Transmittal

EA Engingeering, Science, and Technology, Inc., PBC
320 Gold Ave. SW, Suite 1300
Albuquerque, New Mexico 87102
Phone: 505-224-9013

May 11, 2017

Attention: Hot Shot Service Inc.
Re: Delivery to and from NMED, Hazardous Waste Bureau, Santa Fe, NM

Hello,

Attached are documents for hand delivery to:

Mr. John Kieling, Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

The letter is to be stamped by the Hazardous Waste Bureau. Once stamped, they will make a copy for you to return to EA Engineering, Science and Technology. This stamped copy will need to be received at EA by 4:30 today.

Please call Kevin McKeage at 505-933-6417 or 316-765-1486, if you have any questions or concerns. Alternately you can contact Devon Jercinovic at 505-401-1181.

Thank you,

Sherri Schoenberger

EA Engineering, Science, and Technology, Inc., PBC
320 Gold Ave., Suite 1300
Albuquerque, New Mexico 87102
www.eaest.com

TECHNICAL MEMORANDUM

ESTABLISHING BASIS OF DESIGN MAXIMUM CONCENTRATION LIMITS FOR THE KIRTLAND BULK FUELS FACILITY GROUNDWATER TREATMENT SYSTEM

The groundwater treatment system (GWTS) has been designed to treat water from extraction wells as part of the Resource Conservation and Recovery Act groundwater interim measure at Solid Waste Management Unit ST-106/SS-111, the Bulk Fuels Facility (BFF) site, at Kirtland Air Force Base, New Mexico. This Technical Memorandum establishes maximum concentration limits for the sand filters and the lead granular activated carbon (GAC) vessel for inorganic and organic constituents at the GWTS to ensure treated effluent meets all applicable discharge limits. Influent to the GWTS consists of extracted contaminated groundwater and any non-hazardous investigation-derived waste (IDW) associated with Kirtland BFF remedial activities that include IDW water generated during well installation, well development and testing, well maintenance, and groundwater monitoring.

Tigg modeling was used to determine the organic criteria loading on the lead GAC based on operations and maintenance (O&M) not to exceed six month change out of the lead GAC. The six month lead GAC change out is a cost effective O&M approach for the GWTS based on a maximum process flow rate of 400 gallon per minute (gpm). To determine the organic concentration loading rates, the Tigg model used the worst case concentrations, which is the most conservative and not expected. It is important to note that the Tigg modeled continuous loading of these organic concentrations at the maximum process flow rate of 400 gpm to the lead GAC. This loading model results in breakthrough of the lead GAC in approximately 175 days (approximately 6 months) and subsequent GAC change out in the lead GAC vessel.

GROUNDWATER TREATMENT SYSTEM PROCESS

The treatment capabilities of the GWTS includes 1) removal of organic compounds by adsorption to GAC and 2) removal of dissolved metals and biologic materials in the sand filters containing catalytic media that are being installed as a pretreatment process. The GWTS process flow is shown in Figure 1 for one treatment train. Contaminated groundwater is extracted from the extraction wells and conveyed to the GWTS building. Once inside the building, the contaminated water is diverted into two influent tanks where hydraulic mixing achieves equalization. Following equalization, the contaminated water is pumped at 400 gpm per treatment train (i.e., Treatment Train #1 or Treatment Train #2) which consist of the following process units:

- Influent tank
- Influent pumps
- Sand filters with special media for biologic and metals pretreatment (installation pending)
    - Influent sampling port
- Bag filters
- Lead GAC vessel; 20,000 pounds of carbon
    - Post-lead GAC sampling port
- Lag GAC vessel; 20,000 pounds of carbon; redundant vessel for process safety factor
- Effluent tank
- Effluent pump
    - Effluent sampling port
- Bag filters

Following treatment, treated water is diverted into two effluent tanks for equalization, the treated water is pumped from treatment trains into a single conveyance line to either the Tijeras Arroyo Golf Course main pond or the gravity-fed underground injection control (UIC) well KAFB-7. Additional discharge options are under evaluation and may be available in the future. Discharge to the Tijeras Arroyo Golf Course main pond does not require a discharge permit under New Mexico Administrative Code 20.6.2.3104 (2004) as long as the treated effluent meets the numerical standards of New Mexico Administrative Code 20.6.2.3103. Discharge to UIC well KAFB-7 is performed under DP-1839, a Class V UIC permit issued on April 28, 2017 pursuant to New Mexico Administrative Code 20.6.2.3106.

SAND FILTER TREATMENT PROCESS AND MAXIMUM CONCENTRATION LIMITS

Sand filters are scheduled for installation in the GWTS as a pretreatment for the GAC vessels to assist in removal of biologic material and to treat dissolved iron (Fe) and manganese (Mn), which are not removed by the GAC treatment process. The sand filters, which contain a catalytic media, are designed to precipitate out the dissolved Fe and Mn by advanced oxidation processes and filter out suspended solids including biological materials. Once precipitated as iron and manganese oxides, the oxides and suspended solids are captured by the sand filter media and removed during backwashing to a storage tank for disposal. System backwashing is automatic and based on an increase in back pressure (typically set at 10-15 percent above the normal operating pressure). In order for the sand filter media to oxidize the Fe and Mn, an oxidant (sodium hypochlorite) is added to the water entering the treatment trains. Additionally, sodium hypochlorite acts as a disinfectant to mitigate biofilm formation on the sand filter media.

The Basis of Design for the GWTS sand filters (Attachment 1) provides a description of the advanced oxidation processes that catalyze the dissolved metals to metal oxides. The sand filters are designed to catalyze and remove up to 10 milligrams per liter (mg/L) of dissolved iron or manganese down to approximately 1 microgram per liter (µg/L) with a sodium hypochlorite concentration of 0.1-0.3 mg/L. The sand filters should minimize the amount of suspended solids and microorganisms that reach the lead GAC vessels, mitigating plugging and increased pressure drop along the lead GAC vessels.

For this Technical Memorandum, maximum sand filter concentration limits for Fe and Mn are established by manufacturer design. These maximum inorganic concentration limits are substantially higher than dissolved Fe and Mn concentrations at the BFF site. For example, the actual maximum dissolved Fe and Mn concentrations measured in Q4 2016 were 6,600 µg/L and 6,930 µg/L, respectively in KAFB-106006. KAFB-106006 is designated a hazardous IDW well due to benzene concentrations and would not be accepted to the GWTS; however, even these maximum concentrations of dissolved Fe and Mn are 60 percent below the maximum concentrations that the sand filters can treat.

MAXIMUM LEAD GAC CONCENTRATION LIMITS

Figure 1 shows the maximum organic concentration limits reaching the lead GAC vessel modeled by the GAC manufacturer (Attachment 2). The Tigg modeling assumed worst case concentrations as follows:

- Maximum EDB detected of all wells between Q1 2016 and Q3 2016 was 17 µg/L. **EDB was conservatively set at the modeled influent level to 20 µg/L**; however, the highest concentration within the GWTS capture zone is 0.7 µg/L as of Q4 2016.
- **Benzene worst case was set at 450 µg/L** which is 10% safety factor below the regulatory standard for D018 hazardous waste of 500 µg/L. The highest concentrations within the GWTS capture zone is 3 ug/L as of Q4 2016 results.
- Worst case concentrations of ethylbenzene, toluene, and total xylenes were extrapolated using linear regression between benzene and each ethylbenzene, toluene, and total xylenes for all wells

containing detectable benzene concentrations between Q1 and Q3 2016. The interpolated concentrations for ethylbenzene, toluene, and total xylenes were calculated at a benzene concentration of 450 µg/L and then multiplied by safety factor of 2 (double the interpolated concentration). **Ethylbenzene, toluene, and total xylenes were set at 102 µg/L, 212 µg/L, and 110 µg/L, respectively**. As of Q4 2016, there are no concentrations of ethylbenzene, toluene, and total xylenes above the NMWQCC standards or EPA maximum contaminant levels within the GWTS capture zone.

At no time are the GWTS effluent limits exceeded because both Treatment Train #1 and Treatment Train #2 have a second, redundant 20,000 pound lag GAC vessel in series behind the lead GAC vessel. Treated groundwater samples are collected monthly between the two GAC vessels to monitor for breakthrough. Breakthrough is defined as a detectable concentration of a contaminant of concern (COC) and therefore, breakthrough concentrations will be much lower than the NMWQCC standards or EPA maximum contaminant levels for a COC. When breakthrough occurs in the lead GAC vessel, process flow is switched from the lead GAC vessel to the lag GAC vessel, and the former lead GAC vessel is scheduled for carbon change out.

REFERENCES

New Mexico Administrative Code. 2004. State of New Mexico, Title 20.6.2 Ground and Surface Water Protection.

Figures

1 GWTS Process Flow Diagram

Attachments

1 Basis of Design Groundwater Treatment System Sand Filters
2 TIGG Maximum Loading Concentrations at 400 Gallons per Minute

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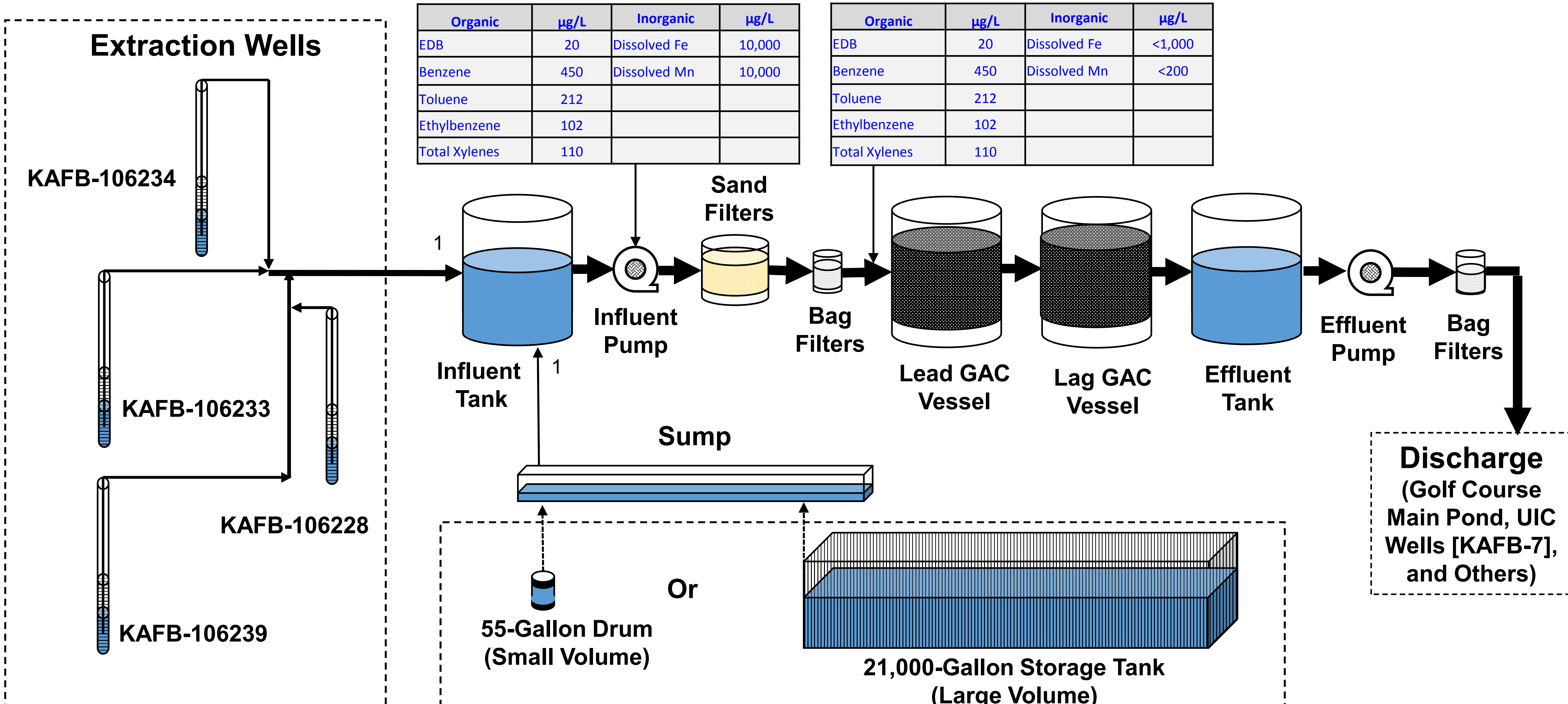
FIGURES

Sand Filter Concentration Limits

Organic	µg/L	Inorganic	µg/L
EDB	20	Dissolved Fe	10,000
Benzene	450	Dissolved Mn	10,000
Toluene	212		
Ethylbenzene	102		
Total Xylenes	110		

Lead GAC Concentration Limits

Organic	µg/L	Inorganic	µg/L
EDB	20	Dissolved Fe	<1,000
Benzene	450	Dissolved Mn	<200
Toluene	212		
Ethylbenzene	102		
Total Xylenes	110		



Note 1: Total process flow for each treatment train is 400 gpm.

Notes:
µg/L = Microgram(s) per liter
EDB - Ethylene dibromide
Fe = Iron
GAC = Granular activated carbon
gpm = Gallons per minute
Mn = Manganese
UIC = Underground injection control

TECHNICAL MEMORANDUM ESTABLISHING MAXIMUM INFLUENT LIMITS TO THE GROUNDWATER TREATMENT SYSTEM
BULK FUELS FACILITY
SOLID WASTE MANAGEMENT UNIT ST-106/SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1

GWTS PROCESS FLOW DIAGRAM

ATTACHMENT 1

BASIS OF DESIGN
GROUNDWATER TREATMENT SYSTEM SAND FILTERS

Sand Filter
Design Calculations

Kirtland Air Force Base Bulk Fuel Facility
Groundwater Treatment System

U.S. Army Corps of Engineers
Albuquerque District
Contract No. W912DR-12-D-0006

Prepared by

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Revision: 2

CONTENTS

Section **Page**

1.0 INTRODUCTION

1.1 Background

The mid-plume pump and treat system is part of an interim remedial measure for the Bulk Fuels Facility (BFF) groundwater plume at Kirtland AFB. The mid-plume groundwater is currently contaminated with ethylene dibromide (EDB) at concentrations above the maximum contaminant level (MCL) of 0.05 μg/L. The mid-plume pump and treat system will eventually consist of several extraction wells that are expected to produce up to 800 gpm of groundwater. Currently three groundwater extraction wells and one groundwater treatment (GWT) system designed for 400 gpm of groundwater are in operations. A second GWT system also designed for 400 gallons per minute (gpm) of groundwater is currently under construction.

Groundwater from the extraction wells is pumped from the wells through buried pipelines into the GWT system feed tanks, one for each GWT system. Groundwater is then pumped from the feed tank through bag-filters for pretreatment, and activated carbon adsorbers which remove the EDB. The treated water from the carbon adsorbers is collected in a discharge tank and then pumped to either the golf course irrigation pond or an injection well for disposal.

Shortly after startup of the first GWT system downhole a corrosion and biofouling issue in the extraction network was identified. Subsequently the biofouling issue made its way to the bag-filters and lead GAC of the first treatment system. An additional pre-treatment system consisting of sand filters installed prior to the existing bag-filters has been proposed to address the biofouling issue.

In addition to addressing biofouling, removal of dissolved iron and manganese may be necessary in the future. Monitoring well results indicate that elevated concentrations of dissolved iron and manganese in the influent water delivered to the GWT system may be expected as additional extraction wells are brought on line.

The sand filters will be pre-fabricated skid mounted units installed with each GWT system. Each unit having flow capacity of 400 gpm will consist of two or more sand filters and include provisions for backwashing of the individual sand filter. Backwash water will be pumped to a Baker-type clarifier tank located outside of the GWT system building. Piping and valves for connection of the additional pre-treatment system to existing pumps and bag filters will be included in the design modifications. Piping and valves necessary to facilitate conveyance of backwash between the outside tanks and both GAC and sand filter units will also be included in the design modifications.

1.2 Objectives

The objectives for these calculations are to determine the appropriate sand filter, pipe sizing and to determine alterations of the existing feed pumps necessary to provide a maximum flow rate from the feed tank, pre-treatment (both sand filters and bag-filters) and GAC to the treated water tank of 400 gpm for each GWT system.

2.0 INPUTS AND ASSUMPTIONS

2.1 Calculation Methodology

Sand filters sizing is based on a loading rate expressed as gpm applied per square foot (ft^2) of filter surface area, i.e., gpm/ft^2. For high pressure rapid sand filters loading rates range from approximately 3 gpm/ ft^2 to 13 gpm/ft^2. The diameter of the sand filter bed has to be large enough so that the pressure drop through the bed is reasonable but not so large that the groundwater flow is too low. As a general practice lower loading rates are used to remove inorganic suspended solids. For the removal of organic material such as biofouling products higher loading rates are acceptable.

The feed pumps for the pre-filters and carbon beds of each GWT system are two identical centrifugal pumps sized for 200 gpm each. The flow from the pumps is controlled by a variable frequency drive (VFD) controlling the speed of the pumps. The system process piping for each GWT was designed by CB&I Federal Services LLC (CB&I) based on a flow rate of 400 gpm. Design Flow Solutions (DFS), a pipeline modeling software program (Reference 1), was used to calculate the frictional head loss within the process piping. The frictional head loss from the piping and components, equipment head loss, and elevation changes are summed to a resultant head loss for process system. This information was in turn used to size the pumps. This software program can be used to calculate the additional frictional head loss within the process piping with the addition of planned sand filter units. The resultant head loss can be used to determine modifications to the existing pumps to maintain the required flow rate for each GWT system.

2.2 Inputs

Inputs include:

- The groundwater design (maximum) feed rate is 400 gpm to each GWT system. Existing feed pumps consist of two pumps for each GWT system, 200 gpm each pump and operating at total head of 104 ft.
- Groundwater inlet temperature from the extraction wells will be between 55 and 60°F.
- Concentrations of dissolved metals, iron and manganese, are expected to increase.
- Monitor pressure and flow through sand filter units.
- Bed expansion of at least 20 percent at 239 gpm during backwash with duration of four minutes minimum for single media system.
- One sand filter at a time will be backwashed while continuing to process water until the entire unit is clean.
- Backwash water to be directed to Baker-type roll-off container located outside the GWT system building. Effluent from tank returned to sump in building and pumped to Feed Tank 110.

