Chain and Scraper Rectangular Clarifiers

Design and Component Details

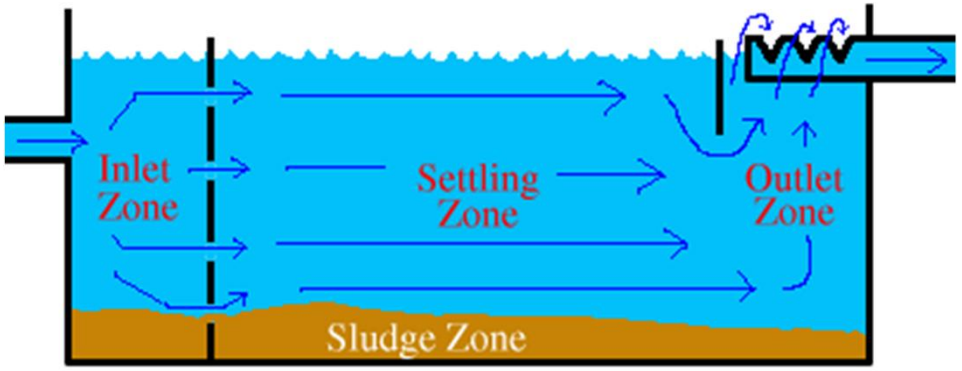
TRANSFORMING WATER. ENRICHING LIFE.

Introduction - Agenda

- Clarifier Basics
- Circular vs Rectangular
- History
- Application, Designs & Sizing
- Component Details

Clarifier Basics

- Develop quiescent conditions in tank
- Allow settleable solids to separate from liquid (Stokes Law)
  - Solids Settle = Sludge
  - Solids Float = Scum
- Continuous mechanism required to convey sludge away for removal



YouTube Graphic

Clarifier Basics – Primary Clarifiers (Municipal Wastewater)

Hydraulic Settling

- § Removes Settleable Solids (90-95%)
- § Removes TSS (~40-55%)
- § BOD_5 removal (~25-50%)
- § Suggested loading rate = 750-1200 gpd/ft^2 [1.27- 2.04 m/hr] for typical municipal wastewater at average design flow.

Sludge Loadings/Concentration

- § Typically 3-5% solids

Clarifier Basics – Secondary Clarifiers (Activated Sludge)

Hydraulic Settling

§ Remove suspended solids generated during biological treatment.

§ Suggested loading rate = 500-800 gpd/ft^2 [0.60-1.10 m/hr]

§ Up to 85-90% removal of suspended solids in secondary tanks

Sludge Loadings/Concentration

§ Typically 1-1.5% Settled Sludge Concentration after the activated sludge process

Circular vs Rectangular

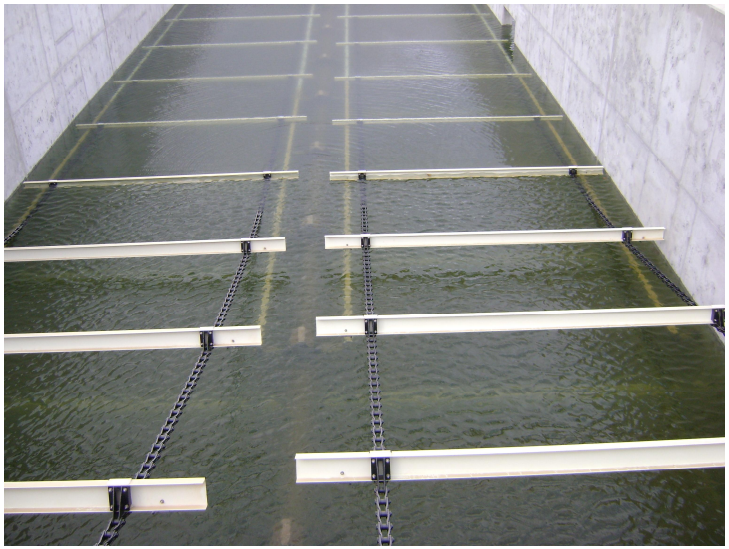
Circular Clarifiers

- Tangential arrangement
- Less sensitive to surge flows
- Lower operation and maintenance costs
- Engineer’s preference (typically)

Circular vs Rectangular

Rectangular Clarifiers

- Common wall construction
- Occupy less space when multiple units used
- Provide longer travel distance for settling to occur
- Less short circuiting
- Better skimming



History

Envirex®

USFilter

SIEMENS

EVOQUA
WATER TECHNOLOGIES

- Original equipment by Chain Belt Co. of Milwaukee in 1890s
- Chain Belt became Rex Chain Belt
  - First chain & scraper installation in 1929
- Name changed to Rexnord
- 1973 - Envirex Products environmental products division of Rexnord moved to Waukesha, Wisconsin
- Envirex acquired by USFilter
- USFilter acquired by Vivendi/Veolia
- Acquired by Siemens
- 2014 Siemens divested water group and purchased by AEA Investors, renamed Evoqua

History continued

- Longest history & most experience
- Over 10,000 mechanisms installed in more than 1,000 sites around the globe
- Broader catalog of components, capabilities and applications than any other manufacturer
- Track record and capabilities to manage large projects

History continued

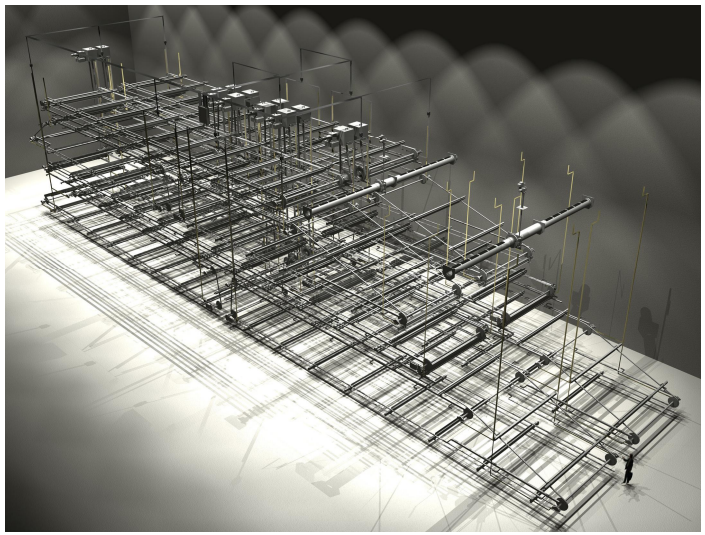
FMC Envirex®

EVOQUA WATER TECHNOLOGIES

1929	*- Industry's first chain and flight sludge collector (Rex)*
1976	*- Industry's first non-metallic chain and flight sludge collector*
1976	*- Sigma Flight*
1980	*- Polyurethane Sprockets*
1981	*- Split Sleeve Bearing*
1985	*- Sigma+ Flight*
1986	*- Rex Loop Chain*
1990	*- Flight Monitoring System*
1992	*- Brush cleaning system for rectangular stacked sedimentation basins*
1993	*- Kevlar® coated stainless steel pin for Rex Loop Chain*
1995	*- Polyurethane ball for bearings*
1996	*- C-rail wear strip*
1996	*- J-Track return system*
1997	*- Stainless Steel J-Track system*
1997	*- Molded UHMW Wear Shoes*
1998	*- Diamond Flight*
2001	*- Press Lock™ Chain*
2012	*- One-piece Fiberglass Headshaft*

