.077
7	Heavy metals such as zinc, lead, mg/L	0.001		
8	Silica mg/L	8.02	8.75	9.6
9	Fluoride mg/L	0.8	1.1	1.21
10	Ammonia mg/L	0.02	0.19	0.209
11	Nitrate mg/L	0.01	0.54	0.594
12	Total Phosphorous mg/L	0.05	0.56	0.616
13	TOC mg/L	<1	<1	< 1.0
14	COD mg/L	<13	<13	<14
15	Alkalinity mg/L as CaCO3	41	96	105.6
17	Chloride mg/L	124	142	156.2
18	pH mg/L	6.4	7.3	7.5
19	Sulfate mg/L	0	1080	1188
20	Oil and grease mg/L	nil	<2	<2
21	Calcium mg/L	79	167	183.7
22	Magnesium mg/L	107	123	135.3
23	Sodium mg/L	173	189	207.9
24	Potassium mg/L	36	43	47.3
23	Algae cts/mL	140	2200	2420
24	Temperature	10	28	

DMI-65 is tailor made to remove high concentrations of manganese typically 1 – 3 mg/L down to undetectable levels.

Manganese, unlike iron requires a greater detention time to oxidise, it is pH dependant with our recommendation being as close to pH 8 for best results.

Filtration of oxidised manganese is also more successful with a greater linear passing through the media bed. For example a 1000mm bed depth has much higher adsorption than that of a 600mm bed depth.

The DMI-65 consists of grains of sand that have had proprietary products infused into them. This means that the active ingredients do not form a coating but become homogenous within the grains of sand. The DMI-65 acts as a catalyst in the presence of an oxidation environment created by the continuous injection of chlorine. The chlorine injection must be maintained to yield a free chlorine residual of 0.1 to 0.3 ppm at the filter effluent. The oxidation reaction causes dissolved manganese and iron to form a solid, insoluble precipitate that is captured by the DMI-65 filter media. The captured iron is released during the filter backwash cycle.

The DMI-65 has been tested in applications for reducing manganese levels in excess of 3ppm down to less than 0.05 ppm. Based on Australian experience in the mining and municipal drinking water industries the DMI-65 is expected to have a lifespan of up to 10 years of continuous use.