2.3 Assumptions

- Removal of organic biofouling products of primary importance. Removal of inorganic suspended solids of lessor importance with bag-filters following sand filter units. Based on manufacture's recommendation the sand filter units will be designed at maximum loading rate of 13 gpm/ft^2.
- Operation including backwash of each sand filter unit independent from the other.
- Controller PLC for the sand filters to be based on Allen Bradley logic and have Ethernet capability.
- Backwash can be initiated manually, via timer, or when observed pressure is ≤10 psi differential pressure from that of clean filter operation.
- Air activated valves switch operation filter to backwash mode. Air provided by small compressor mounted with each sand filter unit.
- Backwash will be initiated when observed pressure is 10 psi greater than from clean filter operation.
- Backwash rate based on manufacture's recommendations.
- Flow rate of feed pumps will be reduced to match backwash rate when backwash of sand filter units is required.
- Flow to GAC units suspended during backwash cycle.
- Provide oxidation and filtration for removal of dissolved iron and manganese

3.0 RESULTS AND CONCLUSIONS

3.1 Results

At the design flow rate of 400 gpm of groundwater and a design loading rate of 13 gpm/ft^2 filter surface area of 30.8 ft^2 is required (Attachment 1). Two 54-inch diameter filter vessels equal 31.8 ft^2 (Attachment 2). A 60-inch vertical side shell depth multi-media filter is recommended for removal of biofouling products as well as dissolved iron and manganese (Attachment 2).

High levels of dissolved iron and manganese greater than 10 mg/l can be treated by chemical oxidation, using an oxidizing chemical such as chlorine, followed by a sand trap filter to remove the precipitated material. DMI-65, a specialty media manufactured in Australia acts as an oxidation catalyst with immediate oxidation and filtration of the precipitates that has been certified to the US Standard of NSF/ANSI 61 for Drinking Water System Components. DMI-65 is an extremely powerful silica sand based catalytic action water filtration media that is designed for the removal of iron and manganese without the use of potassium permanganate through an Advanced Oxidation Process. The DMI-65 media has been shown to efficiently remove dissolved iron to the almost undetectable levels as low as 0.001 ppm and manganese to 0.001 ppm. Qualitative information about how this media works, its capabilities and limitations are included in Attachment 2. Yardney's IMA-65 Specialty Media is the United States equivalent of the DMI-65 media.

Continuous injection of sodium hypochlorite (liquid bleach) to maintain a 0.1 to 0.3 parts per million (ppm) residual level of chlorine (Attachment 2) promotes the oxidation process. Calculations supporting the design for the injection of sodium hypochlorite solution are included in Attachment 3. Based on these calculations injection of 3 gallons per day of household bleach would be required to maintain chlorine residual of 0.3 ppm.

Frequency of backwash is dependent on the production of biofouling products. At the backwash rate of 239 gpm for Yardney Model IL 5424-2A (Attachment 2) each backwash cycle will expand the filter bed 22 percent (Attachment1) and produce nearly 1,000 gallons of water during four minute backwash cycle. The same backwash rate applies to the Yardney Model IL 5460-2A (Attachment 2). One sand filter at a time will be backwashed while continuing to process water until the entire unit is clean (Attachment 3). Backwash effluent from each sand filter unit is conveyed by 4-inch diameter pipe and join with 6-inch diameter pipe to exit the building and discharge to Baker-style settling/clarifier (Attachment 4).

The 120V Allen Bradley Micrologix 1400 PLC Controller (Ethernet compatible) integrated with either Yardney model sand filter requires 120V/<1 A service. The Yardney IL 5424-2A and IL 5460-2A Filter Units each include a 1HP 3 gallon oil lube air compressor to control backwash valve operation and require 120V/15A service.

The groundwater treatment feed pump units for each GWT system will be required to pump 200 gpm each (400 gpm total). Based on modeling the hydraulic performance of the process piping system with dirty sand filters, dirty bag filters, and allowing for fouling/blinding across carbon vessels, a worst case condition, the required head is 120.59 ft wg. With a 20% design margin, per UFC 3-280-01A (Reference 2), the required head is 144.71 ft wg (Attachment 5). Currently each feed pump unit has two Gould model 3196 2x3-6 pumps with impeller diameter of 5.375 inches. The existing pumps will not achieve 200 gpm pumping at head of 144.71 ft wg.

Changing impeller diameter of this pump to 6.062 inches can achieve 200 gpm at total head of 148.9 ft wg. (Attachment 6).

3.2 Conclusions

Two 54 inch diameter sand filter units having 24 inch vertical sides meets the design criteria for removing biofouling products. Two 54 inch diameter multi-media sand filter units having 60 inch vertical sides with crushed gravel, garnet, and IMA-65 media meets the design criteria for removing biofouling products and dissolved iron and manganese. Small chorine injection units as used for residential purposes will provide the required sodium hypochlorite injection rates. Units selected should provide solution storage of at least 15 gallons (5 day capacity). Example systems are included in Attachment 3.

A 40 cubic yard roll-off settling/clarifier has capacity of 8,000 gallons, i.e., eight backwash cycles (Attachment 4).

Changing the impellers of the existing pumps to 6.062 inch diameter will exceed the 20% design margin criteria per UFC 3-280-01A.

4.0 REFERENCES

1. DF DesigNet® Version 4. Design Flow Solutions Software, ABZ, Incorporated
2. UFC 3-280-01A, Unified Facilities Criteria, Guidance for Ground Water/Fuel Extraction and Ground Water Injection Systems

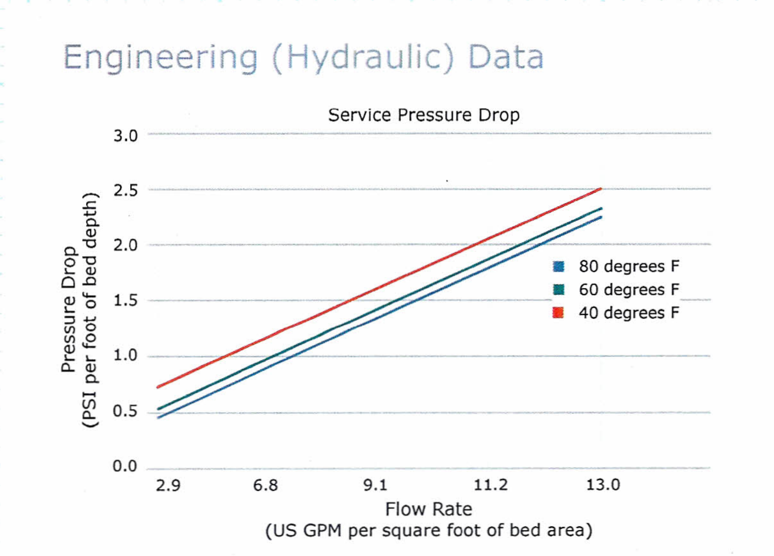
Attachment 1

Design Calculations for Sand Filter Selection

Project	Kirtland AFB Bulk Fuels Facility	Project No.	10912 DK-12-D-0006 / 1083
Subject	Sand Filter Design	Sheet No.	1 of 2
		Drawing No.	
Computed by	H. Lee Becker	Date	10/24/2016
Checked by		Date	

- Loading Rate High Pressure Sand Filter 2.9 - 13 gpm/ft²
- Sand Filters Followed By Bag Filter → Particulate Removal Not Significant Requirement As Through Put
  Use Upper Limit of Recommended Range → 13 gpm/ft²
- Filter Area Required = $\frac{400 \text{ gpm}}{13 \text{ gpm/ft}^2} = 30.8 \text{ ft}^2$
- Space Limitations - 2 Filter/Unit

- Yardney Sand Media Filters Specification Model IL-5424-2A
  Filtration Surface Area = 31.8 ft² > Required OK



Model IL 5424-2A Bed Depth ⇒ 2.0 ft

Service Pressure Drop/ft @ $\frac{400 \text{ gpm}}{31.8 \text{ gpm/ft}^2}$ = 2.25 psi/ft

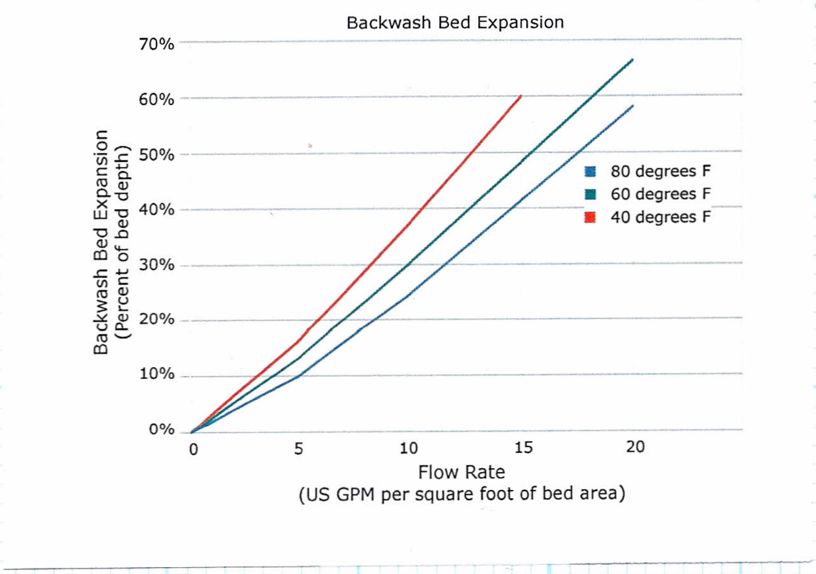
Pressure Drop = 2.25 psi/ft (2 ft) = 4.5 psi

Project: KIRTLAND AFB BULK FUELS FACILITY | Project No. W912DK-12-D-0006 1033
Subject: SAND FILTER DESIGN | Sheet No. 2 of 2
Drawing No.
Computed by: H. Lee Becker | Date: 10/24/2016 | Checked by: | Date:

MODEL IL 5460-2A   BED DEPTH ⇒ 5.0 ft

SERVICE PRESSURE DROP/ft @ $\frac{400\ gpm}{31.8\ gpm/ft} = 2.25\ psi/ft$

PRESSURE DROP = 2.25 psi/ft (5.0 ft) = 11.25 psi



BACKWASH BED EXPANSION

YARDNEY SAND FILTER SPECIFICATION   BACKWASH RATE

MODEL IL 5424-2A ⇒ 239 gpm

$gpm/ft^2 = \frac{239}{31.8} = 7.5\ gpm/ft^2$

FROM GRAPH ABOVE @ 7.5 gpm/ft² BED EXPANSION AS % BED DEPTH = 22%

MODEL IL 5460-2A   BACKWASH RATE = 239 gpm

$gpm/ft^2 = \frac{239}{31.8} = 7.5\ gpm/ft^2$

FROM GRAPH ABOVE @ gpm/ft² BED EXPANSION AS % BED DEPTH = 22%

Attachment 2

Yardney Industrial Sand Filter Specifications

WATER FILTRATION SYSTEMS

Sand Media Filters

Removal of Solids Down to 20 Microns

Yardney Sand Media filters are designed for the most challenging dirty water conditions with a high performance solution for water filtration down to 20 microns. These durable carbon steel filters utilize a 24" vertical side shell depth for removal of organic and inorganic suspended solids for filtering large volumes of water with very little pressure drop and a long-term value. All Yardney industrial media filters utilize our simple backwash system for ease of operation and consistent water quality. The Yardney automatically controlled filter systems operate for extended periods of time prior to a short backwash cycle.

Applications

- Removal of organic and/or inorganic suspended solids down to 20 microns
- Storm water runoff, industrial process water, incoming plant water, waste water clean-up, industrial water for plant reuse
- Pre-filtration in applications such as granular activated carbon, reverse osmosis, cartridge or bag filtration and deionized water
- 80 psi standard operating pressure (high pressure systems available)
- Flow ranges from 10 gpm and up

Advantages

- State of the art fabrication provides added strength under pressure and long system life
- ASME code shaped head construction for durability and safety
- Stainless steel wedgewire underdrain
  - Ensures structural integrity in the harshest conditions
  - Hydraulically balanced to increase effectiveness of backwash while reducing flush frequency and waste of water
  - High strength stainless steel wedgewire will withstand a collapse pressure in excess of 600 psi
- Standard carbon steel products - 3/16" thick material
- Backwash automatically initiated by elapsed time or pressure differential
- Yardney easy-entry lid closure with weld tabs for operator safety
- Available in welded carbon steel
- 3M Scotchkote® 134 fusion bonded epoxy coating on interior surfaces
- Made in USA

Industrial Systems

Specifications

SPECIFICATIONS | INDUSTRIAL | SAND MEDIA FILTERS													
Model	Number of Tanks in System	Standard Flow Range				Filtration Surface Area (total sq ft)	Backwash Flow Rate (per tank)		Media Requirements (cubic feet)		Maximum Pressure	Inlet/ Outlet Pipe Size	Backwash Line Pipe Size
		Minimum		Maximum									
		gpm	m³/hr	gpm	m³/hr		gpm	m³/hr	Gravel 1/2" - 3/4"	Media			
IL-1824-1A	1	18	4	26	6	1.75	26	6	1	3	100 psi	2"	2"
IL-2424-1A	1	32	7	47	11	3.15	47	11	2	5	100 psi	2"	2"
IL-1824-2A	2	35	8	53	12	3.50	26	6	2	5	100 psi	3"	2"
IL-3024-1A	1	49	11	74	17	4.91	74	17	3	7	100 psi	3"	3"
IL-1824-3A	3	53	12	79	18	5.25	26	6	3	8	100 psi	3"	2"
IL-2424-2A	2	63	14	95	22	6.30	47	11	3	9	100 psi	3"	2"
IL-3624-1A	1	71	16	107	24	7.10	107	24	4	10	100 psi	3"	3"
IL-2424-3A	3	95	22	142	32	9.45	47	11	5	14	100 psi	3"	2"
IL-3024-2A	2	98	22	147	33	9.82	74	17	5	14	100 psi	4"	2"
IL-4824-1A	1	126	29	189	43	12.60	189	43	7	21	80 psi	4"	4"
IL-3624-2A	2	142	32	213	48	14.20	107	24	8	20	100 psi	4"	4"
IL-3024-3A	3	147	33	221	50	14.73	74	17	8	21	100 psi	4"	2"
IL-5424-1A	1	159	36	238	54	15.90	239	54	10	23	80 psi	4"	4"
IL-3624-3A	3	213	48	320	73	21.30	107	24	12	30	100 psi	4"	4"
IL-4824-2A	2	252	57	378	86	25.20	189	43	14	42	80 psi	6"	4"
IL-5424-2A	2	318	72	476	108	31.80	239	54	19	46	80 psi	6"	4"
IL-4824-3A	3	378	86	567	129	37.80	189	43	21	63	80 psi	6"	4"
IL-5424-3A	3	477	108	714	162	47.70	239	54	29	69	80 psi	6"	4"
IL-4824-4A	4	504	115	756	172	50.40	189	43	28	84	80 psi	8"	4"
IL-4824-5A	5	630	143	945	215	63.00	189	43	35	105	80 psi	10"	4"
IL-4824-6A	6	756	172	1134	258	75.60	189	43	42	126	80 psi	10"	4"
IL-5424-4A	4	636	145	952	216	63.60	239	54	38	92	80 psi	8"	4"
IL-5424-5A	5	795	181	1190	270	79.50	239	54	48	115	80 psi	10"	4"
IL-5424-6A	6	954	217	1428	325	95.40	239	54	57	138	80 psi	10"	4"

Standard product includes:

- Completely assembled for easy installation
- Skid mounted tanks
- Yardney easy-entry lid closure with side manway
- Valves
- Inlet/outlet and backwash manifolds
- Controller, solenoids, electrical wire, tubing
- Removable underdrain
- 3M Scotchkote® 134 fusion bonded epoxy coating on interior surfaces

Available options:

- ASME code
- High pressure
- Solar package
- PLC controller
- Custom filter station layout piping
- Air scour

Made in USA

Phone: 951.656.6716
Toll-Free: 800.854.4788
Fax: 951.656.3867
info@yardneyfilters.com

yardney WATER FILTRATION SYSTEMS

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WATER FILTRATION SYSTEMS

MULTIPLE TANK FILTRATION PROCESS | SAND MEDIA

Media filtration is the most effective method for removal of suspended organic and inorganic solids from water down to 20 microns. Yardney media filters operate on the same basic principle as nature's own ground water filtering process. Contaminated, unfiltered water enters the system through the inlet in the top of the filter and flows, with gravity and under pressure, through the media bed where solid particulates are entrapped. This occurs until the filtration system initiates an automatic backwash to expel all contaminates entrapped within the media bed. Yardney media filters are known for their capacity to extract and hold large amounts of water-borne particulate while continuing to deliver the rated flow of clean water.