Capabilities & Experience – Large Project & Stacked Clarifiers

★ Boston, Massachusetts – Deer Island	*412 mechanisms*
Philadelphia, Pennsylvania – DELCORA	*172 mechanisms*
Detroit, Michigan	*72 mechanisms*
Denver, Colorado	*62 mechanisms*
Phoenix, Arizona	*102 mechanisms*
San Francisco, California	*48 mechanisms*
Los Angeles, California – Hyperion	*48 mechanisms*
Rio de Janiero, Brazil – Guandu	*24 mechanisms*
Chung Chun, China	*36 mechanisms*
Chung Chao, China	*60 mechanisms*
★ Selectar, Singapore	*68 mechanisms*
★ Ulu Pandan, Singapore	*32 mechanisms*
★ Changi, Singapore	*262 mechanisms*
Higasinada, Japan	*96 mechanisms*
Pa-Lee, Taiwan	*64 mechanisms*
★ Hong Kong – Stonecutters Island	*36 mechanisms*
★ Cleveland, Ohio – Nottingham WTP	*28 mechanisms*

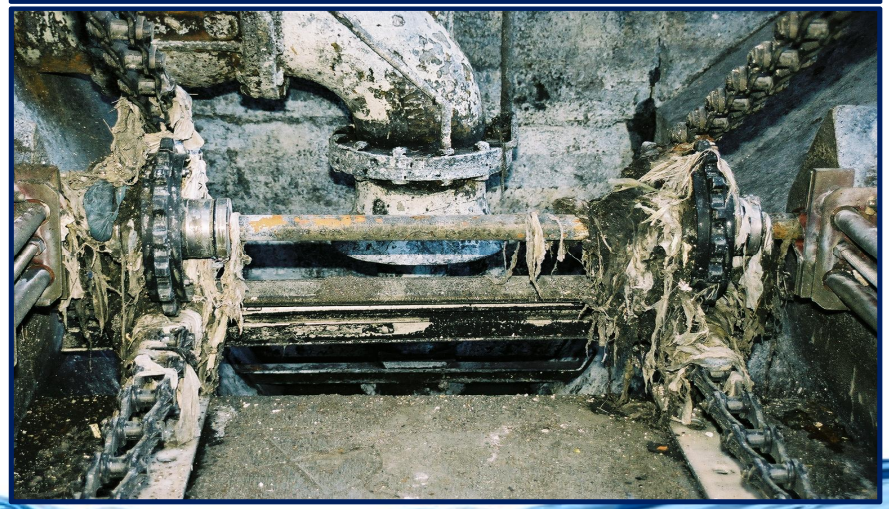


★ Stacked Clarifier Project

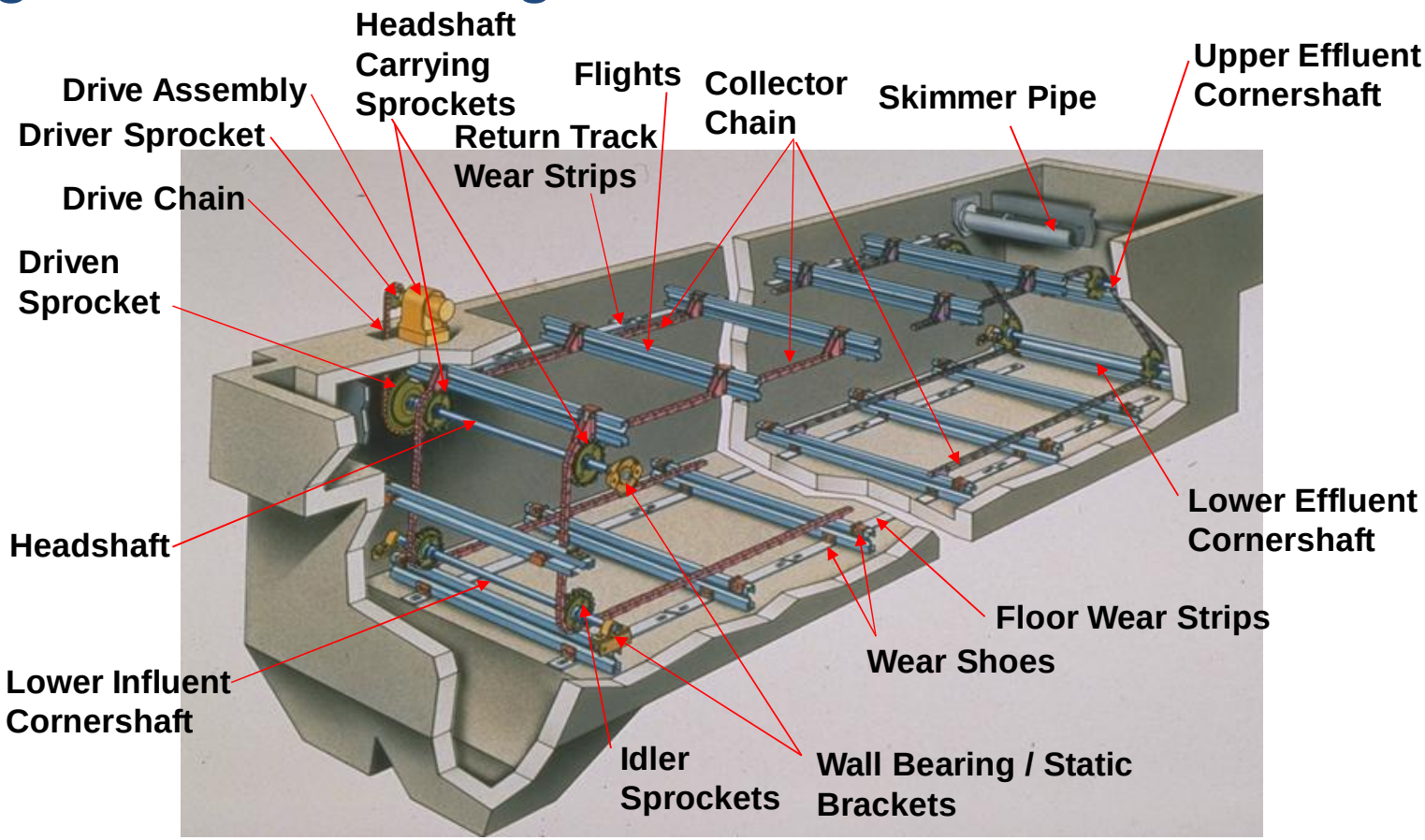
How is Equipment Sized?