FILTRATION PROCESS

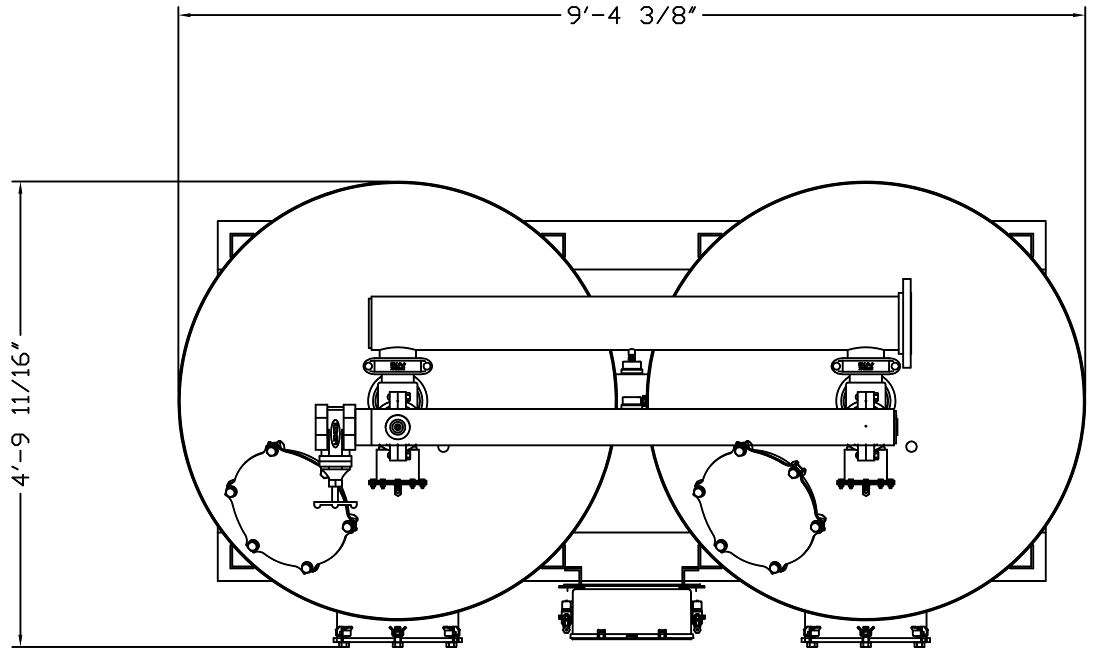
- The contaminated water enters the tank through the inlet manifold, transitioning to the Yardney 3-way valve and into the top inlet of each tank
- The Yardney two-stage deflector creates a uniform distribution for laminar flow across the media bed while avoiding channeling of the media bed
- Particulate is trapped and retained within the media bed resulting in clean process water flowing out through the stainless steel wedgewire underdrain, to the outlet of each filter tank and to the outlet manifold for end use

In addition to the Yardney filter's ability to filter large volumes of water with very little pressure drop, one of the outstanding features is the simple backwash operation. This backwashing process is possible due to the highly efficient and hydraulically balanced underdrain systems utilized in Yardney media filters.

BACKWASH PROCESS

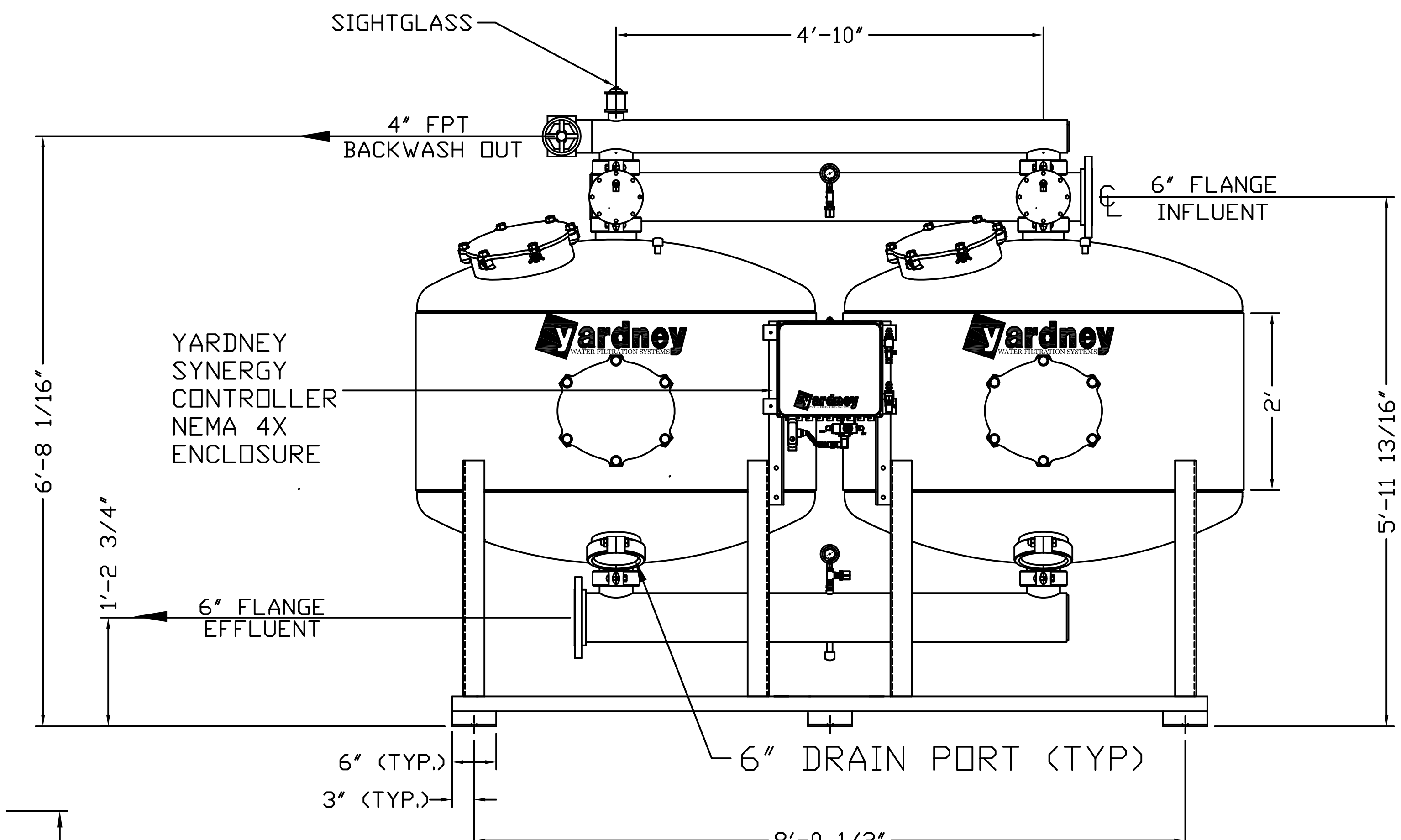
- Backwash sequence is initiated by either elapsed time of the Yardney controller or pressure differential between the inlet and outlet manifolds
- Water or air pressure opens the Yardney 3-way valve causing the reverse flow of a portion of filtered water up through the stainless steel underdrain to hydraulically and uniformly lift the media bed
- The use of a hydraulically balanced underdrain in conjunction with a gravel pack creates a proper and uniform lift of the media bed while avoiding a turbulent backwash
- Entrapped particulates are released during the backwash event, exhausted through the backwash manifold and routed to a convenient location
- One tank at a time is backwashed while continuing to process water for use until the entire system is clean
- Once completed with the backwash, filtration continues until the next backwash event is called for

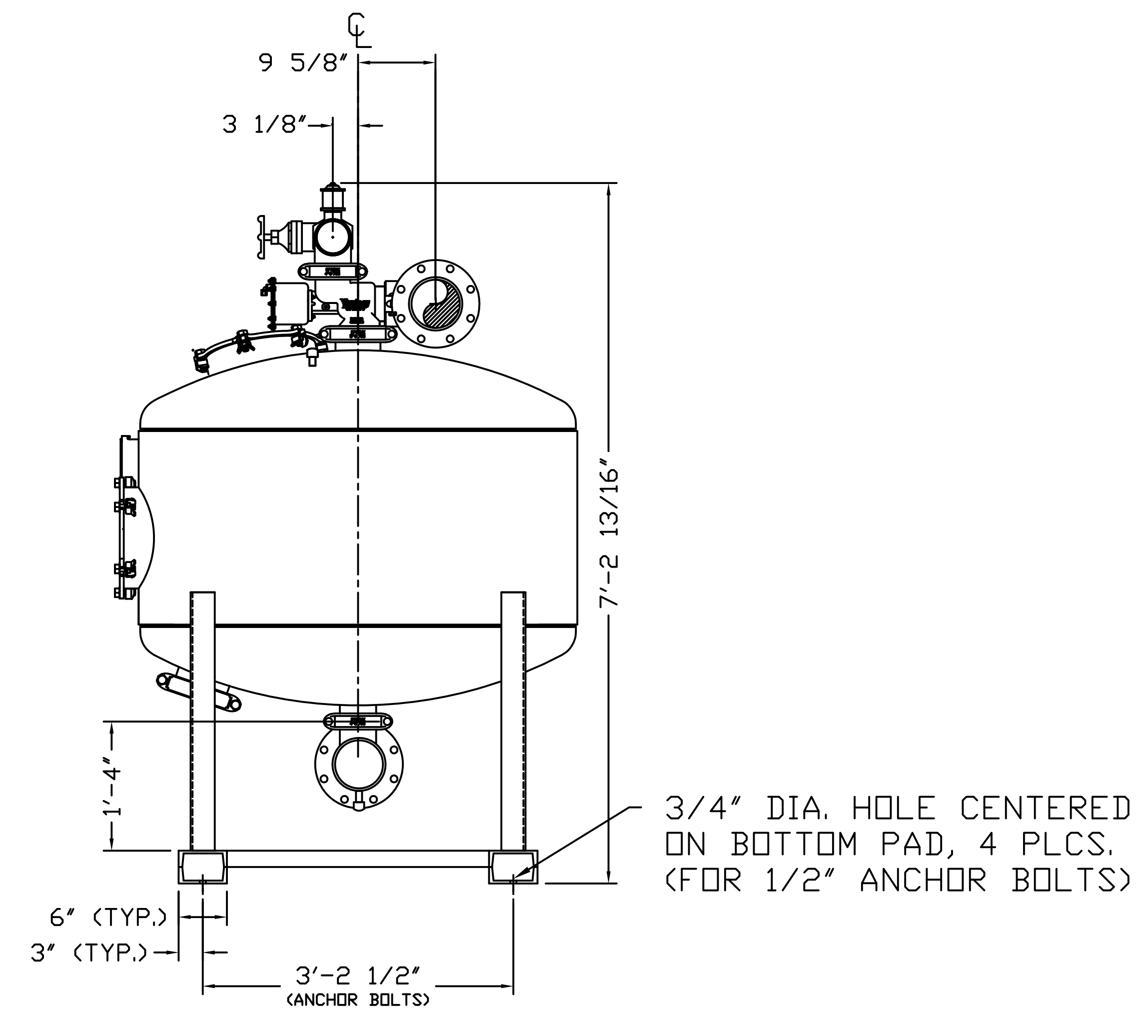
IL 5424-2A

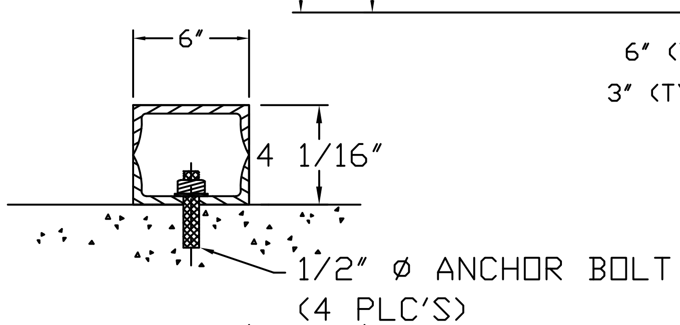


NOTES:

1. DESIGN FLOW RATE: 318-477 GPM.
   BACKWASH RATE: 15 GPM/FT^2.
2. MAXIMUM OPERATING PRESSURE: 80 PSI.
3. ELECTRICAL REQUIREMENTS:
   CONTROLLER 120V;
   SOLENOIDS 24VAC; FACTORY WIRED
4. AIR SUPPLY REQUIRED: 2 CFM @ 70 PSIG (MIN.).
5. MEDIA REQUIREMENT PER TANK:
   A. 1/2"x3/4" CRUSHED ROCK: 9.5 CU. FT. .
   B. 0.47mm CRUSHED SILICA SAND: 23.0 CU. FT. .
6. WEIGHT: (APPROX.)
   A. SHIPPING: 3,630 LBS (WITH MEDIA)
   B. OPERATING: 9,560 LBS
7. EXTERIOR PAINT COLOR: STANDARD BLUE, RAL 5010.







SECTION A – A

SYM	REVISIONS	BY	DATE	
F	REPLACE HEAD 104018954 w/104018955	DTO	8-16	APP
E	4" DRAIN PORT CHANGED TO 6"	DTO	5-15	APP
D	UPDATED YARDNEY LOGO	DTO	1-13	APP
C	WELD TABS ON MANWAY RINGS	DTO	11-12	APP
B	ADDED 4" DRAIN PORT	DTO	11-09	APP
A	DESIGNED WITH NEMA 4 ENCLOSURE	DTC	9-06	APP

APPROVALS	DATE
DRAWN BY: DTC	1/22/06
CHECKED BY:	
APPROVED BY:	
ARCHITECTURAL SCALE:	
USED ON:	

yardney
WATER FILTRATION SYSTEMS
RIVERSIDE, CALIFORNIA

IL 5424-2A
FILTER SYSTEM

SIZE: D | DRAWING NO: 9500542402 | REV: F
SCALE: | ACAD #: SYSTEMS\IL | SHEET 1 OF 1

Multi-Media Filters

Removal of Solids Down to 5 Microns

Yardney Multi-Media filters are designed for enhanced water quality filtration for the removal of organic and inorganic suspended solids down to 5 microns. Multi-Media filters may be used as a stand-alone system or in conjunction with or as a pretreatment for other filtration technologies. The Multi-Media Filtration Systems utilize a vertical side shell depth of 60" with accompanied reverse stacked medias for progressive filtration through the filtration system. All Yardney industrial media filters utilize our simple backwash system for ease of operation and consistent water quality.

Applications

- Removal of organic and/or inorganic suspended solids down to 5 microns with enhanced solids capacity vs. single media sand filtration
- Storm water runoff, industrial process water, incoming plant water, waste water clean-up, industrial water for plant reuse
- Pre-filtration in applications such as granular activated carbon, reverse osmosis, cartridge or bag filtration and deionized water
- 80 psi standard operating pressure (high pressure systems available)
- Flow ranges from 10 gpm

Advantages

- State of the art fabrication provides added strength under pressure and long system life
- ASME code shaped head construction for durability and safety
- Stainless steel wedgewire underdrain
  - Ensures structural integrity in the harshest conditions
  - Hydraulically balanced to increase effectiveness of backwash while reducing flush frequency and waste of water
  - High strength stainless steel wedgewire will withstand a collapse pressure in excess of 600 psi
- Standard carbon steel products, 3/16" thick material
- Backwash automatically initiated by elapsed time or pressure differential
- Yardney easy-entry lid closure with weld tabs for operator safety
- Available in welded carbon steel or stainless steel
- 3M Scotchkote® 134 fusion bonded epoxy coating on interior surfaces
- Made in USA

SPECIFICATIONS | INDUSTRIAL | MULTI-MEDIA FILTERS															
Model	Number of Tanks in System	Standard Flow Range				Filtration Surface Area (total sq ft)	Backwash Flow Rate (per tank)		Media Requirements (cubic feet per tank)				Maximum Pressure	Inlet/ Outlet Pipe Size	Backwash Line Pipe Size
		Minimum		Maximum											
		gpm	m^3/hr	gpm	m^3/hr		gpm	m^3/hr	Gravel 1/2" - 3/4"	Garnet 1.45 mm	Garnet 0.35 mm	Anthracite 0.75 mm			
MM-1860-1A	1	9	2	26	6	1.77	27	6	1	1	2.5	2.5	100 psi	2"	2"
MM-2460-1A	1	16	4	47	11	3.15	47	11	2	2	5	5	100 psi	2"	2"
MM-1860-2A	2	18	4	53	12	3.54	27	6	1	1	2.5	2.5	100 psi	2"	2"
MM-3060-1A	1	25	6	74	17	4.91	74	17	3	3	8	8	100 psi	3"	3"
MM-1860-3A	3	27	6	79	18	5.31	27	6	1	1	2.5	2.5	100 psi	3"	2"
MM-2460-2A	2	32	7	95	22	6.30	47	11	2	2	5	5	100 psi	3"	2"
MM-3660-1A	1	35	8	107	24	7.10	107	24	4	4	11	11	100 psi	3"	3"
MM-2460-3A	3	48	11	142	32	9.45	47	11	2	2	5	5	100 psi	3"	2"
MM-3060-2A	2	50	11	147	33	9.82	74	17	3	3	8	8	100 psi	4"	2"
MM-4860-1A	1	63	14	189	43	12.60	189	43	7	7	19	19	80 psi	4"	4"
MM-3660-2A	2	70	16	213	48	14.20	107	24	4	4	11	11	100 psi	4"	4"
MM-3060-3A	3	75	17	221	50	14.73	74	17	3	3	8	8	100 psi	4"	2"
MM-5460-1A	1	80	18	239	54	15.91	239	54	10	8	24	24	80 psi	4"	4"
MM-3660-3A	3	105	24	320	73	21.30	107	24	4	4	11	11	100 psi	4"	4"
MM-4860-2A	2	126	29	378	86	25.20	189	43	7	7	19	19	80 psi	6"	4"
MM-5460-2A	2	160	36	477	108	31.82	239	54	10	8	24	24	80 psi	6"	4"
MM-4860-3A	3	189	43	567	129	37.80	189	43	7	7	19	19	80 psi	6"	4"
MM-5460-3A	3	240	55	716	163	47.73	239	54	10	8	24	24	80 psi	6"	4"
MM-4860-4A	4	252	57	756	172	50.40	189	43	7	7	19	19	80 psi	8"	4"
MM-4860-5A	5	315	72	945	215	63.00	189	43	7	7	19	19	80 psi	10"	4"
MM-5460-4A	4	320	73	955	217	63.64	239	54	10	8	24	24	80 psi	8"	4"
MM-4860-6A	6	378	86	1134	258	75.60	189	43	7	7	19	19	80 psi	10"	4"
MM-5460-5A	5	400	91	1193	271	79.55	239	54	10	8	24	24	80 psi	10"	4"
MM-5460-6A	6	480	109	1432	325	95.46	239	54	10	8	24	24	80 psi	10"	4"

Standard product includes:

- Completely assembled for easy installation
- Skid mounted tanks
- Yardney easy-entry lid closure with side manway
- Valves
- Inlet/outlet and backwash manifolds
- Controller, solenoids, electrical wire, tubing
- Removable underdrain
- 3M Scotchkote® 134 fusion bonded epoxy coating on interior surfaces

Available options:

- ASME code
- High pressure
- Solar package
- PLC controller
- Custom filter station layout piping
- Air scour
- Continuous flow
- Rinse to waste

Made in USA

Phone: 951.656.6716
Toll-Free: 800.854.4788
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info@yardneyfilters.com

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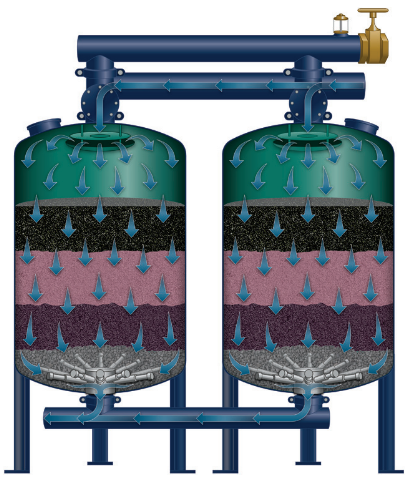
WATER FILTRATION SYSTEMS

MULTIPLE TANK FILTRATION PROCESS | MULTI-MEDIA

Multi-media filtration is a more effective method for removal of suspended organic and inorganic solids from water down to 5 microns. Yardney Multi-Media filters operate on a similar principle to the sand media but utilize multiple levels of coarse to fine media to achieve progressive filtration through the entire filter media bed. The coarse media within the top section of the tank filters the largest particulates while the finer media beds filter the fine particulates. This occurs until the filtration system initiates an automatic backwash to expel all contaminants entrapped within the media bed. Yardney Multi-Media filters are known for their capacity to extract and hold large amounts of water-borne particulate while continuing to deliver the rated flow of clean water.