- Type of application
  - Primary, Secondary, Water Treatment
- Tank Dimensions
- Mechanism calculations and loads
- - Determines component selection
- - Shaft sizing
- - Drive torque requirements

Unforeseen Loadings…



Rectangular 4-shaft Sludge Collector



Design Program Input Sheet

Input

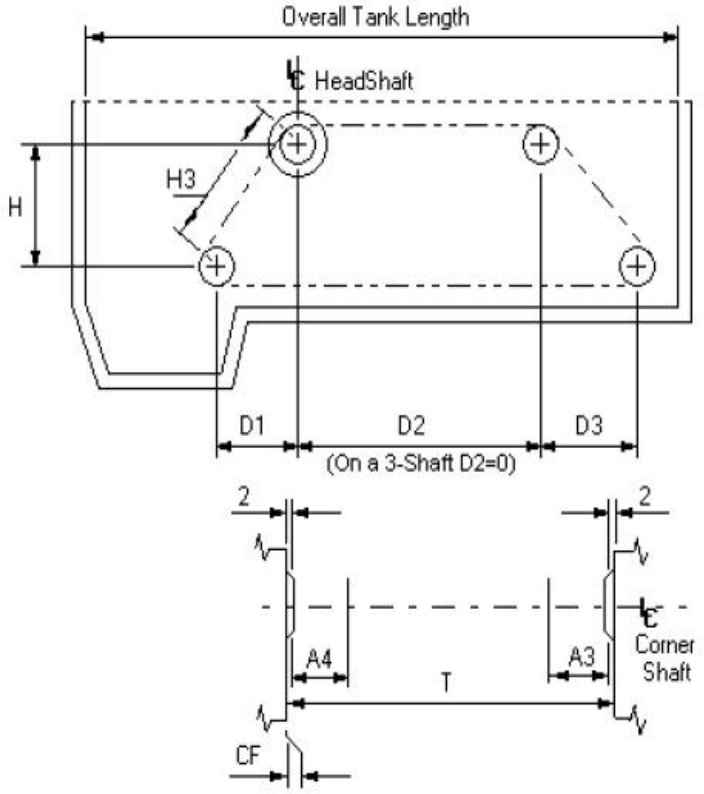
Project Name: 2033/000772.P.01
Location: Detroit, MI Long Coll. 1-8
User: CC
Date: 10/24/16

Collector Dimensions

D1 =	-1	H1 =	190
D2 =	2977	A1 =	25.5
D3 =	134.5	A2 =	27.5
H =	136.125	A3 =	25.5
T =	192	A4 =	25.5

Flight Information

CF - Corner Fill =	6
Z - Counterweight =	0
S2 - Flight Spacing =	10
S4 - Flight Speed =	2



Design Program Input Sheet Cont.

Collector Chain type

Shoe / Wear strip coefficient

Flight Size

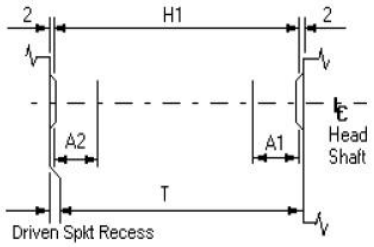
Sludge loading

Collector Chain Information

Collector Chain =	HS730
Cornershaft Sprocket - No Teeth =	23
Shoes / Wear Strip =	Poly/Steel
Design Criteria =	Standard

Drive Chain Information

Drive Chain =	HB78
Headshaft Sprocket - No Teeth =	12
Flight Type =	3 x 8 Fiberglass
Average Sludge Load Along Flight =	4.5



Allowable Deflection =	1/360	Span
Headshaft Stress =	12500	psi
Other Shaft Stress =	24000	psi
KM =	1.5	
KT =	1	

Sprocket Information

Driven Sprocket Material:	Polymeric	Collector Sprocket Material:	Polymeric

Design Program Output

Shaft diameters

Total collector chain pull

Drive chain pull

Torque at reducer output shaft

Date: 10/24/16

Wet Tank Output

Shaft Selection

Shaft	Selected Diameter	Allowed Deflection	Actual Deflection	Actual Stress
Headshaft	3.9375	0.528	0.500	6170
Take Up	3.9375	0.522	0.205	4757
Effluent Corner	3.9375	0.522	0.197	4727
Influent Corner	3.9375	0.522	0.427	8509

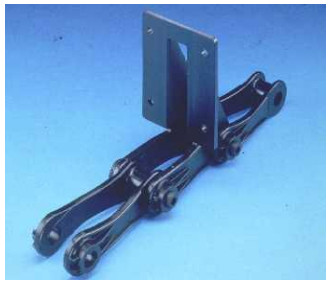
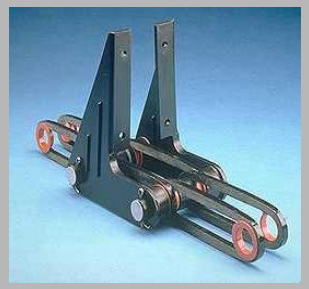
Bottom Sprocket Center Distance =	259.2	ft	
Top Sprocket Center Distance =	248.1	ft	
Tank Width =	16.000	ft	
Height of Collector =	11.344	ft	
The Flight Assembly Weight/Foot =	1.75	lbs / ft	
The Chain Assembly Weight/Foot =	1.78	lbs / ft	
Flight Speed =	2.0	fpm	
Flight Spacing =	10.00	ft	
Average Sludge Load/Foot of Flight =	4.5	lbs / ft	
Sliding Friction (Wear Shoes on Track) =	0.248		
Bearing Friction (at corners) =	0.050		
The Pretension In The Catenary =	190.681	lbs	
Allowable HeadShaft Stress (Shear) =	12500	psi	
Allowable Stress In Other Shafts =	24000	psi	
Allowable Deflection =	1/360	of span	
Bending Moment Factor =	1.500		
Torsional Moment Factor =	1.000		
Total Collector Chain Tension =	2532	lbs	Collector Chain Ten
Design Single Strand Collector Chain Tension =	1823	lbs	
Drive Chain Tension =	1853	lbs	Drive Chain Tensior
Torque At Reducer Output Shaft (with 1.0 S.F.) =	8384	in-lbs	
Input Horsepower (with 1.0 S.F.) =	0.167	hp	
Head Shaft Drive Bearing Reaction =	115	lbs	

Design Program Output Information

With the program output we can then;

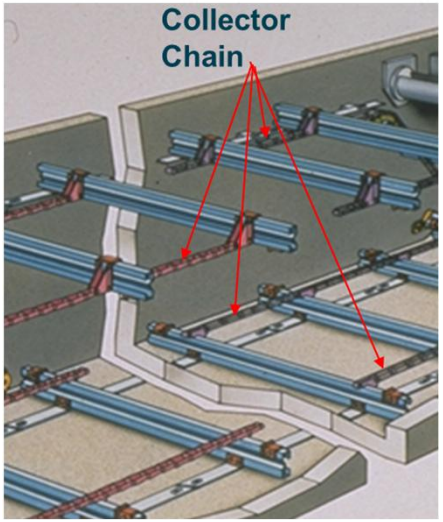
- ***Choose the correct type of collector chain***
- ***Choose the correct type of drive chain***
- ***Size the gearbox (torque requirement) and motor HP required***
- ***Select the correct flight to handle the width and sludge loading***

Evoqua Collector Chain Comparison

	 NCS720S	 HS730	 SAV or ENV715
Pitch	6 inch [152.4mm]	6 inch [152.4mm]	6 inch [152.4mm]
Working load	3,400 lbs [1,545 kg]	4,500 lbs [2,045 kg]	5,000 lbs [2,272 kg]
Minimum ultimate tensile strength	7,300 lbs [3,318 kg]	20,000 lbs [9,090 kg]	23,000 lbs [10,454 kg]
Weight per foot	1.3 lb/ft [1.94 kg/m]	1.69 lb/ft [0.77 kg/m]	3.8 lb/ft [5.67 kg/m]
Material of construction	Injection molded acetal thermoplastic	Filament wound composite	Type 403 stainless steel

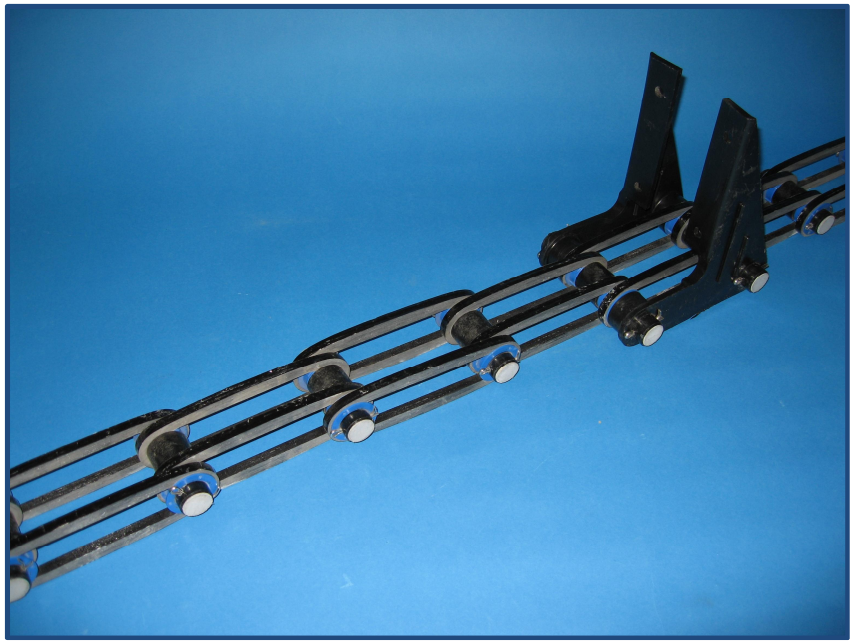
NCS720S Collector Chain

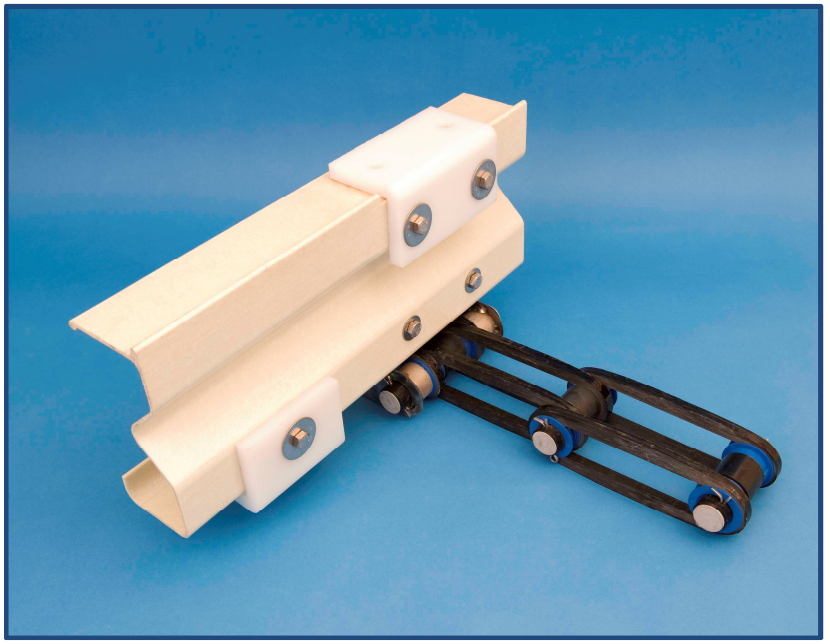
- Basic applications
- 95% of our orders are Molded Chain
- Competitors all carry a Molded Chain
- Press fit pin
- Strongest Molded Chain in Market



HS730 Loop Chain
High Strength Option

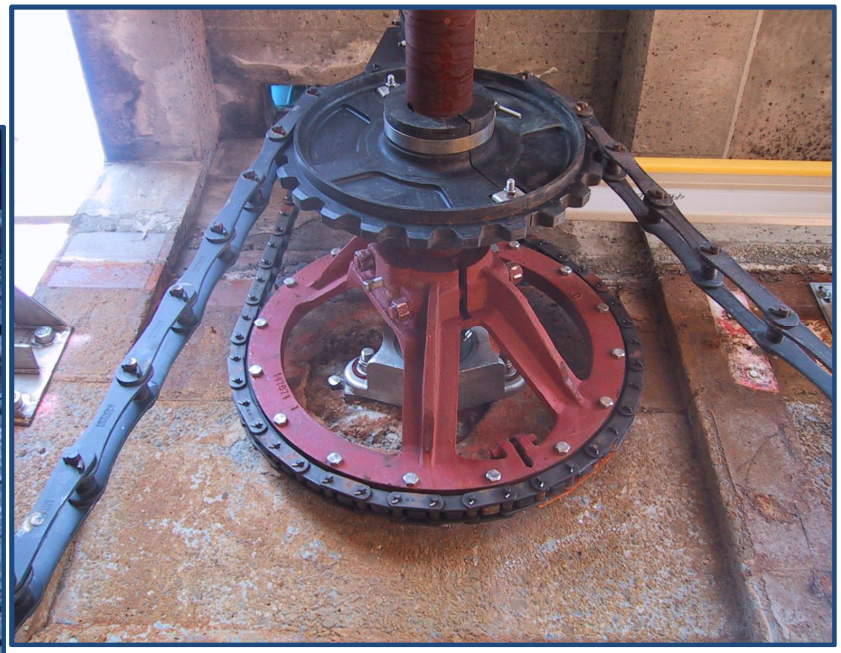
- Long Basins
- Heavy sludge loads
- Grit applications
- Cotter pins