FILTRATION PROCESS



- The contaminated water enters the tank through the inlet manifold, transitioning to the Yardney 3-way valve and into the top inlet of each tank
- The Yardney two-stage deflector creates a uniform distribution for laminar flow across the media bed while avoiding channeling of the media bed
- Particulate is trapped and retained within the media bed resulting in clean process water flowing out through the stainless steel wedgewire underdrain, to the outlet of each filter tank and to the outlet manifold for end use

In addition to the Yardney filter's ability to filter large volumes of water with very little pressure drop, one of the outstanding features is the simple backwash operation. This backwashing process is possible due to the highly efficient and hydraulically balanced underdrain systems utilized in Yardney Multi-Media filters. Yardney Multi-Media filters are hydraulically designed not to commingle the multiple levels of media during a backwash cycle due to the specific gravity of each media.

BACKWASH PROCESS

- Backwash sequence is initiated by either elapsed time of the Yardney controller or pressure differential between the inlet and outlet manifolds
- Water or air pressure opens the Yardney 3-way valve causing the reverse flow of a portion of filtered water up through the stainless steel underdrain to hydraulically and uniformly lift the media bed
- The use of a hydraulically balanced underdrain in conjunction with a gravel pack creates a proper and uniform lift of the media bed while avoiding a turbulent backwash
- Entrapped particulates are released during the backwash event, exhausted through the backwash manifold and routed to a convenient location
- One tank at a time is backwashed while continuing to process water for use until the entire system is clean
- Once completed with the backwash, filtration continues until the next backwash event is called for

HOW DMI-65 WORKS

Introduction

The purpose of this paper is to provide users of DMI-65 catalytic water filtration media with qualitative information about how the material works, its capabilities and limitations and enable them to apply the material to water treatment processes in the appropriate manner and with confidence. The paper avoids the detailed complexity of solid surface electrochemical layers and colloidal science, quantitative physical and chemical processes and reactions. For readers having already significant knowledge in this area the paper brings more understanding of what DMI-65 is and its intended use. Newcomers to this area are provided with the bases, and perhaps motivation, for directing their more in depth studies as they might wish.

History

In the early days of water treating, naturally occurring zeolites (such as glauconite greensand) were used to soften and remove the iron and manganese from boiler make-up and process waters. As the demand for higher quality water increased (due in part to higher pressure class boilers) the water treating industry largely moved away from these products for softening to the newly developed synthetic ion exchange resins.

However, in the case of iron and manganese removal this move was much slower and the result was that the use of glauconite greensand (greensand) filtration media continues until the present time. Greensand was and is often used as a pretreatment step prior to ion exchange processes since the iron in a feed water can and does foul the cation resin. Other processes include aeration and oxidation-filtration with standard media filters or proprietary types of media and/or filters

While there have been other iron/manganese removal products and processes developed since greensand was introduced the use of greensand continued even though there were several issues that made it a less than ideal media. It required periodic regeneration with potassium permanganate, could not be used in lower pH waters (<6.2), had a relatively low operating temperature (80°F), and tended to soften through time resulting in pressure drop issues at higher flow rates. Additionally, the supply could occasionally become restricted due to environmental concerns with the processing facilities along the Eastern coast of the United States.

Because of these issues in the 1970s water treating companies and end-users began to express an interest in “something else” to replace the greensand. In response to their requests, scientists and researchers in Japan began to look for ways to infuse oxidizing agents to different matrix materials. It was felt that a commercially produced product could be made more powerful, have better physical properties and be more subject to improvements and/or modifications than any naturally occurring media.

Decades of further research and development of the Japanese Infusion Technology have resulted in the uniquely Australian made product, DMI-65 a granular catalytic media used to boost the advanced reduction/oxidation (redox) processes in water. The media is part of a broad category of products deriving their physical and chemical action from the interaction of their metal oxide surface with the water molecules and ions in solution. This product is revolutionary due to proprietary infusion technology that penetrates the micro pours substrate of the matrix material, allowing for a greater catalytic surface area and of a tight particle size distribution. DMI-65 has low level of fines, a tolerance to wider pH range and chemically infused catalytic surface that won’t be consumed or diminished under normal operating conditions. Last 5 – 10 years of continuous use.

Background information

DMI-65 is an extremely powerful catalytic water filtration media that is designed for the removal of iron and manganese in aqueous solutions (water) without the need for potassium permanganate or chemical regeneration. The unique microporous structure of DMI-65 efficiently removes dissolve iron to the almost undetectable levels as low as 0.001 ppm and manganese to 0.001 ppm. DMI-65 acts as an oxidation catalyst with immediate oxidation and filtration of the insoluble precipitates derived from this oxidation reaction. DMI-65 can also remove Arsenic, Aluminium and other heavy metals and Hydrogen Sulfide under certain conditions.

The material is part of the broad category of products deriving their physical and chemical action from the interaction of their metal oxide surface with the water molecules and ions in solution.

Solid surface interaction with water distinguishes between adsorption as the weak van der Waal forces that hold a hydrophobic molecule in a rigid core media such as activated carbon and absorption as the weak van der Waal forces that hold a hydrophobic molecule in a swellable matrix (such as benzene) in a polymer of T-butyl styrene or absorption by liquid-liquid extraction. Ion exchange resins utilize absorption processes while interaction of DMI-65 with water molecules and ions in solution is initiated through adsorption.

Non catalytic type adsorbent materials retain target ions from water until either sites available for adsorption reach a maximum density and saturation or concentration of target ions in the treated water attain maximum acceptable concentration. At this point, the adsorbent material has to be regenerated to remove or replace the contaminant ions, or the used material is replaced with new material that is loaded in the treatment container. When the process works by swapping one type of ion for target ions from water the process is called ion exchange. This category of adsorbent and some partly absorbent materials remove the target ions from water. The larger the surface per volume of material the larger the amount of contaminant target ions which could be retained from the water.

Purely catalytic materials adsorb the reactant ions from solution bringing them in the proximity of chemical bonding. Then the reaction product moves away from the surface of catalyst. Strictly speaking catalysts facilitate chemical reactions; they do not implicitly remove anything. If the reaction product is a solid precipitate, often the product is retained in the catalytic bed, hence removed by filtration.

Many materials act in a mixed mode; with both ion exchange and catalytic action taking place. For those materials used primarily for their catalytic action, ion exchange resulting in dissolution of the catalytic layer leads to the need for periodic regeneration or reactivation to correct the matrix of ions at their active surface.

DMI-65 – Advanced Oxidation Catalytic Media

DMI-65 is a granular material of dark brown to black colour. This colour is produced by the manganese oxide in the outer layers of the granules. DMI-65 is a catalytic media in the true meaning of the word and facilitates oxidation – precipitation - filtration and does not get consumed in the reactions. Strictly speaking, the media facilitates chemical reactions and does not explicitly remove anything. Once oxidized, the depth filtration aspect of the media removes the solids that are then periodically backwashed out of the filter vessels.

The media does not need regeneration or reactivation and does not display a decaying capacity to do its catalytic work. Over 5 to 10 years period, through many backwashing operations of the bed to remove retained solids, the media is degraded by contact between particles and mechanical abrasion. Then the material has to be replaced.

BASIC OPERATION:

The processes that take place in a bed of DMI-65 involve reduction/oxidation (redox). Redox reactions involve a transfer of electrons between species. Reduction is the gain of electrons or a decrease in the oxidation state of a molecule, atom or ion. Oxidation is the loss of electrons or an increase in the oxidation state of a molecule, atom or ion. Redox reactions occur simultaneously whereby there cannot be a reduction reaction without an oxidation reaction. The media "helps" chemical reactions to occur by interacting with the reaction without being permanently altered. An in depth discussion about redox chemistry is outside the scope of this paper, it will only deal with how the redox process applies in the removal of iron and manganese using DMI-65. The individual redox equations will be covered in the following iron and manganese removal sections.

In order to begin the process of oxidation of the ions in solution and to ensure that the oxidative layer is not compromised the media is designed to operate in the presence of chlorine or other oxidant. In this process the oxidant removes electrons and is consumed in the process. The operator needs to ensure that there is a 0.1 – 0.3 ppm free chlorine residual in the effluent water.

Chlorine, fed as sodium hypochlorite (NaOCl) or bleach (12.5% NaOCl), is the preferred oxidant since it is relatively inexpensive, readily available around the world and it is effective. Other oxidants such as hydrogen peroxide (H_2O_2), chlorine oxide (ClO_2) or ozone can also be used so long as a residual can be measured and maintained.

Another function of the chlorine is that it keeps the media free from bacterial or slime growth. The manganese oxide catalytic surface has to remain clean so that the ions in the water can come in contact with it. At the same time, the chlorine is a source of oxygen more reactive than molecular oxygen. The following chart indicates safe levels for other water constituents that could interfere with the surface interaction.

Unlike ion exchange resins where higher regenerant dosages will increase the ion exchange capacity, chlorine residuals or concentrations higher than required to oxidize the Fe and Mn do not increase the oxidative properties of the media. Additionally, since the media is often used to pretreat waters prior to an Reverse Osmosis (RO) system a higher free chlorine residual would require more extensive post treatment to reduce the residual to protect the membranes from chlorine attack.

The DMI-65 must be activated prior to being placed into service for the first time. This activation requires a higher dosage of chlorine than used during normal operation but only has to be performed once during the initial start up. The dosage rate is 10 fluid ounces of 12.5% chlorine per cubic foot (ft^3) of the media. The activation only requires a soak of several hours but an overnight soak is preferred.

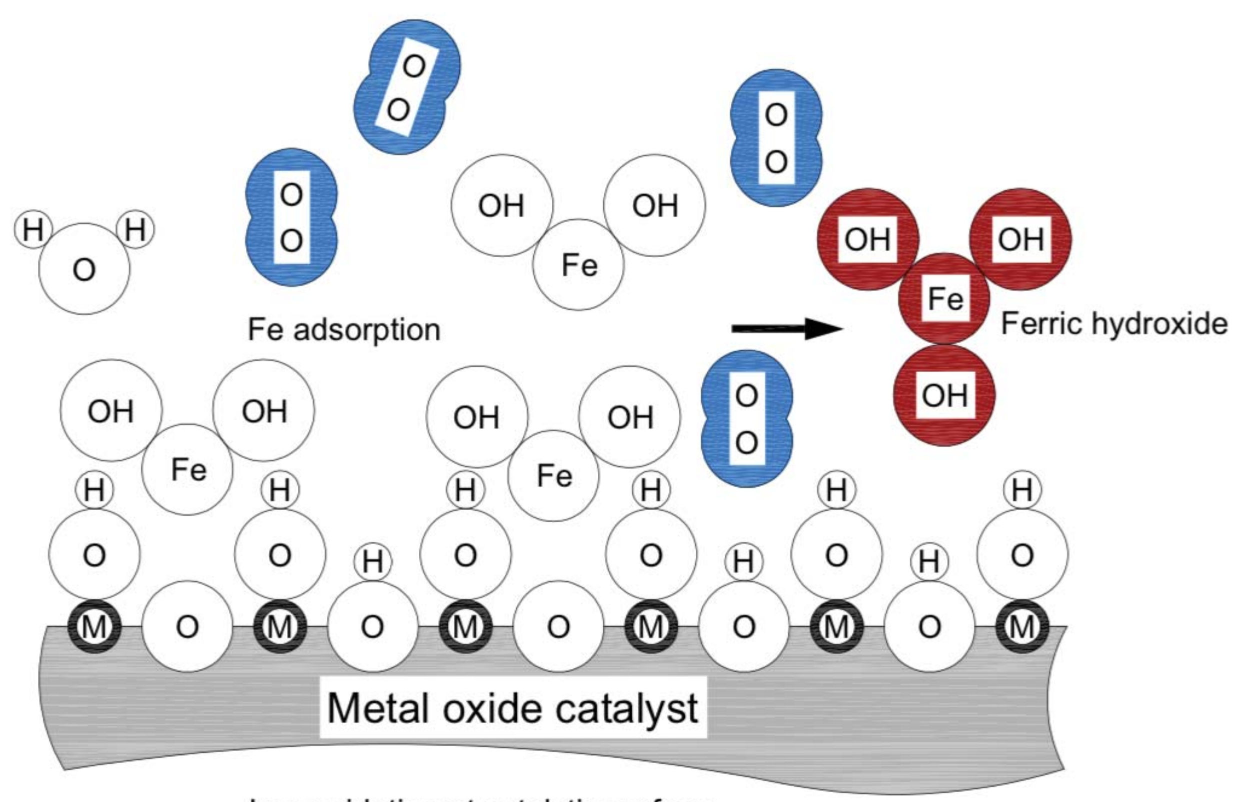
Once activated, the vessel(s) must be backwashed to remove the excess NaOCl and any fines. Since manganese oxide is one of the constituents used in the manufacture of the media an extended rinse is required at start up to remove any trace free manganese oxide residual left over from the manufacturing process. Once the Mn level in the backwash water reaches values of 0.05 to 0.15 ppm and the free chlorine residual is set the filter is ready to be placed into service.

Media replacement due to the decreased physical filtration properties of the Media due to physical abrasion will occur before complete degradation of the catalytic layer takes place. Under normal operating conditions media life is estimated at 5 – 10 years.

Iron (Fe) precipitation and removal using DMI 65

Iron (Fe) is the fourth most common element found in the earth's crust and exists in a wide range of oxidation states from -2 to +6 although the most common states are ferrous (+2) and ferric (+3).

Ferrous salts are readily soluble. Before the ferrous iron, a dissolved solid commonly found as ferrous bicarbonate, can be removed by filtration it must be oxidized, become ferric hydroxide and in neutral pH waters precipitate out in the media bed. The catalytic surface of DMI-65 contains manganese oxide or exposes manganese and oxygen sites for adsorption of [Fe] ions that are in the water. The reaction of ferrous bicarbonate and NaOCl is almost instantaneous and the ferrous bicarbonate oxidizes (gives up an OH^-) to become the insoluble ferric hydroxide which is then removed through filtration in the catalytic surface of the media. The following redox reaction equation explains the process.



Iron oxidation at catalytic surface.

$$2Fe(HCO_3)_2 + NaOCl + H_2O \rightarrow 2Fe(OH)_2 + 2CO_2 + NaCl$$

In the above figure the catalytic surface is presented in a simplified smooth form. Letter "M" was used to represent a generic metal ion in the lattice of this surface. Letter "O", in the centre of circles, represents an oxygen atom. Various ion size and oxygen molecule (blue) are represented at true relative scale. Except the oxygen molecule, bonded irons are shown as tangent circles. The interpretation for letters and ions in the figure "Ion oxidation at catalytic surface" is:

M: generic metal ion in the catalytic surface lattice (Mn+); n = 1, 2…

O: oxygen atom or ion (O-)

Fe: iron atom or ion (Fe2+, Fe3+)

H: hydrogen atom or ion (H+)

OH: hydroxide, or hydroxyl anion (OH-)

H2O, water molecule shown as tangent circles

Fe (OH)2, ferrous hydroxide is shown as tangent circles

Fe (OH)3, ferric hydroxide, shown as tangent circles, brown colour

O2, oxygen molecule, atoms shown at covalent bonding distance, blue colour

Dissolved ferrous bicarbonate is attracted with the Fe end towards the lattice oxygen of the catalytic material. This brings the Fe in the proximity of covalent bonding with the hydroxide ion of a neighbouring site and the ferrous bicarbonate changes into insoluble ferric hydroxide which precipitates in crystalline form aggregates of size from 3 nanometre and larger. The aggregates coagulate in larger flocks and are retained in the catalytic bed.

As the ferrous bicarbonate is converted into ferric hydroxide, its concentration at the catalytic surface decreases. In the bulk of the water, away from the catalytic surface, the concentration of ferrous bicarbonate is higher resulting in it diffusing towards the lower concentration according to diffusion law. Diffusion flux is linearly dependent with concentration gradient over distance.