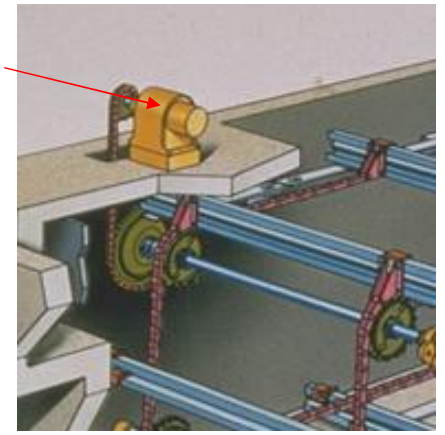
Stainless Steel Collector Chain

- Strongest collector chain on the market.
- High grit and heavy loadings
- Cross Collectors
- Cotter pins



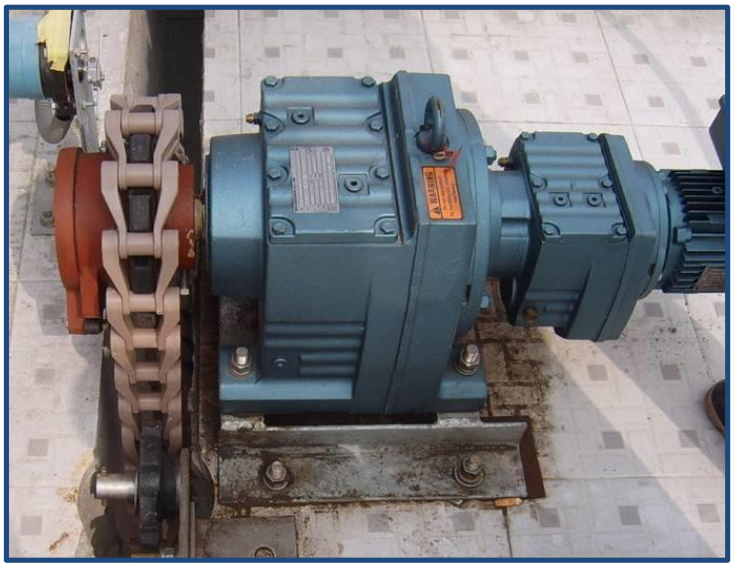
Drive Assemblies

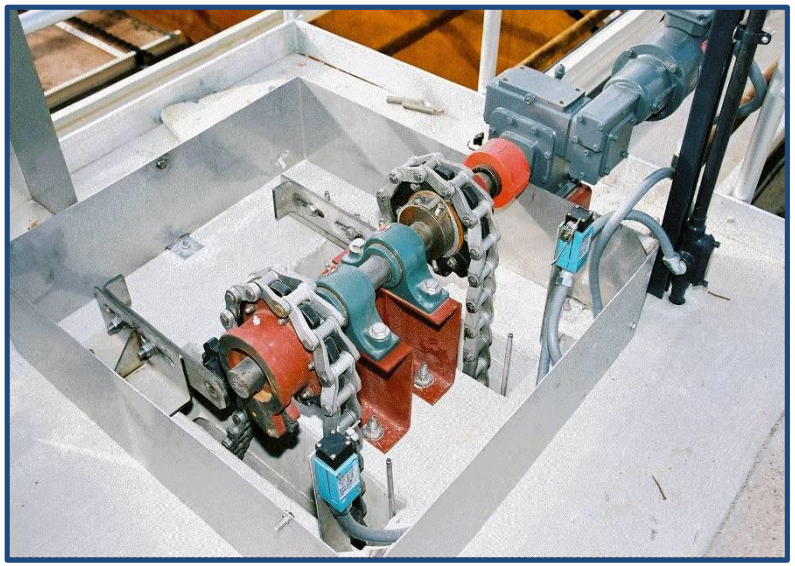
Drive Assembly



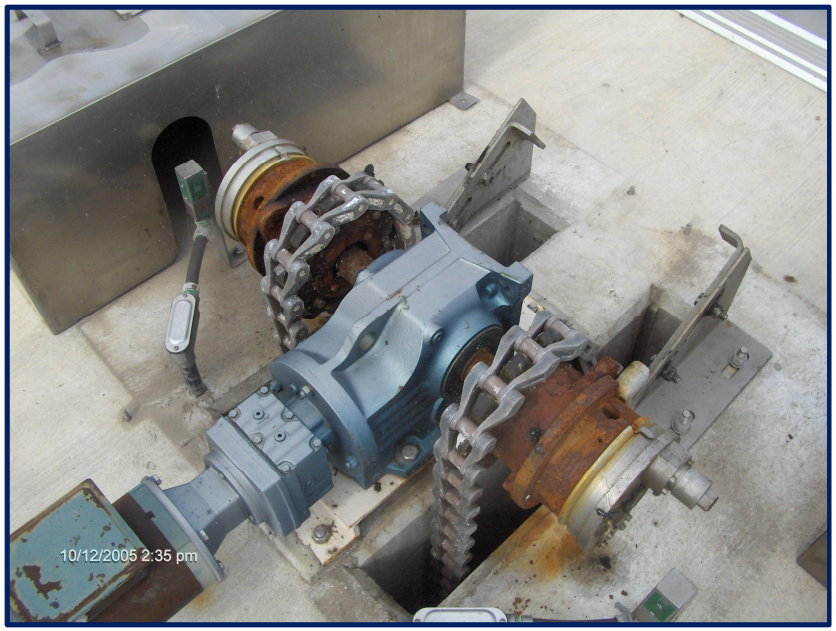
Single Output – Single Mechanism

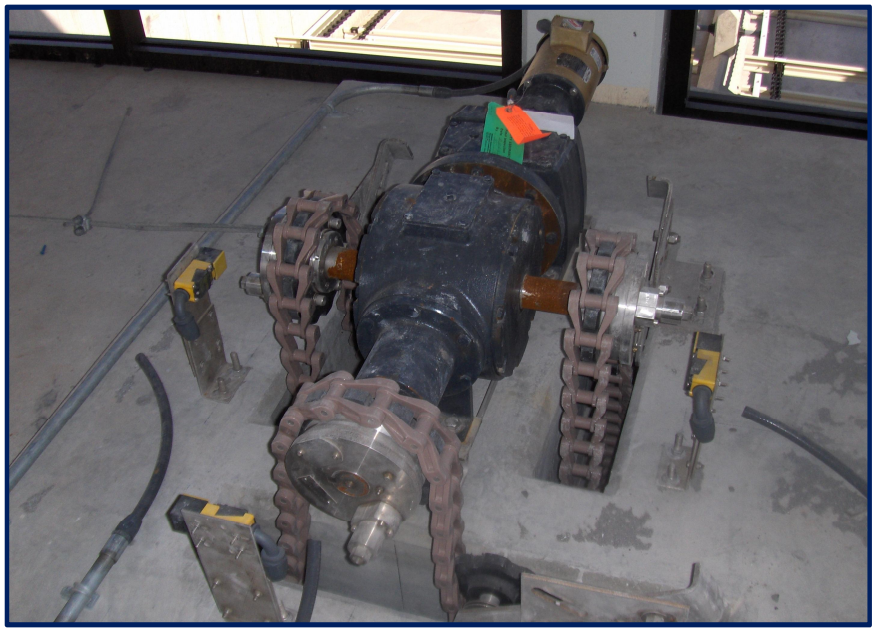
Single Output - Dual Collector thru Jackshaft





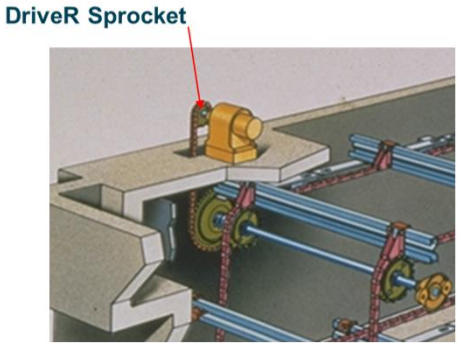
Dual and Triple Output Shaft Drive Assembly





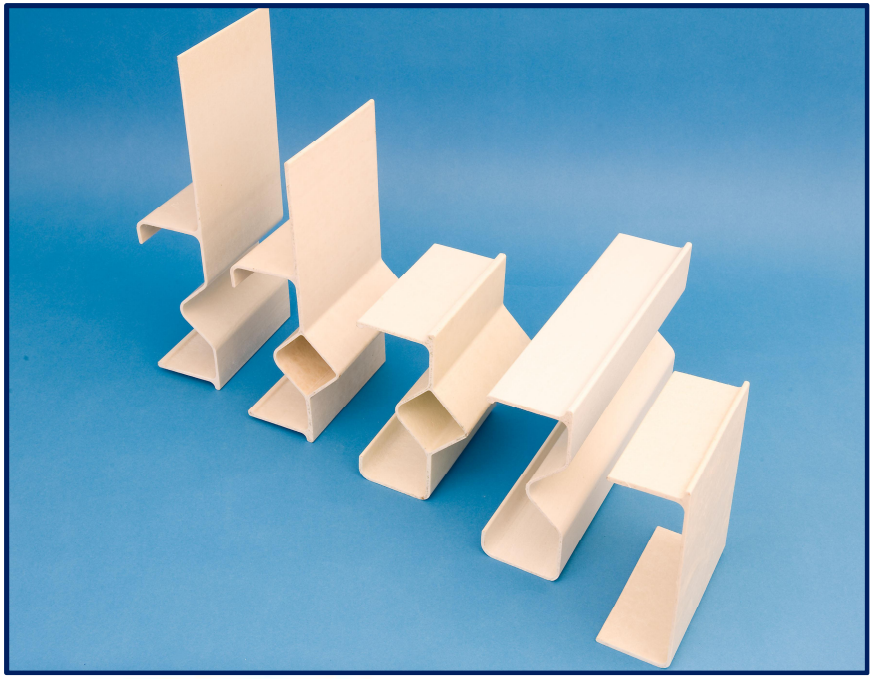
Driver Sprockets

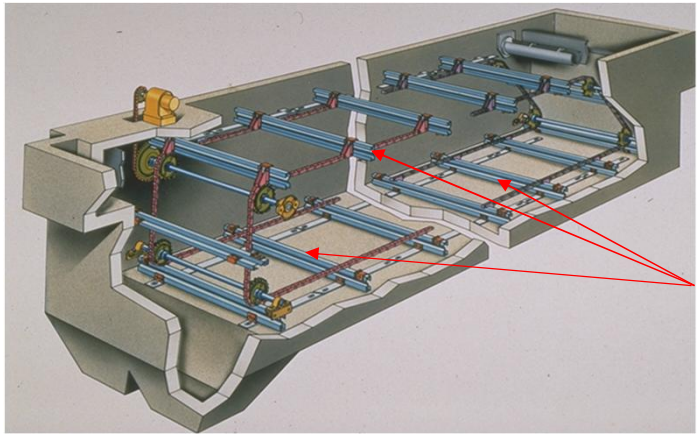
- Cast Iron Shear Pin Driver Sprocket
- Maintenance Free Stainless Steel Shear Pin Driver Sprocket



Collector flights

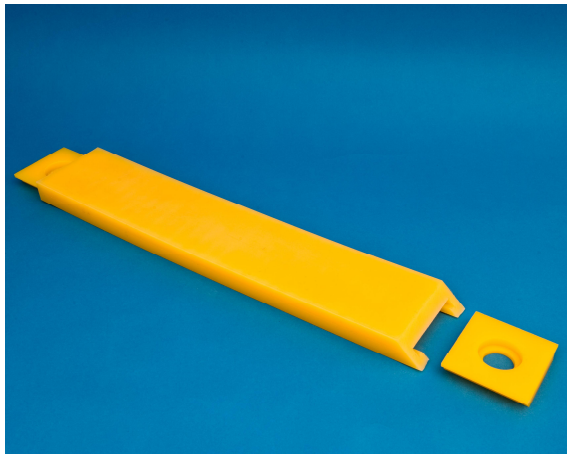
Fiberglass Material



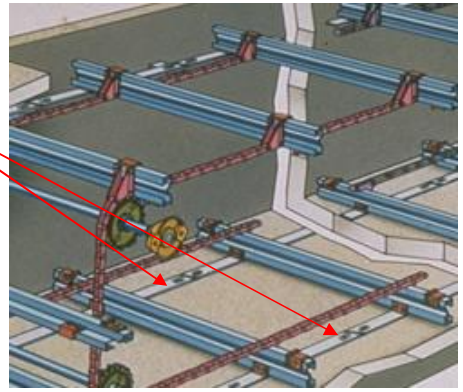


- Channel up to 15’ wide tanks
- Sigma-plus up to 24’ wide tanks
- diamond up to 30’ wide tanks
- Diamond w/extension 33’ wide
- Sigma plus w/extension 28’ wide