Dissolved oxygen contributes to production of hydroxide ions through direct oxidation of hydrogen in combination with Fe splitting the water molecule and by reacting with the hydrogen at the catalytic surface

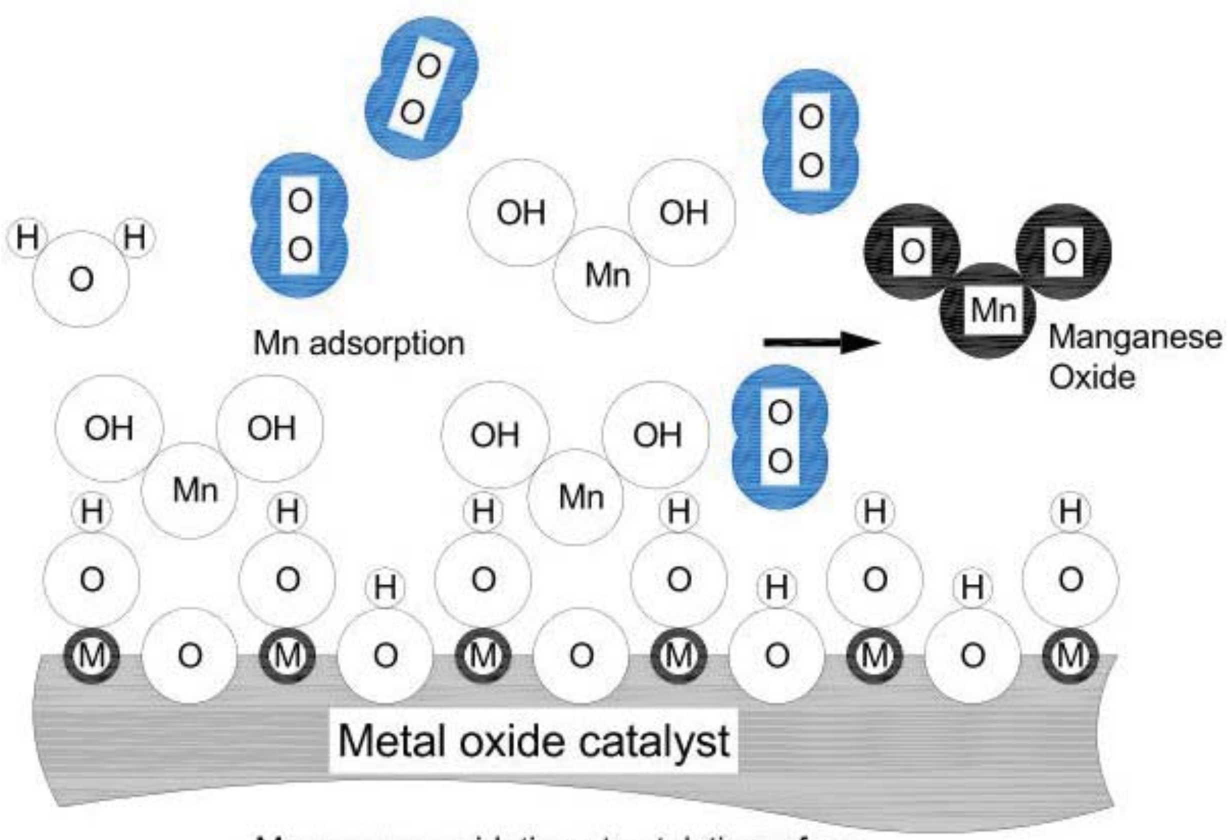
It is important to note that although a source of oxygen is needed oxidation and precipitation of Fe is driven by the hydroxide ion. Even under relatively acidic conditions hydroxide ions (a very strong anion) are easier available for binding to Fe than oxygen. Thus, Fe is not very difficult to oxidise and precipitate around neutral pH condition. In addition, concentration of hydroxyl ions increases with pH value exponentially and so does the rate of oxidation and precipitation of Fe.

Chlorine (usually in the form of NaOCl) is a source of oxygen more reactive than molecular oxygen. The ideal residual to be maintained downstream of the catalytic filter is 0.2 mg/l (0.1 to 0.3) free chlorine. A higher residual of free chlorine and therefore higher sodium hypochlorite level in the catalytic filter does not always help. It could have an adverse effect due to venting of chlorine and an increase of competing sodium ions, Na+. The catalytic surface has to be clean so that ions in water could come in contact with it so the chlorine injected also prevents bacteria growth and blinding of the catalytic surface with slime.

Manganese, Mn precipitation and removal using DMI 65

DMI-65 is a catalytic material specifically tailored to the oxidation and removal of manganese. The catalytic surface contains manganese oxide for brining into proximity of covalent bonding manganese and oxygen atoms from water. However, oxidation and removal of manganese (Mn) is vastly different from that of Fe. A major difference is caused by the solubility of manganese oxyhydroxide, $MnO(OH)_2$.

$$\mathbf{Mn(HCO_3)_2 + NaOCl \rightarrow MnO(OH)_2 + NaCl + 2CO_2}$$



Manganese oxidation at catalytic surface.

Manganese does not precipitate as oxyhydroxide but as oxide, MnO_2 and higher valency oxides. Presence and concentration of hydroxide anions does not help much in the precipitation and removal of manganese. Manganese hydroxide will be attracted with the manganese end to the oxygen in catalytic lattice surface. An Oxygen molecule has to be available in the proximity for facilitating oxidation through the oxygen from lattice and swapping to the lattice with molecular oxygen. Conditions for this to happen are statistically less probable and reaction is of much slower rate than the oxidation of Fe via hydroxide.

While increases in pH to alkaline levels facilitates oxidation and removal of manganese, under these conditions the oxidised manganese could also dissolve back into the water. Consequently, regardless of the target contaminant to be removed, anoxic conditions have always to be avoided to protect the catalytic layer against leaching into water. When oxidising manganese the recommended pH is close to 8.

Manganese oxide has good autocatalytic effect. When backwashing it is better to stop the process before the water becomes very clear. Manganese oxide residue in the filter bed will enhance manganese oxidation.

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Key DMI-65 operating conditions

Treatment processes have to be conducted in such manner so that the catalytic surface of the material is kept clean and available to ion from water to contact.

Water with a large amount of suspended solids has to be clarified before passing it through the catalytic filter with DMI-65. Acceptable levels of suspended solids depends on their nature. A larger amount of mineral suspended solids than organic suspended solids could be handled.

Bacteria could grow and deposit slime on DMI-65. Thus disinfectant and oxidation conditions have to be maintained.

Water containing clays and large organic molecules may result in deposition of such material on the surface of DMI 65 and blinding of the catalytic surface. Treatment for removal of such contaminant before the catalytic filter is needed.

Polymer flocculent could also stick to the DMI-65 and blind catalytic surface.

Hard, unstable groundwater could cause scale deposition in the catalytic filter and blind the material in a solid mono bloc. In such case the DMI-65 material in the bed is lost and would have to be replaced. Treatment for stabilizing the water to prevent scale formation in the catalytic filter has to be carried out.

Both low acidic pH and anoxic conditions could cause dissolution of manganese from catalytic layer of DMI-65 and loss of its capacity. Excessively high pH means excessive concentration of hydroxyl ions (corrosive to metals) and could also cause dissolution of manganese from the catalytic layer.

Do not use demineralized water, distilled water or water known to be strongly corrosive to metals for initial soaking and activation of DMI-65.

yardney
WATER FILTRATION SYSTEMS

IMA-65 Specialty Media

Iron and Manganese Removal

IMA-65 Specialty Media is a revolutionary silica sand based filtration media designed for the removal of iron and manganese without the use of potassium permanganate. The unique micro porous structure of IMA-65 efficiently removes dissolved iron to as low as 0.005 ppm and manganese to 0.001 ppm. After initial activation, the IMA-65 acts as an oxidation catalyst with immediate oxidation and filtration of the insoluble precipitates. The media has been used extensively in a wide variety of applications in Japan for over 30 years. IMA-65 has been tested and certified by the Water Quality Association in accordance with NSF/ANSI 61.

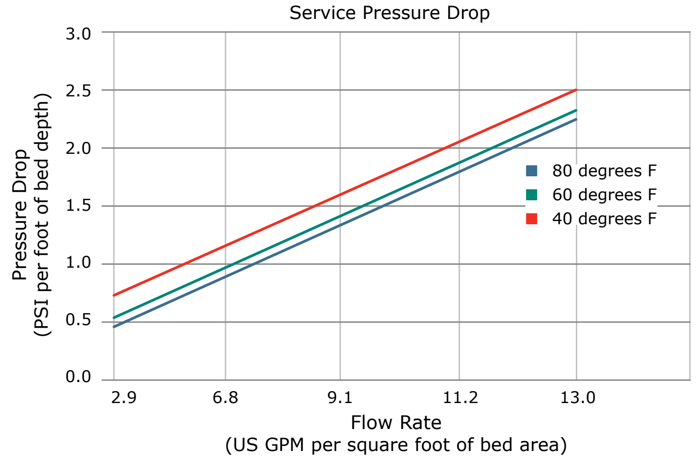
Advantages

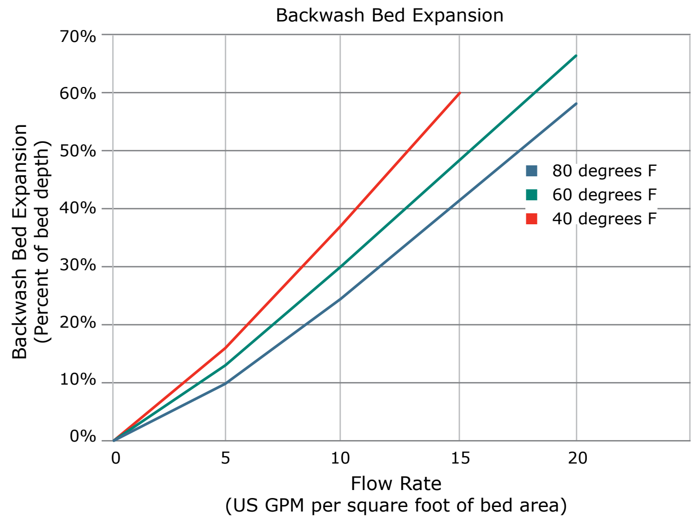
- **Eliminates Potassium Permanganate.** Operates with continuous injection of sodium hypochlorite at low residual levels (0.1 to 0.3 ppm).
- **Wide pH range.** Stable and satisfactory performance at pH 5.8 to 8.6.
- **High Flow Rates.** IMA-65 can operate at linear filtration velocities up to twice that of conventional media with a corresponding reduction in capital equipment costs.
- **Higher Operating Temperatures.** Maximum operating temperature of 113 °F (45 °C).
- **Long Life.** IMA-65 is not consumed in the process, providing considerable advantages over other processes or media.
- **Regeneration Not Required.** After initial activation, only sodium hypochlorite feed is required.
- **System Compatibility.** Physical properties are similar to that of competitive media, allowing conversion to IMA-65 without major hardware modifications.
- **Arsenic Removal.** IMA-65 has been shown to be effective in the removal of arsenic associated with iron-containing influent. If necessary, ferric chloride can be introduced to treat waters with low influent iron levels or to enhance removal when treating waters with high levels of arsenic.

|<< PREV | NEXT

SPECIFICATIONS | IMA-65 SPECIALTY MEDIA			
Physical Properties		Operating Conditions	
Color	Brown to black	pH range	5.8 – 8.6
Bulk density	92.0 lbs./cu. ft.	Maximum water temp	113 °F (45 °C)
Specific gravity	2.7	Minimum bed depth	24 inches (600 mm)
Effective size	0.48	Freeboard	40% minimum
Uniformity coefficient	<1.8	Service flow rate	2 – 12 gpm per sq. ft.
Mesh size	20 – 45	Backwash flow rate	10 – 20 gpm per sq. ft.
Annual attrition	1-5%	Backwash expansion	15 – 50%

Engineering (Hydraulic) Data





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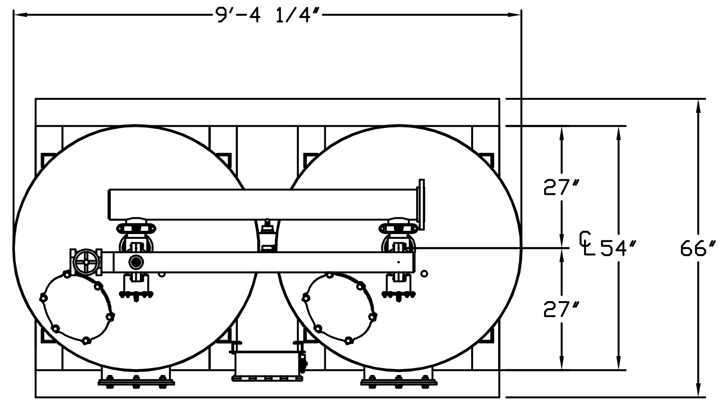
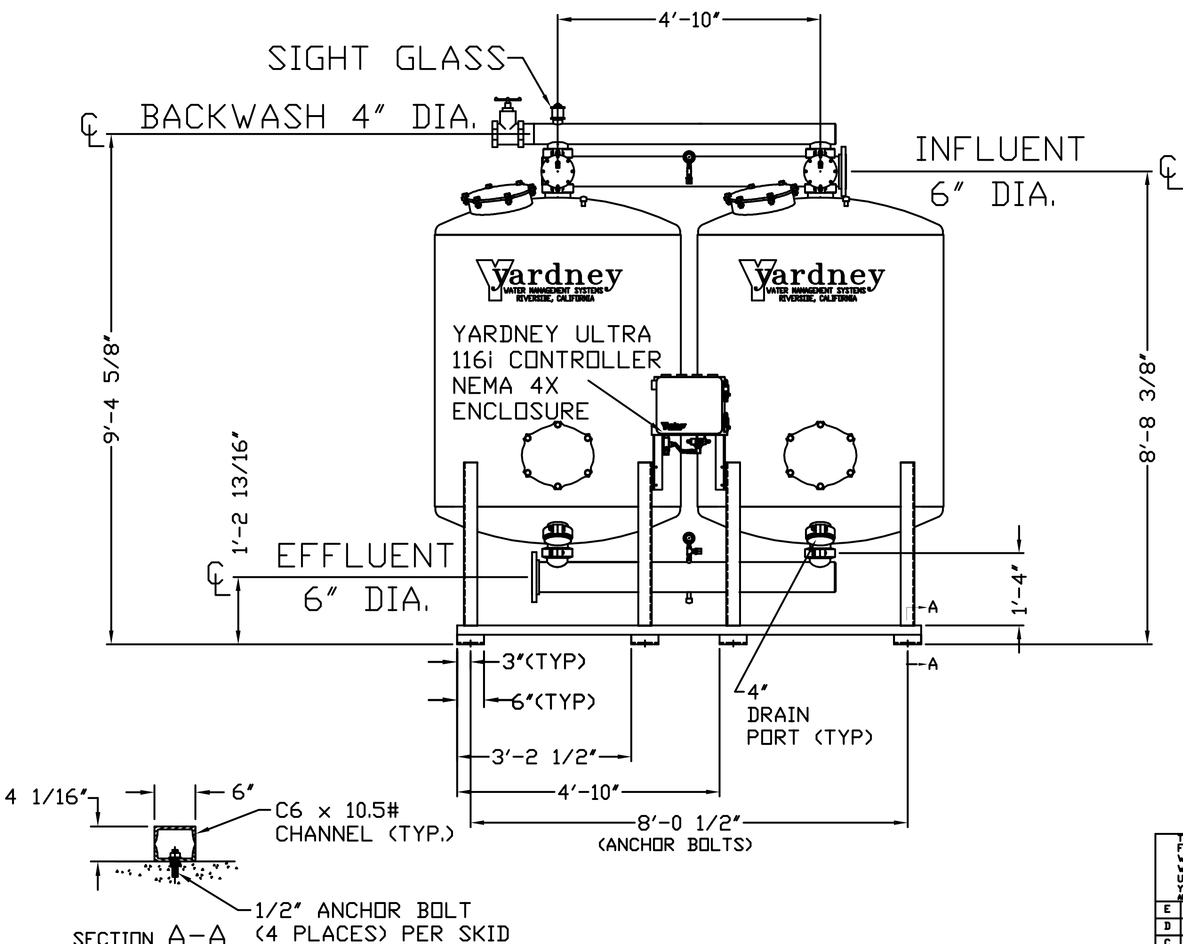
 IND105-01-2016

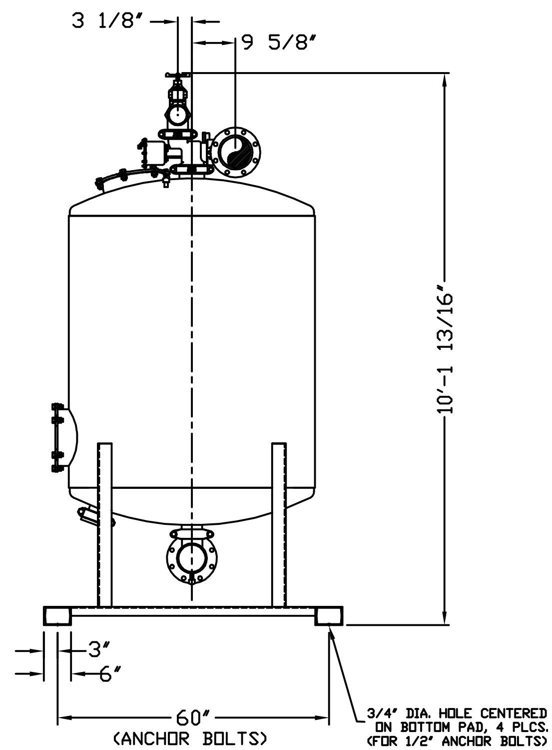
MODEL MM 5460-2A



NOTES:

1. FLOW RATE DESIGN: 160-477 GPM; MAX TO 636 GPM
2. MAXIMUM WORKING PRESSURE: 80 PSI.
3. ELECTRICAL REQUIREMENTS:
   CONTROLLER 120V;
   SOLENOIDS 24VAC; FACTORY WIRED
4. AIR SUPPLY REQUIRED: 2 CFM @ 70 PSIG (MIN.).
5. MEDIA REQUIREMENT PER TANK:
   A. 1/2"x3/4" CRUSHED ROCK: 9.5 CU. FT. .
   B. 1.45mm GARNET: 8.0 CU. FT. .
   C. 0.35mm GARNET: 24.0 CU. FT. .
   D. 0.75mm ANTHRACITE: 24.0 CU. FT. .
6. WEIGHTS: (APPROX.)
   EQUIPMENT: 2,710 LBS (LESS MEDIA)
   MEDIA: 12,746 LBS
   OPERATION: 22,850 LBS





SYM	REVISIONS	BY	DATE	APP
E	ADDED 4" DRAIN PORT	DTO	11-09	APP
D	ADDED SIGHTGLASS	DTO	8-07	APP
C	REVISED SKID TO STANDARD	DTC	11-06	APP
B	CORRECTED GPM FLOW RATES	DTC	10-05	APP
A	STANDARDIZED NOTES	DTC	9-05	APP

APPROVALS	DATE
DRAWN BY: K.A.T.	6/17/94
CHECKED BY:	
APPROVED BY:	
ARCHITECTURAL SCALE:	
USED ON:	

DO NOT SCALE DWG.

Yardney
WATER MANAGEMENT SYSTEMS
RIVERSIDE, CALIFORNIA

MODEL MM 5460-2A

SIZE	DRAWING NO:	REV:
D	9500546002	E

SCALE: DWG DIR: SYSTEM\MM SHEET 1 OF 1

Attachment 3

Design Calculations for Chlorine Injection

Configurable Dosing Tank Station

Storing and dosing liquid chemicals

General

Dosing is precision work and one of the main tasks in chemical and process engineering as well as water treatment. Thus dosing requires precise adjustment of the pump and its accessories to the process parameters of the respective application. DIGITAL DOSING™ pumps are delivering an optimal performance in these application fields.

As they are easy to install, DTS dosing tank stations are the first choice in the matter of economic efficiency when adding liquids such as coagulants, disinfectants or neutralising agents to a process in a precise and controlled way.

DTS dosing tank stations are intended for storing and dosing liquids. Many different configurations can be selected flexibly to fulfil various dosing tasks. Due to the use of high-quality materials, DTS dosing tank stations can be employed for diverse dosing liquids. The selection of materials can be adapted via the configuration.

Components and features

- Chemically resistant tank made of UV-stabilised, semitransparent or black polyethylene, in 6 sizes from 60 to 1000 litres, with embossed litre scale and PE screw cover
- PE collecting tray
- Handheld mixer or electric stirrer (230 V, 50 Hz) with level switch for dry-running protection
- Rigid suction lance or foot valve made of PE, with 2-step level switch for dry-running protection, suction line to the dosing pump
- PVC or PP injection unit with G 1/2 process connection
- PE or PVC discharge line (10 m)
- Drain valve
- Filling armature with ball valve (for all tank sizes) or dissolving hopper (from 200 l)
- Multi-function valve
- Prepared for the installation of a dosing pump DDA, DDC, DDE, DMX 221 or DDI 60-10 including necessary assembly material (connectors, click-plate and screws depending on pump type)

Note:
Dosing pumps are not comprised in a standard delivery. They have to be ordered separately.

Applications

- Dosing of biocides and inhibitors into cooling water
- Dosing of lyes and acids for pH regulation
- Dosing of coagulants, such as ferric(II)chloride or ferric(III) chloride, for waste water treatment
- Dosing of hypochlorite
- Dosing of cleaning agents and disinfectants (CIP, cleaning machines)

Type key

Example DTS 100 T 1 0 3 4 RE E 4 A 1 H

Product type
DTS Dosing Tank Station

Tank size
60 60 litres
100 100 litres
200 200 litres
300 300 litres
500 500 litres
1000 1000 litres

Tank colour
T Transparent
B Black

Collecting tray
0 Without
1 Collecting tray

Screw cover
0 Black screw cover without lock

Mixer or stirrer
0 Without
1 Handheld mixer, PE
2 Electric stirrer, stainless steel
3 Electric stirrer, PP, with sealing flange

Preparation for dosing pump
0 Without
1 Preparation for DMX 221 up to 50 l/h
3 Preparation for DDI 60-10
4 Preparation for SMART Digital DDA, DDC, DDE

Suction line
WO Without
RV Rigid suction lance PE/V
RE Rigid suction lance PE/E
RT Rigid suction lance PE/T
FV Foot valve with flexible suction line PE/V
FE Foot valve with flexible suction line PE/E
FT Foot valve with flexible suction line PE/T

Discharge line
A Without
B 10 m of PE hose 4/6 mm (up to 7.5 l/h)
C 10 m of braided PVC hose 6/12 mm (up to 30 l/h)
D 10 m of PE hose 9/12 mm (up to 60 l/h)
E 10 m of PE hose 6/9 mm (up to 30 l/h)

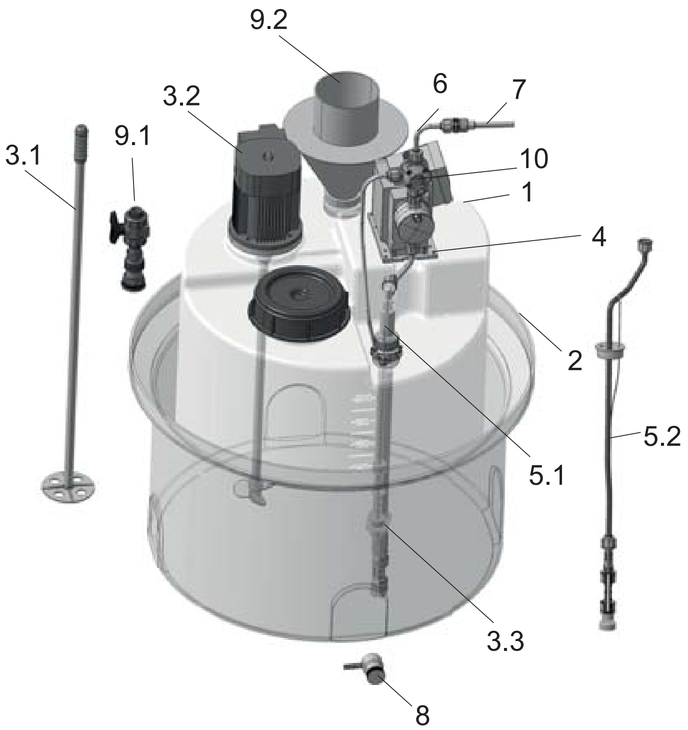
Injection unit (G 1/2 process connection)
0 Without
1 Injection unit PVC/V/C
2 Injection unit PP/V/C
3 Injection unit PVC/E/C
4 Injection unit PP/E/C
5 Injection unit PVC/T/C

Drain valve (not with collecting tray)
A Without
B Drain valve PVC/E

Filling device
0 Without
1 Filling armature PVC/E with ball valve
2 Dissolving hopper

Multi-function valve
A Without
G Multi-function valve PV/V
H Multi-function valve PV/E
I Multi-function valve PV/T

Components overview



1 Tank
2 Collecting tray
3.1 Handheld mixer
3.2 Electric stirrer
3.3 Level switch for electric stirrer
4 Installation material
5.1 Rigid suction lance with connection to the pump
5.2 Foot valve with flexible suction line
6 Discharge line
7 Injection unit
8 Drain valve
9.1 Filling armature with ball valve
9.2 Dissolving hopper
10 Multi-function valve

95715959 0914 ECM: 1139925

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SMART Digital
DDA – DDC – DDE
Modular. Simple. Intelligent.

be
think
innovate

GRUNDFOS

SMART Digital

Now it’s time to break the barriers of conventional dosing

A new era of dosing technology

Chemistry in water treatment, water and wastewater recycling and disinfection has experienced a huge development during the last years, and this poses a challenge for today’s dosing technology. More and more complex applications require intelligent dosing pumps with new drives or new control and adjustment mechanisms to simplify the operators’ job.

SMART Digital dosing pumps meet these challenges. They offer state-of-the-art drive technology, new dimensions of user-comfort and intelligent flow control. These features ensure extremely reliable, cost-effective and high-precision processes at an optimum price-performance ratio.

Reliable processes ✓
Unique user-friendliness ✓
Simple Plug’n’Play ✓

Designed to save costs and to protect the environment

In general, the investment for a dosing pump installation is low compared to its life cycle costs. Low operation costs and longer maintenance intervals combined with an extremely high dosing accuracy make SMART Digital the perfect partner for:

- Saving chemicals with high dosing accuracy and FlowControll
- Saving energy with latest drive technology and improved electronics
- Saving maintenance costs thanks to the universal chemical resistance of the full-PTFE diaphragm and Digital DosingTM
- Saving natural resources with new composite materials and sustainable production processes

Optimal cost control ✓
Environment-friendly ✓

Processes

SMART Digital can be used in a wide range of processes...

- Disinfection
- pH-adjustment
- Chemical dosing
- Cleaning-in-place
- Biocides
- Coagulation
- Precipitation/Flocculation
- Filtration
- Reverse osmosis

Application areas

... within a vast field of application areas:

- Ground water
- Surface water
- Drinking water
- Process water
- Recreational water
- Recycle & reuse

SMART Digital
The perfect system

Simplicity

Precise and easy setup. Intuitive user interface. Simple handling and perfect overview and control even from the distance – it's always easy to handle our SMART Digital!

- Intuitive and self-explanatory menu
- Click wheel (turn-and-push knob)
- Big graphical LCD with four colour "traffic light" concept
- More than 25 languages

Intelligent and intuitive handling saves time and cost – ensuring a seamless integration in all workflows ✓

Modularity

Requirements change, demands grow, and capacities vary – **SMART Digital fits into every environment and situation!**

- Turn-down ratio up to 1:3000 with a dosing spectrum of 0.0025 – 30 l per hour
- Click-stop mounting plate for quick and variable installation
- Control cube can be positioned in three ways (left, right, front)
- Using switch-mode power supply, the SMART Digital model DDA is independent from regional voltages

Highest performance in all operating conditions and a flexible concept you can always rely on ✓

MODULARITY
SIMPLICITY
FLOW INTELLIGENCE

SMART Digital
High performance is our standard

Flow Intelligence

Full control under all conditions. Highest process reliability – at any time with SMART Digital!

- FlowControl with selective fault diagnosis
- Pressure monitoring
- Flow measurement
- AutoFlowAdapt

Groundbreaking flow intelligence guarantees highest process reliability ✓

Digital Dosing™

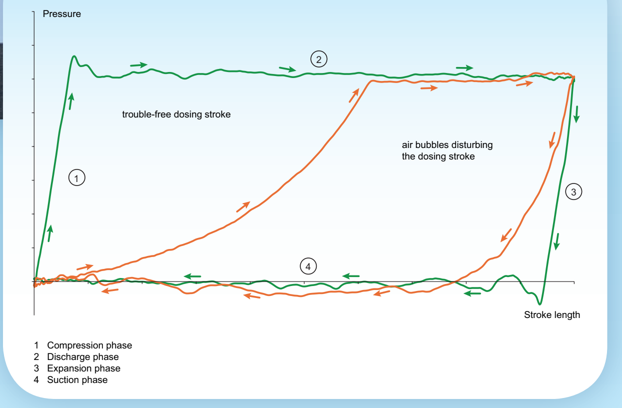
The SMART Digital generation DDA, DDC and DDE with powerful variable-speed stepper motors brings state-of-the-art technology to perfection.

Combined expert knowledge and the new patented solutions set future standards. Traditional technologies such as stroke length/stroke frequency adjustment with synchronous motor or solenoid drive become a thing of the past.

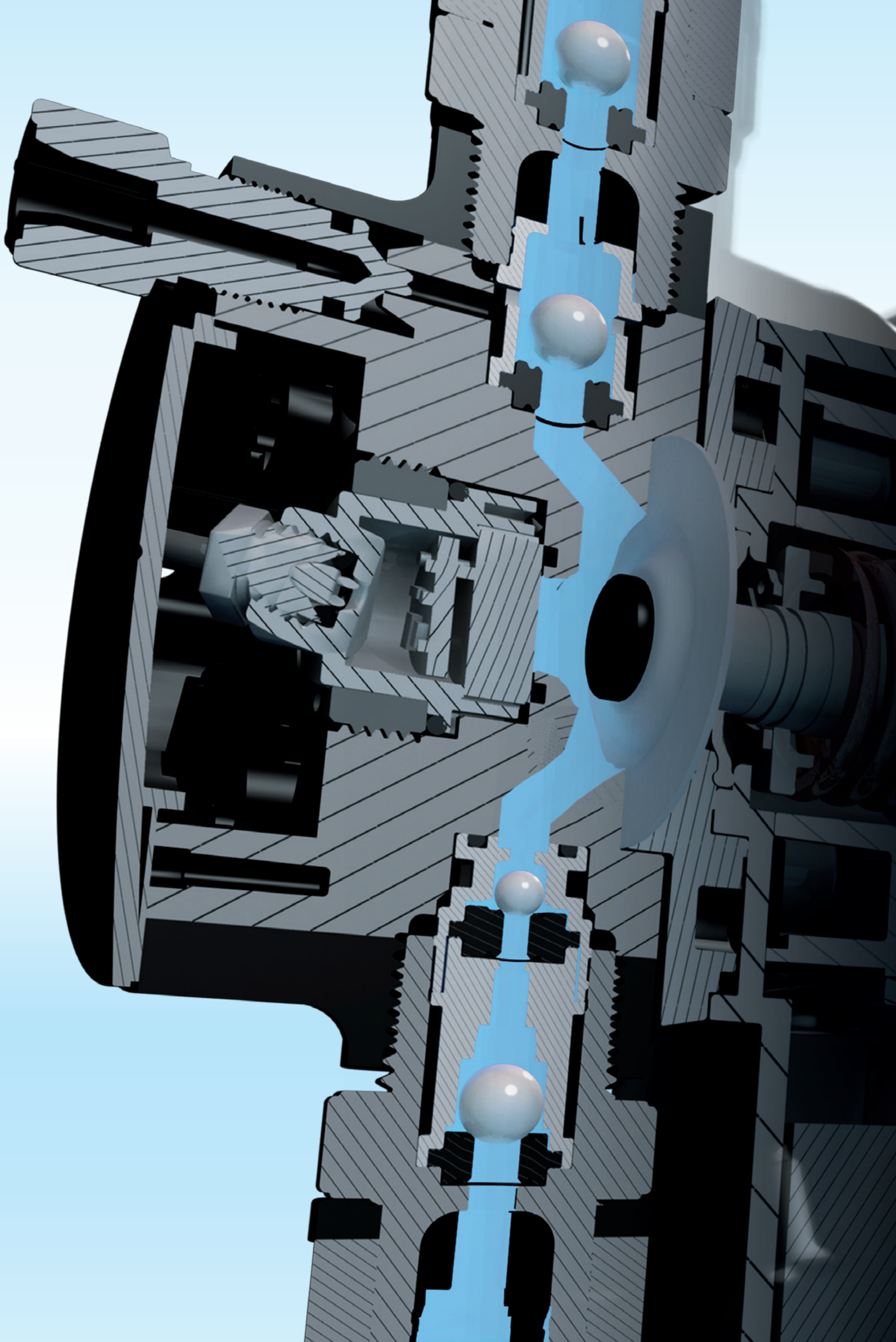
- Powerful variable-speed stepper motor
- Internal stroke speed control
- Turn-down ratio up to 1:3000
- Always full stroke length – even at small flow rates
- Smooth, continuous dosing
- Optimal for degassing liquids
- SlowMode function for high-viscosity liquids

New patented solutions set future standards ✓

Indicator Diagram



MODULARITY
SIMPLICITY
FLOW INTELLIGENCE



SMART Digital DDA, DDC, DDE

Perfect solutions for vast market segments

DDA

This high-end DDA pump range is designed for complex and demanding applications. Whether degassing liquids, flow rates down to 2.5 ml/h or advanced process control are required, this pump offers the perfect solution:

- Max. 30 l/h and 16 bar
- Turn-down ratio 1:3000 (7.5-16) or 1:1000
- FlowControl with selective fault diagnosis
- Integrated flow measurement
- AutoFlowAdapt
- Auto deaeration also during pump standby
- Batch modes (timer- or pulse-based)
- Optional E-box for Profibus DP integration

Please see next page for further details.

DDC

The DDC pump range is the optimum solution for common applications. The easy-to-use interface with the click wheel makes the setup and operation as easy as your car radio system:

- Max. 15 l/h and 10 bar
- Turn-down ratio 1:1000
- Graphical LC display backlit in different colours
- More than 25 languages
- Standard operation modes, e.g. pulse and analog
- SlowMode for high viscosity liquids
- 2 integrated relay outputs

Please see next page for further details.

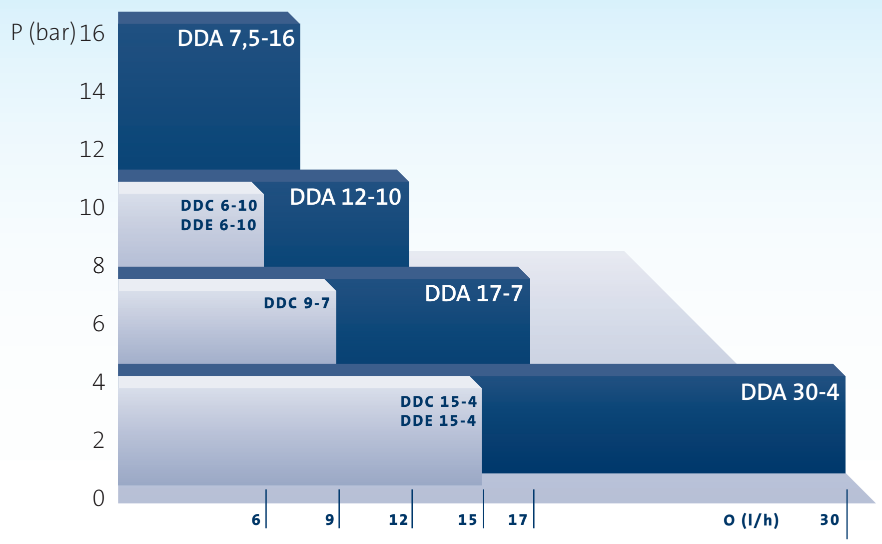
DDE

The DDE offers Digital Dosing with basic functions even for a low budget for easier applications. Now just 2 pump models cover a range where 12 or more were needed in the past:

- Max. 15 l/h and 10 bar
- Turn-down ratio 1:1000
- Smooth continuous dosing
- Always 100 % suction stroke
- Capacity setting 0.1-100 %
- Simple pulse operation mode
- External stop and empty tank alarm

Please see next page for further details.