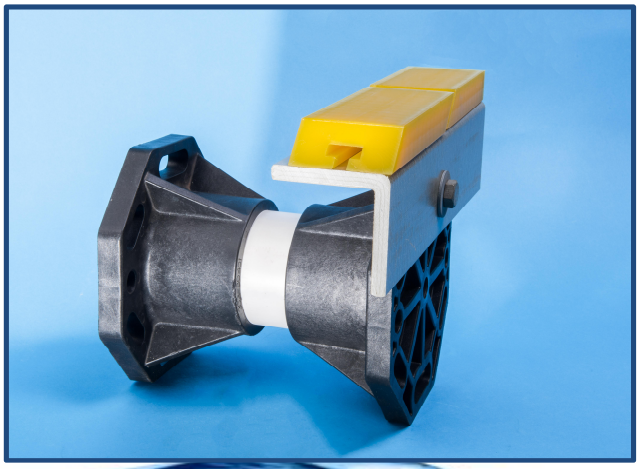
Wear Strips - Floor

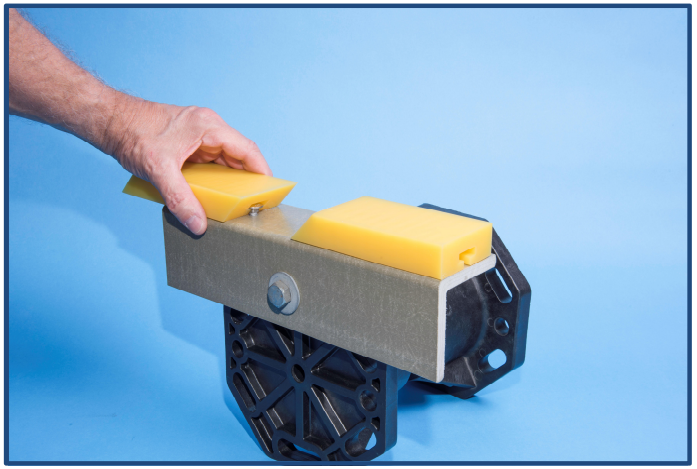


Floor Wear Strips

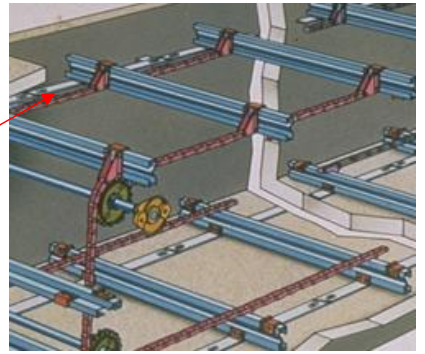


Wear Strips - Return Track



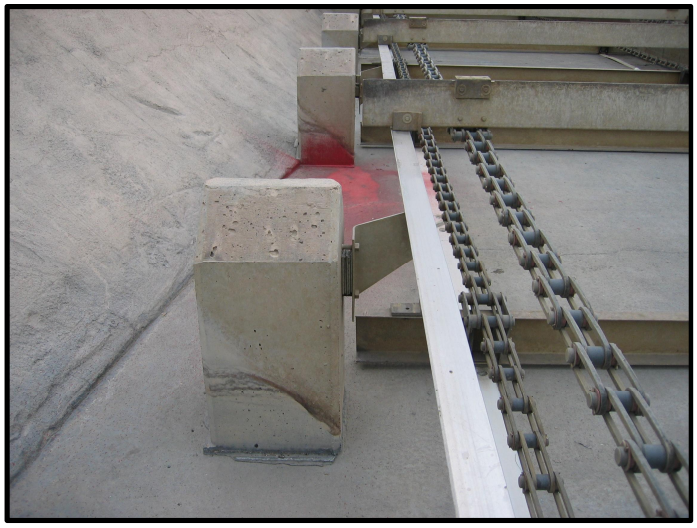


Return Track and Wear Strips



Return Track Angles

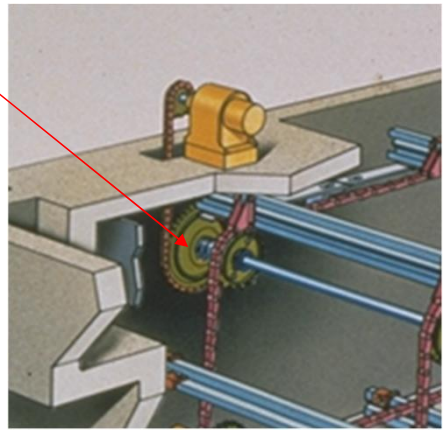
- GRP Angle & Non-metallic Brackets
- Stainless Steel Formed
- Stainless Steel Angles



Driven Sprockets

- Polyurethane and Cast Steel w/ Bolt on Teeth or Cast Nylon w/ Integral Teeth

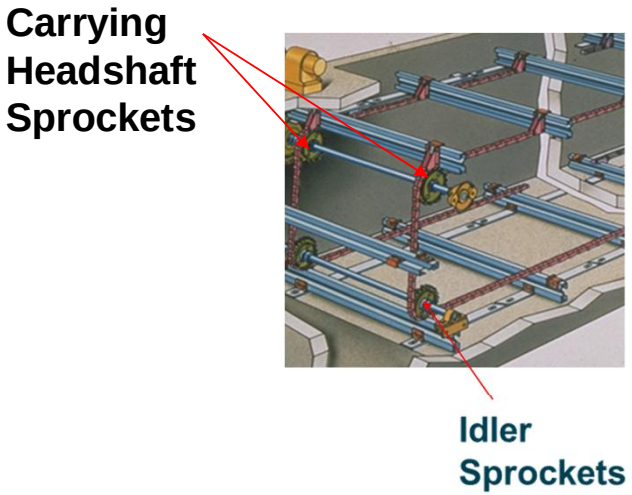
DriveN Sprocket

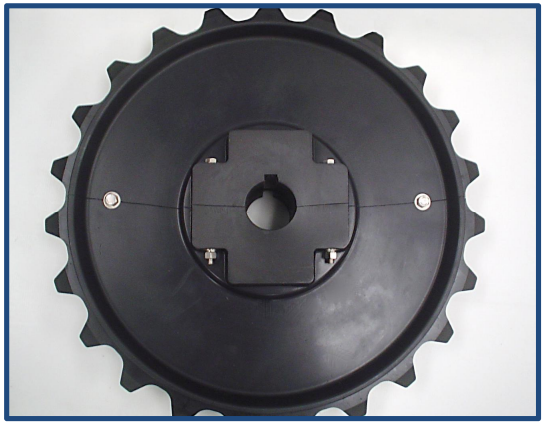


Collector Sprockets

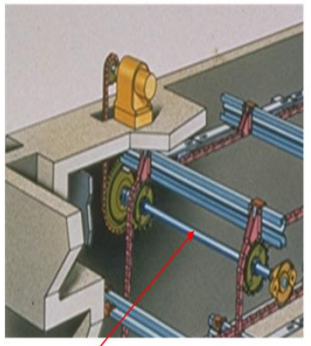
Non metallic materials available

- Polyurethane
- Cast nylon
- 316 SS Hub with 15-5 Participated Hardened bolt on tooth segments
- Cast Hub with UHMW Tooth segments