Performance range



Overview of functions

Control variant:	DDA FCM	DDA FC	DDA AR	DDC AR	DDC A	DDE PR	DDE P	DDE B
General								
Digital Dosing: Internal stroke speed and frequency control	●	●	●	●	●	●	●	●
Mounting plate (basic / wall mounting)	●	●	●	●	●	●	●	●
Supply voltage 100-240 V, 50-60 Hz	●	●	●	●	●	●	●	●
Enclosure class IP 65, Nema 4X	●	●	●	●	●	●	●	●
Control panel								
Control cube mountable in three positions: front, left, right	●	●	●	●	●			
Control panel position: front-fitted						●	●	●
Transparent protective cover for control elements	●	●	●	●	●			
Capacity setting in millilitres, litres or US-gallons	●	●	●	●	●			
Graphical display with background light in four colours for status indication: white, green, yellow, red	●	●	●	●	●			
Plain-text menu in different languages	●	●	●	●	●			
Turn-and-push knob (click wheel) for easy navigation	●	●	●	●	●			
Capacity adjustment knob (0.1 - 100 %)						●	●	●
Start / Stop key	●	●	●	●	●			
100 % key (deaearation)	●	●	●	●	●	●	●	
Operation mode switch (manual / pulse)						●	●	
Operation modes								
Manual speed control	●	●	●	●	●	●	●	●
Pulse control in ml/pulse	●	●	●	●	●			
Pulse control (1:n)						●	●	
Analog control 0/4-20 mA	●	●	●	●				
Batch control (pulse-based)	●	●	●					
Dosing timer cycle	●	●	●					
Dosing timer week	●	●	●					
Fieldbus control	●	●	●					
Functions								
Auto deaeration also during pump standby	●	●	●					
FlowControl system with selective fault diagnosis	●	●						
Pressure monitoring (min / max)	●	●						
Flow measurement	●							
AutoFlowAdapt	●							
SlowMode (anti-cavitation)	●	●	●	●	●			
Calibration mode	●	●	●	●	●			
Scaling of analog input	●	●	●					
Service information display	●	●	●	●	●			
Relay setting: alarm, warning, stroke signal, pump dosing	●	●	●	●		●		
Relay setting (additionally): timer cycle, timer week	●	●	●					
Inputs/outputs								
Input for external stop	●	●	●	●	●	●	●	
Input for pulse control	●	●	●	●	●	●	●	
Input for analog 0/4-20 mA control	●	●	●	●				
Input for low-level signal	●	●	●	●	●	●	●	
Input for empty tank signal	●	●	●	●	●	●	●	
Output relay (2 relays)	●	●	●	●		●		
Output analog 0/4-20 mA	●	●	●					
Input / Output for GeniBus	●	●	●					
Input / Output for E-box (Profibus DP or additional alarm relays)	●	●	●					

SMART Digital
Accessories and Service

E-Box Profibus DP

With the additional E-Box module, the pump can be easily integrated in a Profibus DP network. This enables remote monitoring and setting via the fieldbus system. Just click the E-box in between the DDA pump and the mounting plate. With the plug and play solution, DDA pumps can also be easily retrofitted.

General pump accessories

A wide range of accessories is available for the SMART DIGITAL pump range, among others:

- Installation kit including foot valve, injection unit and hose
- Multi-function valve (PVDF)
- Rigid suction lance (PE, PVDF) with low level and empty tank signal
- Foot valve for flexible suction line (PE, PVDF, stainless steel)
- Injection unit (PP, PVC, PVDF, stainless steel) in different designs
- Hose in PVC, PE, ETFE in different sizes
- Signal cables for all inputs and outputs
- Dosing tanks in different sizes

All components have been especially designed for and adjusted to the new SMART Digital pumps.

Only original SMART accessories can guarantee optimum dosing results.

Service

The following service kits are obtainable (for PP, PVC, PVDF and stainless steel):

- Complete dosing head kit
- Valves and diaphragm kit
- Valve kit
- Diaphragm kit

Please see service catalogue for further service kits and details.

SMART Digital pumps have outstandingly long maintenance intervals.

Wear and tear parts which have been in contact with the media only have to be replaced after 8000 operating hours (or after two years at the latest).

Shorter intervals might be necessary for highly-abrasive media.

Our new SMART Digital pump family can be flexibly installed in various positions due to its modular construction. With its user-friendly display and menu-structure, the pump is easy to operate. The integrated flow intelligence assures safe and continuous processes, making it an absolutely reliable pump.

On top of that, you save TIME and MONEY when opting for SMART Digital.

You save TIME:

- Easy commissioning and service due to the click-stop mounting plate
- Self-explanatory user-interface, comparable to a car-radio system
- Plain-text display for failure indication: no need
- for time-consuming fault analysis
- Quick commissioning without reading the I/O
- Easy process control thanks to the intelligent flow management functions

You save MONEY:

- No additional installation parts needed due to the click-stop mounting plate
- High accuracy saves chemicals
- The required target flow is always achieved due to the AutoFlowAdapt, FlowControl and flow measurement functions; additional monitoring and control devices are made redundant
- Intelligent flow management prevents expensive process breakdowns

95726831/0812

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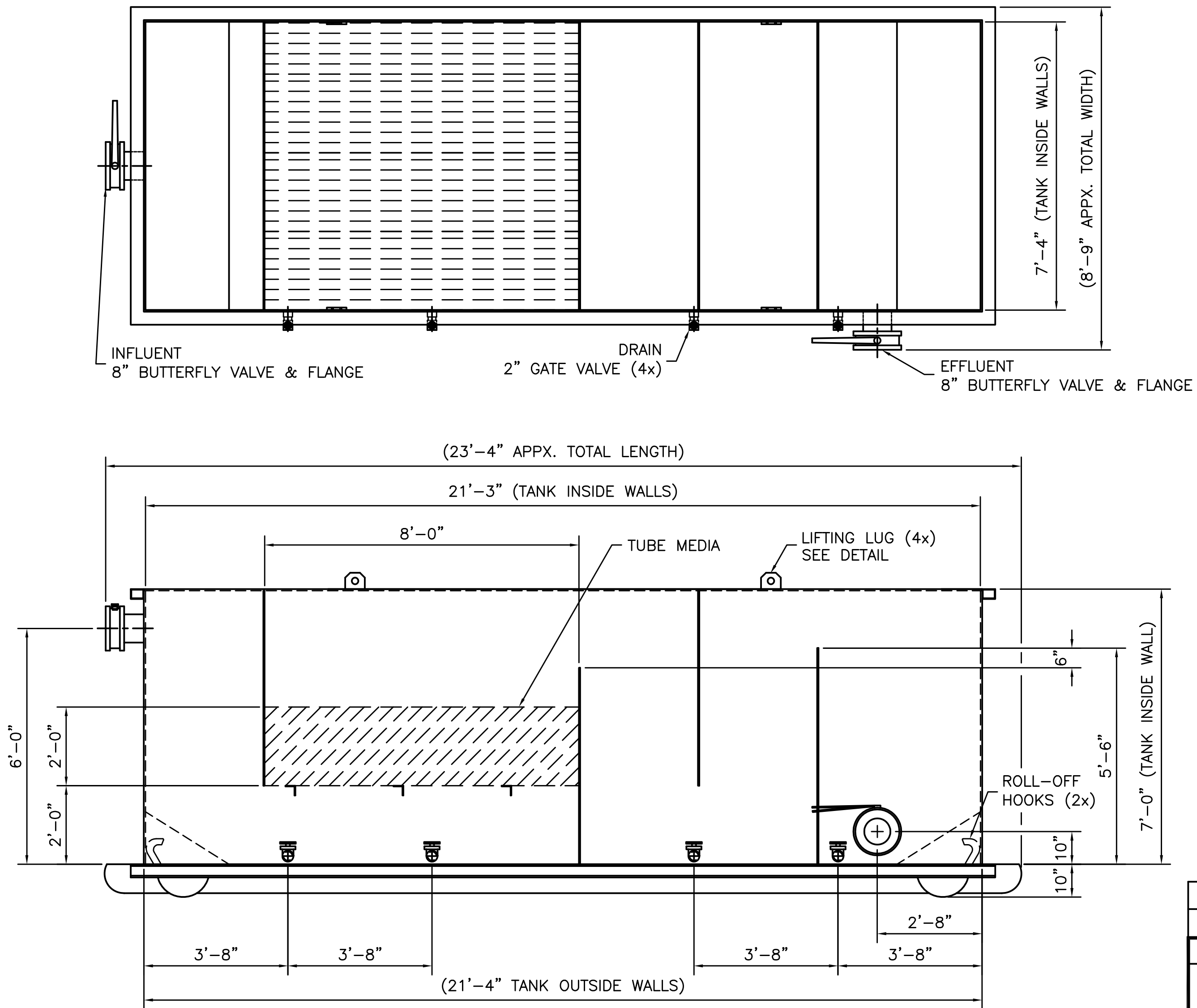
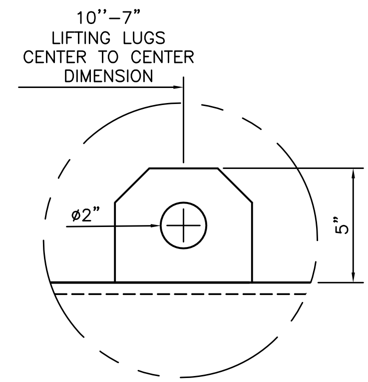
Attachment 4

Clarifier Equipment Specification





LIFTING LUG
DETAIL (TYP.)

40 YARD ROLL-OFF SETTLING TANK SPECIFICATIONS

- NOMINAL VOLUME: 8,000 GALLONS
- OPERATING VOLUME: 6,250 GALLONS
- DESIGN FLOW RATE: 300 GPM
- TANK CONSTRUCTION: A-36 CARBON STEEL
- INLET CONNECTION: 8" FLANGE
- OUTLET CONNECTION: 8" FLANGE
- DRAINS (4x): 2" GATE VALVES
- APPX. TANK WEIGHT (EMPTY): 20,000 Lbs.
- APPX. TANK WEIGHT (OPERATING): 75,000 Lbs.
- TUBE SETTLERS: ACCU-PAC IFR-6024

NO.	REVISIONS	DATE
A	TYPICAL	02/24/09

40 YARD ROLL-OFF SETTLING/CLARIFIER STANDARD EQUIPMENT SPECIFICATION

SCALE: NTS	APPROVED BY: JB	DRAWN BY: AAV
DATE: 02/24/09		

GROUND/WATER TREATMENT & TECHNOLOGY
P.O. BOX 1174
DENVILLE, NJ 07834

DWG SIZE: A	SHEET: 1 OF 1	DRAWING NUMBER: ST-0067-SPC	A

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Attachment 5

Hydraulic Analysis

Sand Filter Addition – Differential Pressure Model Outputs

The following is a presentation of a differential pressure model of the groundwater treatment system (GWTS) located at Kirtland Air Force Base, New Mexico. The model assumes a flow rate on 400 gallons per minute (gpm) on each individual treatment train. Each individual treatment train are modelled individually and are assumed to be of the same piping make up (lengths of pipe, number of valves, etc.). Table 1 shows the model outputs for an individual treatment train's head loss due to piping and equipment. Equipment refers to the flow meter, sand filter(s), bag filter(s), and granular activated carbon (GAC) vessels. The following is a list of important assumptions:

1. The model assumes that 200 gpm will pass through the parallel sand filters and bag filters uniformly.
2. All piping is assumed to be carrying 400 gpm and the separated sections of 200 gpm pipe are modeled as containing 400 gpm flow (yielding a more conservative estimate) except for the piping in the pump skid branch. The pump skid branch (branch 2) was modeled assuming a flowrate of 200 gpm as this branch does not contain large sections of 400 gpm piping but does contain reducers and enlargers that are largely influenced by flowrate. See Table 1 for the corresponding difference between the 400 and 200 gpm models.

Table 1. Head Loss Totals

	Piping Head Loss at 400 gpm from Influent to Effluent Tanks and 200 gpm from Influent to Clarifier[a] (psi)	Influent Skid Head Loss at 200 gpm from Influent to Effluent Tanks and 100 gpm from Influent to Clarifier[b] (psi)	Equipment Head Loss[c] (psi)	Total Head Loss[d] (psi)	Total Head Loss (ft)
Influent Tank to Effluent Tank	13.5	1.78	37	62.74	144.71
Influent Tank to Clarifier	4.7	0.45	20	30.18	69.61

[a] Piping head loss differs from the model calculations in that the model includes a 3" to 2" nominal reducer (accounting for 10.495 psid at 400 gpm) in branch 2 which is actually incorporated in the pump. Thus the reducer is included in the pump efficiency and has been removed from the piping head loss pressure shown above.

[b] Along the influent skid there is a section where the flow diverges into two separate flows of 200 gpm when the train is operating at a 400 gpm total and 100gpm at a 200 gpm total. The difference in headloss between the 400/200 and 200/100 gpm models are provided above and used to calculate total head loss.

[c] Assumes differential pressure at 400 gpm for the Sand Filter is 10 psi, Bag filter is 15 psi, flow meter is 2 psi, and GAC vessels are 10 psi (totaled for both vessels). When operating in sand filter backwash at 200 gpm, the sand filters account for a total of 20 psi (10 psi each).

[d] Total head loss includes additional 20% safety factor. " = inch(es)

% = percent ft = foot/feet

gpm = gallons per minute

psi = pounds per square inch

Attachment 6

Pump Selection

Model: 3196	Size: 2X3-6	Group: 3196STI 60Hz	RPM: 3500	Stages: 1

Job/Inq.No. :
Purchaser : Kirtland AFB BFF
End User:
Issued by :
Item/Equip.No. : ITEM 001
Quotation No. : FEED PUMPS W/SAND FILTER
Date : 10/29/2016
Service :
Order No. :
Rev. : 0

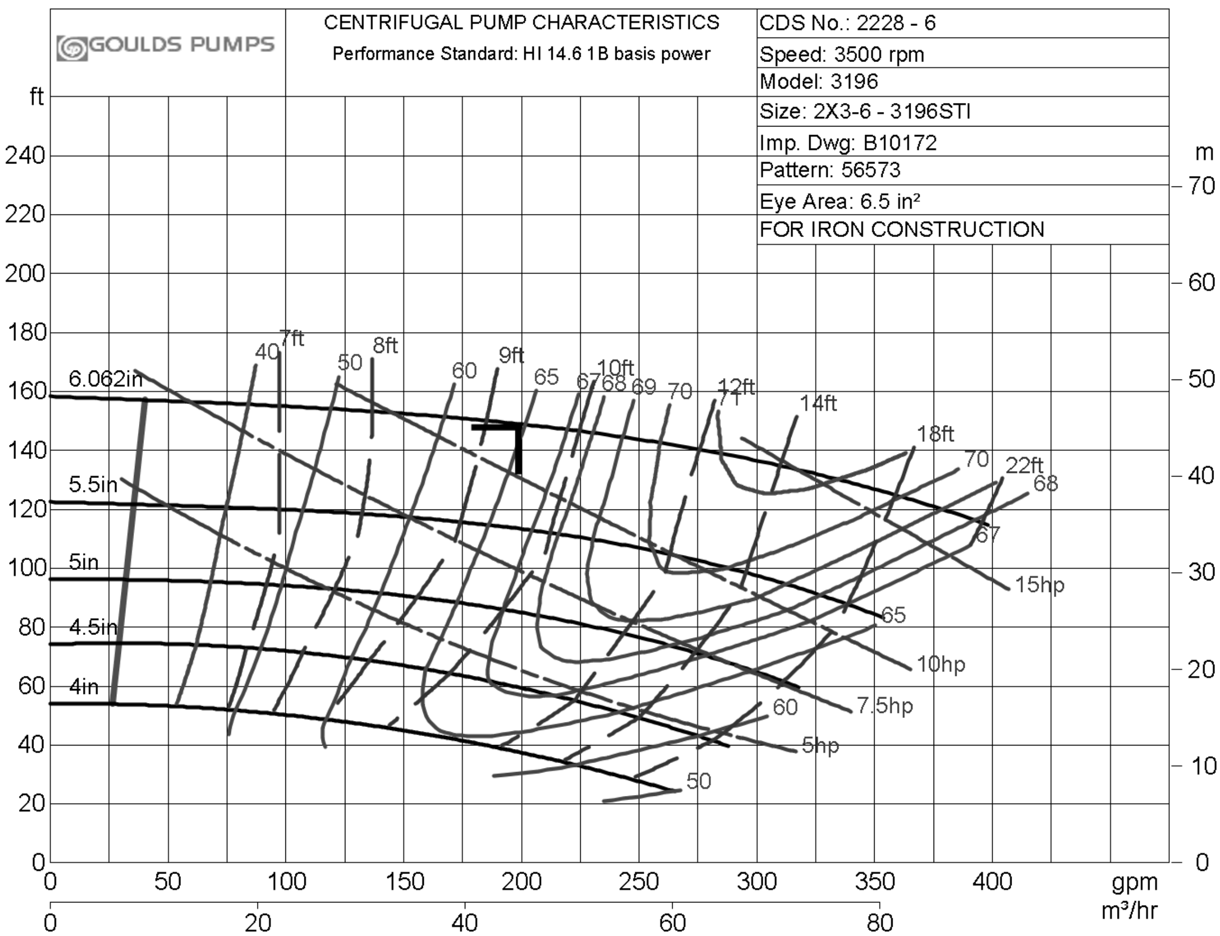
Operating Conditions

Liquid:	Water
Temp.:	70.0 deg F
S.G./Visc.:	1.000/1.000 cp
Flow:	200.0 gpm
TDH:	135.0 ft
NPSHa:	
Solid size:	
% Susp. Solids (by wtg):	

Pump Performance

Published Efficiency:	64.5 %	Suction Specific Speed:	8,473 gpm(US) ft
Rated Pump Efficiency:	64.5 %	Min. Hydraulic Flow:	40.0 gpm
Rated Total Power:	11.7 hp	Min. Thermal Flow:	N/A
Non-Overloading Power:	17.0 hp		
Imp. Dia. First 1 Stg(s):	6.0620 in		
NPSHr:	9.5 ft		
Shut off Head:	158.3 ft		
Vapor Press:		Max. Solids Size:	0.3750 in

Notes: 1.The Mechanical seal increased drag effect on power and efficiency is not included, unless the correction is shown in the appropriate field above. 2. Magnetic drive eddy current and viscous effect on power and efficiency is not included. 3. Elevated temperature effects on performance are not included. 4. Non Overloading power does not reflect v-belt/gear losses.



Model: 3196	Size: 2X3-6	Group: 3196STI 60Hz	RPM: 3500	Stages: 1

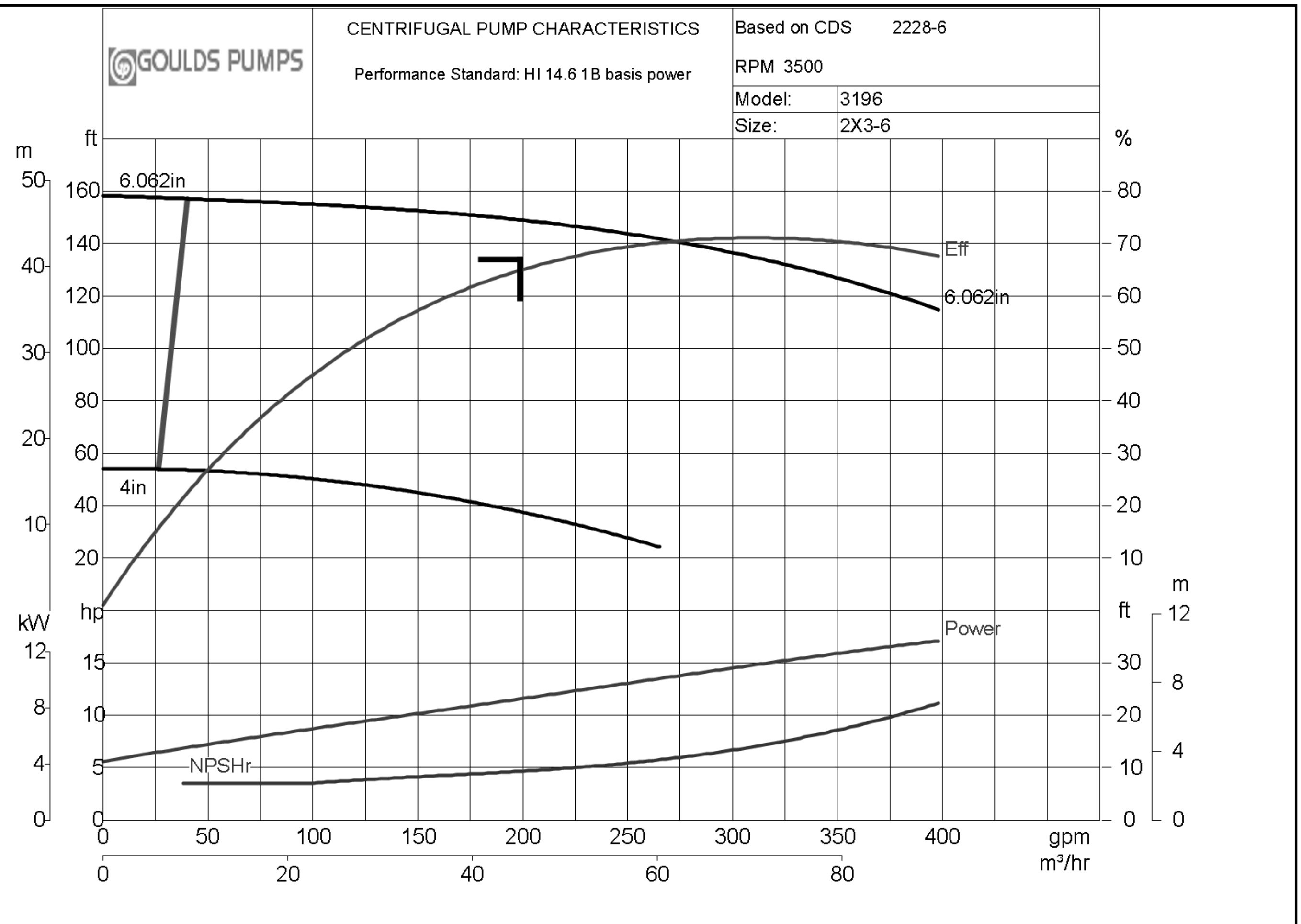
Job/Inq.No. :					
Purchaser :	Kirtland AFB BFF				
End User :		Issued by :		Rev. :	0
Item/Equip.No. :	ITEM 001	Quotation No. :	FEED PUMPS W/SAND FILTER	Date :	10/29/2016
Service :					
Order No. :					

Operating Conditions / **Pump Performance**

Liquid:	Water	Published Efficiency:	64.5 %	Suction Specific Speed:	8,473 gpm(US) ft
Temp.:	70.0 deg F	Rated Pump Efficiency:	64.5 %	Min. Hydraulic Flow:	40.0 gpm
S.G./Visc.:	1.000/1.000 cp	Rated Total Power:	11.7 hp	Min. Thermal Flow:	N/A
Flow:	200.0 gpm	Non-Overloading Power:	17.0 hp		
TDH:	135.0 ft	Imp. Dia. First 1 Stg(s):	6.0620 in		
NPSHa:		NPSHr:	9.5 ft	Shut off Head:	158.3 ft
Solid size:		Max. Solids Size:	0.3750 in	% Susp. Solids (by wtg):	

Vapor Press:

Notes: 1. The Mechanical seal increased drag effect on power and efficiency is not included, unless the correction is shown in the appropriate field above. 2. Magnetic drive eddy current on power and efficiency is not included. 3. Elevated temperature effects on performance are not included. 4. Non Overloading power does not reflect v-belt/gear losses.



Viscosity corrections have been performed in accordance with HI 9.6.7-2015

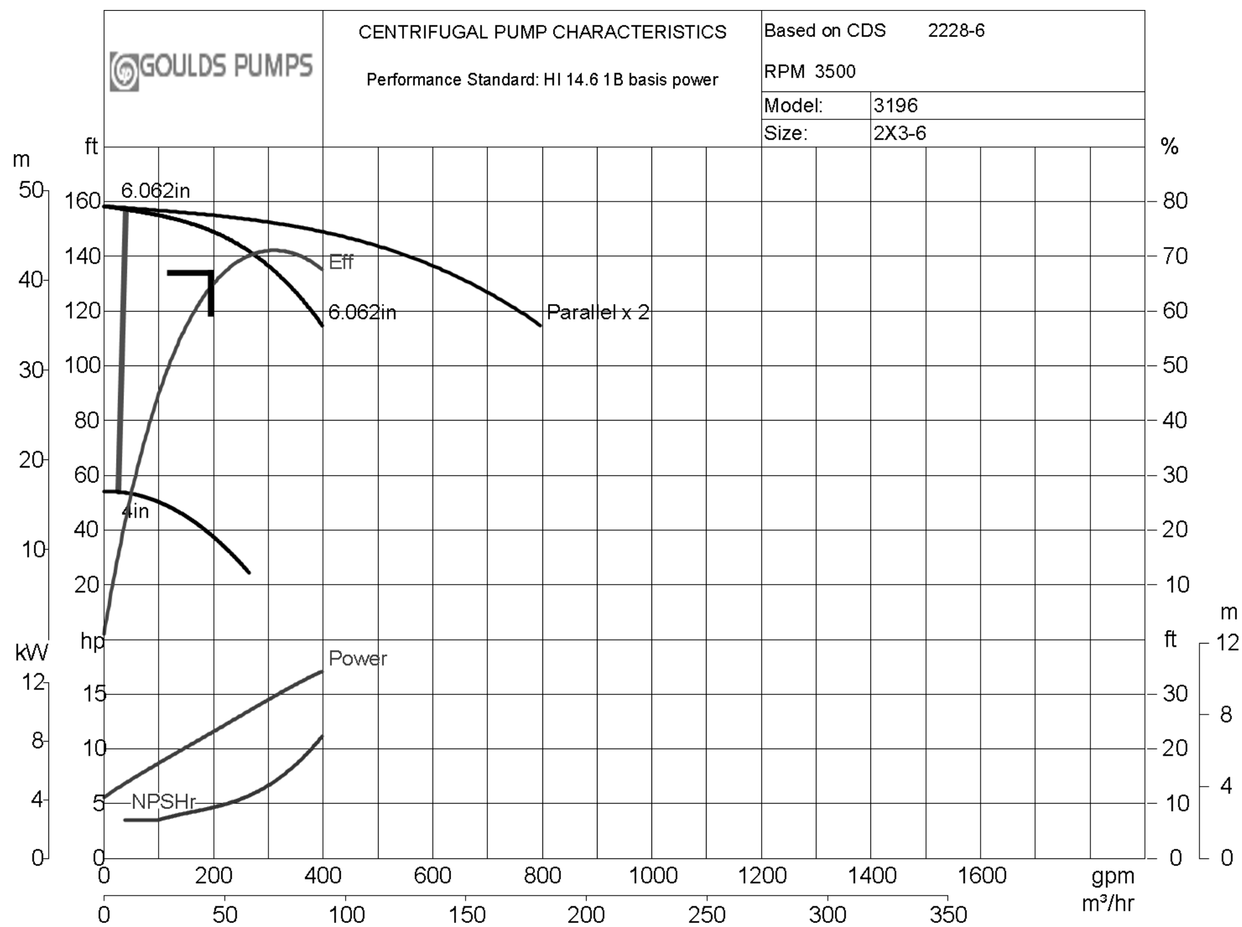
Model: 3196	Size: 2X3-6	Group: 3196STI 60Hz	RPM Variable	Stages: 1

Job/Inq.No. :
Purchaser : Kirtland AFB BFF
End User :
Item/Equip.No. : ITEM 001
Service :
Order No. :

Issued by :
Quotation No. : FEED PUMPS W/SAND FILTER
Date : 10/29/2016
Rev. : 0

Operating Conditions		**Pump Performance @ 3500 RPM**			
Liquid:	Water	Published Efficiency:	64.5 %	Suction Specific Speed:	8,473 gpm(US) ft
Temp.:	70.0 deg F	Rated Pump Efficiency:	64.5 %	Min. Hydraulic Flow:	40.0 gpm
S.G./Visc.:	1.000/1.000 cp	Rated Total Power:	11.7 hp	Min. Thermal Flow:	N/A
Flow:	200.0 gpm	Non-Overloading Power:	17.0 hp		
TDH:	135.0 ft	Imp. Dia. First 1 Stg(s):	6.0620 in		
NPSHa:		NPSHr:	9.5 ft		
Solid size:		Shut off Head:	158.3 ft		
% Susp. Solids (by wtg):		Vapor Press:			
Max. Solids Size:	0.3750 in				

Notes: 1. The Mechanical seal increased drag effect on power and efficiency is not included, unless the correction is shown in the appropriate field above. 2. Magnetic drive eddy current on power and efficiency is not included. 3. Elevated temperature effects on performance are not included. 4. Non Overloading power does not reflect v-belt/gear losses.



ITT

Model: 3196	Size: 2X3-6	Group: 3196STI 60Hz	RPM Variable	Stages: 1

Job/Inq.No. :
Purchaser : Kirtland AFB BFF
End User :
Item/Equip.No. : ITEM 001
Service :
Order No. :

Issued by :
Quotation No. : FEED PUMPS W/SAND FILTER
Date : 10/29/2016
Rev. : 0

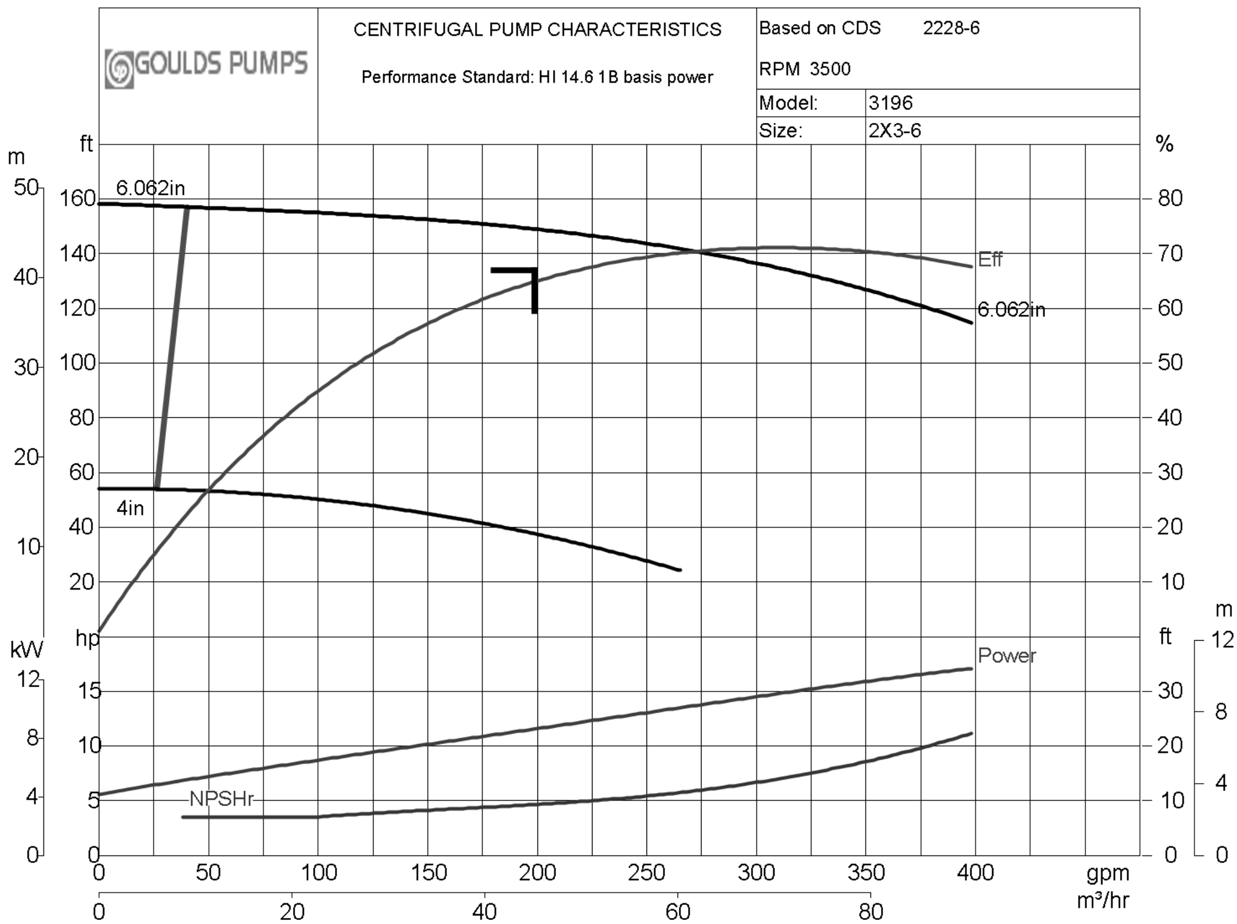
Operating Conditions

Liquid:	Water
Temp.:	70.0 deg F
S.G./Visc.:	1.000/1.000 cp
Flow:	200.0 gpm
TDH:	135.0 ft
NPSHa:	
Solid size:	
% Susp. Solids (by wtg):	
Max. Solids Size:	0.3750 in

Pump Performance @ 3500 RPM

Published Efficiency:	64.5 %
Rated Pump Efficiency:	64.5 %
Rated Total Power:	11.7 hp
Non-Overloading Power:	17.0 hp
Imp. Dia. First 1 Stg(s):	6.0620 in
NPSHr:	9.5 ft
Shut off Head:	158.3 ft
Vapor Press:	
Suction Specific Speed:	8,473 gpm(US) ft
Min. Hydraulic Flow:	40.0 gpm
Min. Thermal Flow:	N/A

Notes: 1. The Mechanical seal increased drag effect on power and efficiency is not included, unless the correction is shown in the appropriate field above. 2. Magnetic drive eddy current and viscous effect on power and efficiency is not included. 3. Elevated temperature effects on performance are not included. 4. Non Overloading power does not reflect v-belt/gear losses.



ATTACHMENT 2

TIGG MAXIMUM LOADING CONCENTRATIONS AT 400 GALLONS PER MINUTE

From:	John Mickler
To:	Jim Kearns; Jercinovic, Devon
Cc:	Nicholas Kelly
Subject:	RE: Kirtland BFF - GAC Lifetime Analysis w/ Update Concentrations
Date:	Friday, April 14, 2017 6:06:26 AM

Devon, EA is granted permission to provide this information to NMED in support of the TIGG equipment and carbons for this application.

Let us know if you need any other help.

John M. Mickler P.E., PMP
Vice President and General Manager

TIGG, LLC
1 Willow Avenue
Oakdale, PA 15071
Office: 724-703-3020 x106
Mobile: 412-370-5833
jmickler@tigg.com

1 Willow Avenue
Oakdale, PA 15071
p. 724-703-3020
f. 724-703-3026

Title: Kirtland AFB 4/13/17

Report Basis

Flow Rate	400 GPM
Water pH	7
Water Temperature	65 °F

Component	Inlet Concentration
ethylene dibromide	20.000 ppb
benzene	450.000 ppb
ethyl benzene	102.000 ppb
toluene	212.000 ppb
xylene	110.000 ppb

Report: 114.31 lbs. activated carbon per day saturated at conditions

Average Loading at Saturation 4.024 lbs./100 lbs. Carbon

Note: Contact TIGG Corporation if comments are needed on preferential adsorption of contaminants above.

1 Willow Avenue
Oakdale, PA 15071
p. 724-703-3020
f. 724-703-3026

Title: Kirtland AFB 4/13/17

Report Basis

Flow Rate	400 GPM
Water pH	7
Water Temperature	65 °F

Component	Inlet Concentration
ethylene dibromide	10.000 ppb
benzene	225.000 ppb
ethyl benzene	51.000 ppb
toluene	106.000 ppb
xylene	55.000 ppb

Report: 43.64 lbs. activated carbon per day saturated at conditions

Average Loading at Saturation 3.245 lbs./100 lbs. Carbon

Note: Contact TIGG Corporation if comments are needed on preferential adsorption of contaminants above.