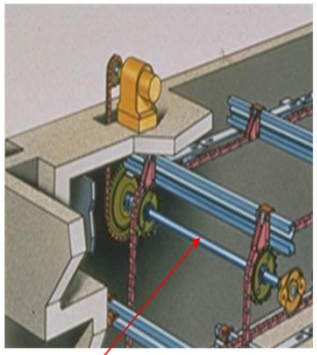


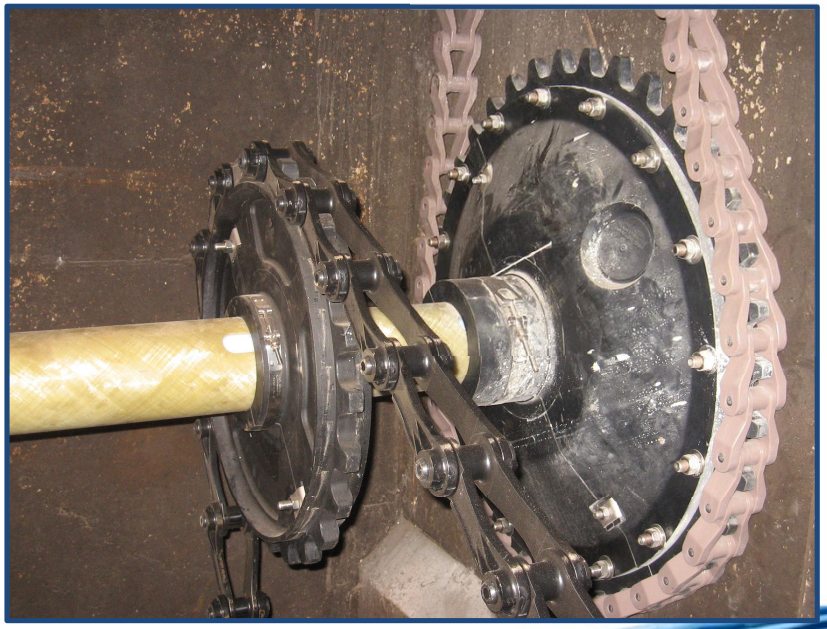
Steel Headshaft Options



- Stainless Steel
- Carbon Steel
- Torque Tube Design Wide Tanks

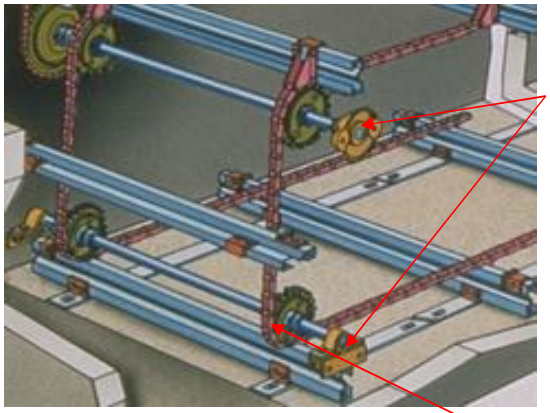
Fiberglass (FRP) Headshaft

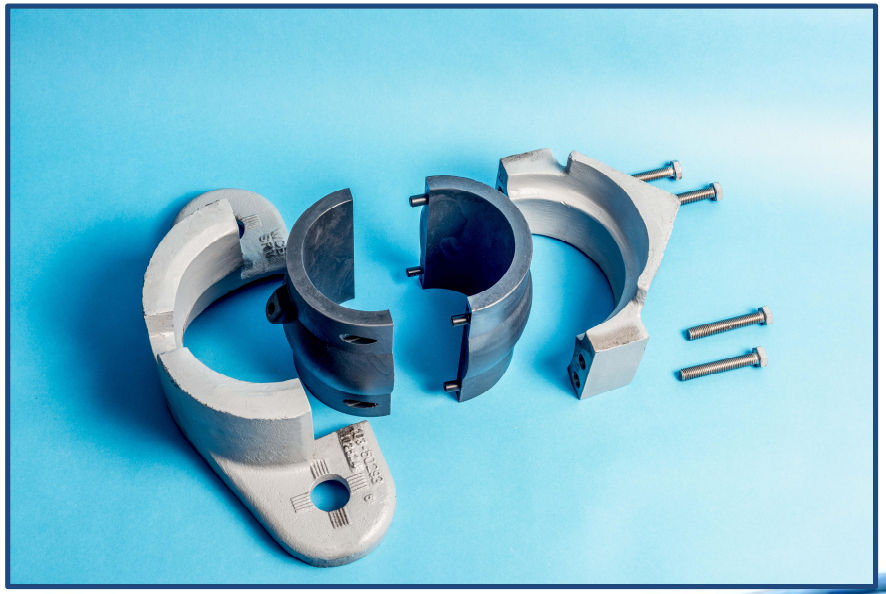




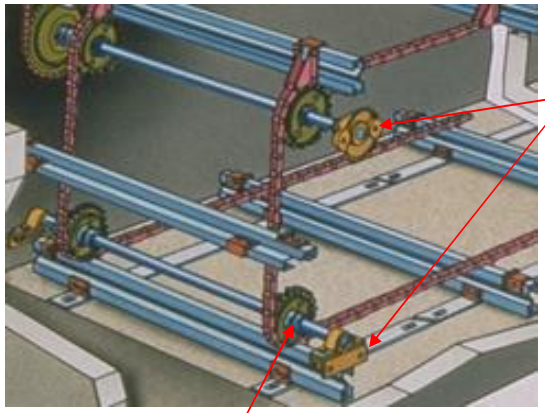
Bearing Options

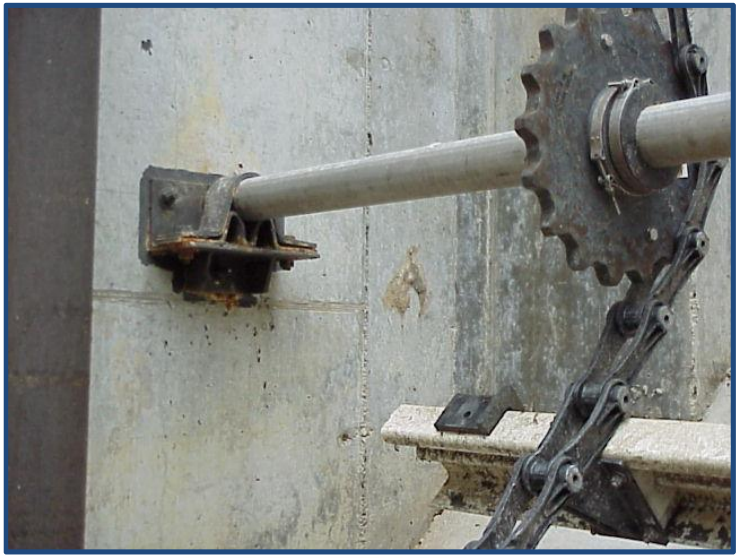
- Split Poly Hub Wall Bearing
- Cast Steel & Cast 316 SS housings





Bearing Options Cont.





Scum Removal – Scum Pipe/Tipping Pipe

- Simplest Operation
- Very Effective

Scum Removal – Scum Pipe/Tipping Pipe

Wrap Up

Evoqua offers:

Nearly 100 years of experience in rectangular collectors

More experience and installations than any other manufacturer

Long history of research and innovation

R&D facility

- Strong Testing Capabilities and Resources

Proper design, and selection of components

- Engineering Expertise
- Complex Systems Design

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