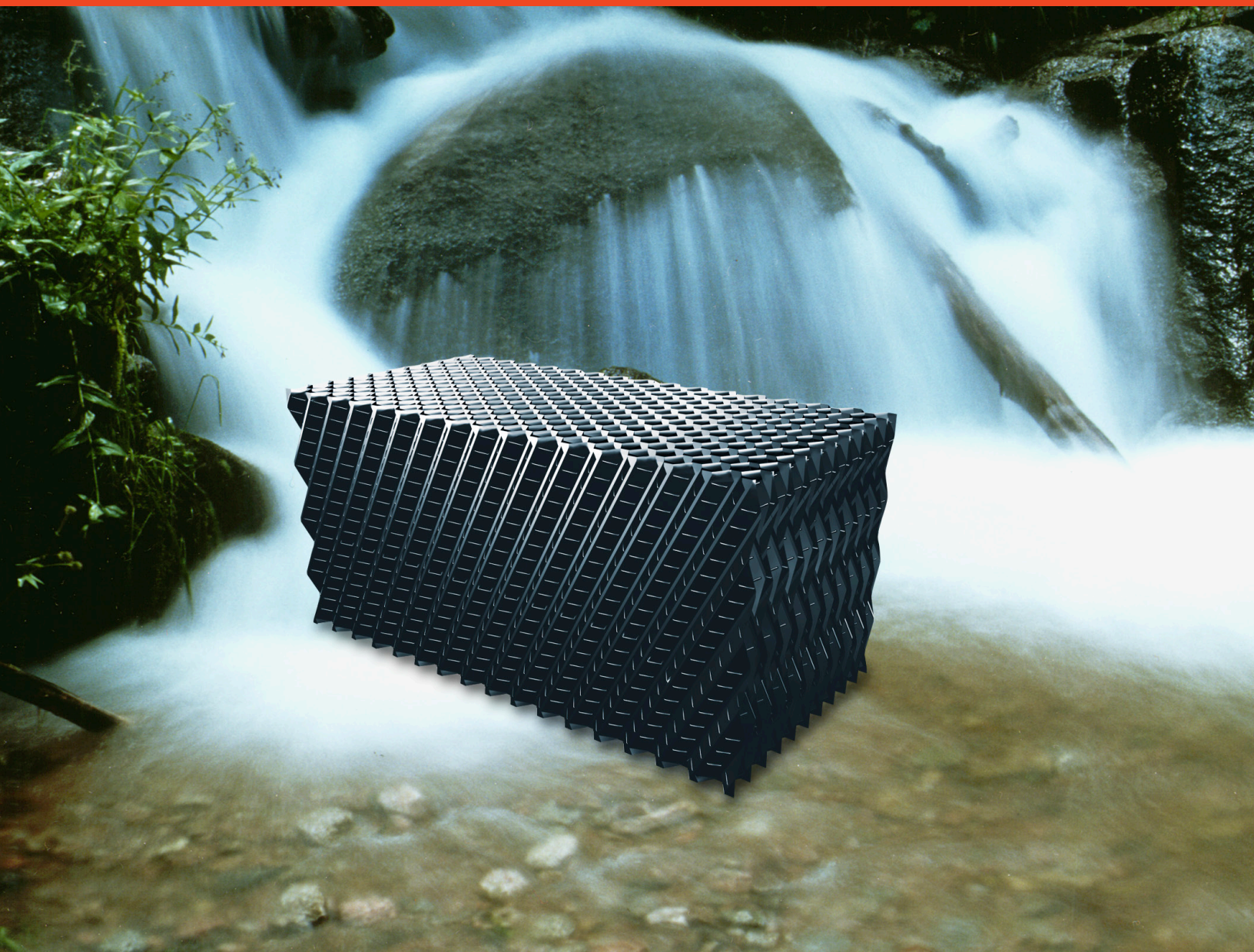


# MARPAK<sup>®</sup> modular biomedica

WASTEWATER TREATMENT

MARLEY<sup>®</sup> 





## The Marley MARPAK Difference

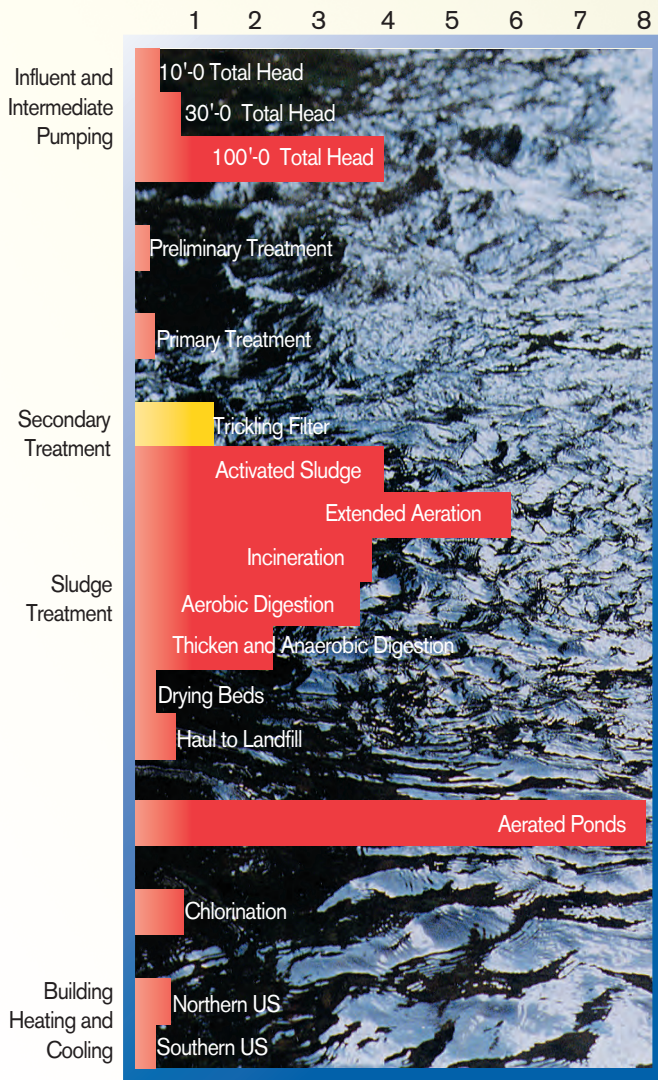
SPX Cooling Technologies is a world leader in the design, manufacturing and construction of evaporative cooling products.

The design and production of modular corrugated PVC media used in Marley evaporative cooling products is the same technology and extensive knowledge utilized in the development of the MARPAK product line of modular PVC media for biological wastewater treatment.

Since the origin of Marley in 1922, we have maintained a commitment to total quality in engineering, in customer service and in the close teamwork of our employees and representatives around the world. This long term dedication is what makes the Marley MARPAK Difference.

## Fixed Film Process

### Relative Energy Consumption



### History

For over 100 years the fixed film reactor (trickling filter) has been used in wastewater treatment to reduce the biochemical oxygen demand (BOD) and for nitrification. As the wastewater passes down through the trickling filter, microorganisms on the surface of the media convert the dissolved organic wastes and ammonia nitrogen into stable by-products – carbon dioxide, nitrates, nitrites and biosolids which are removed by clarification.

### Advantages

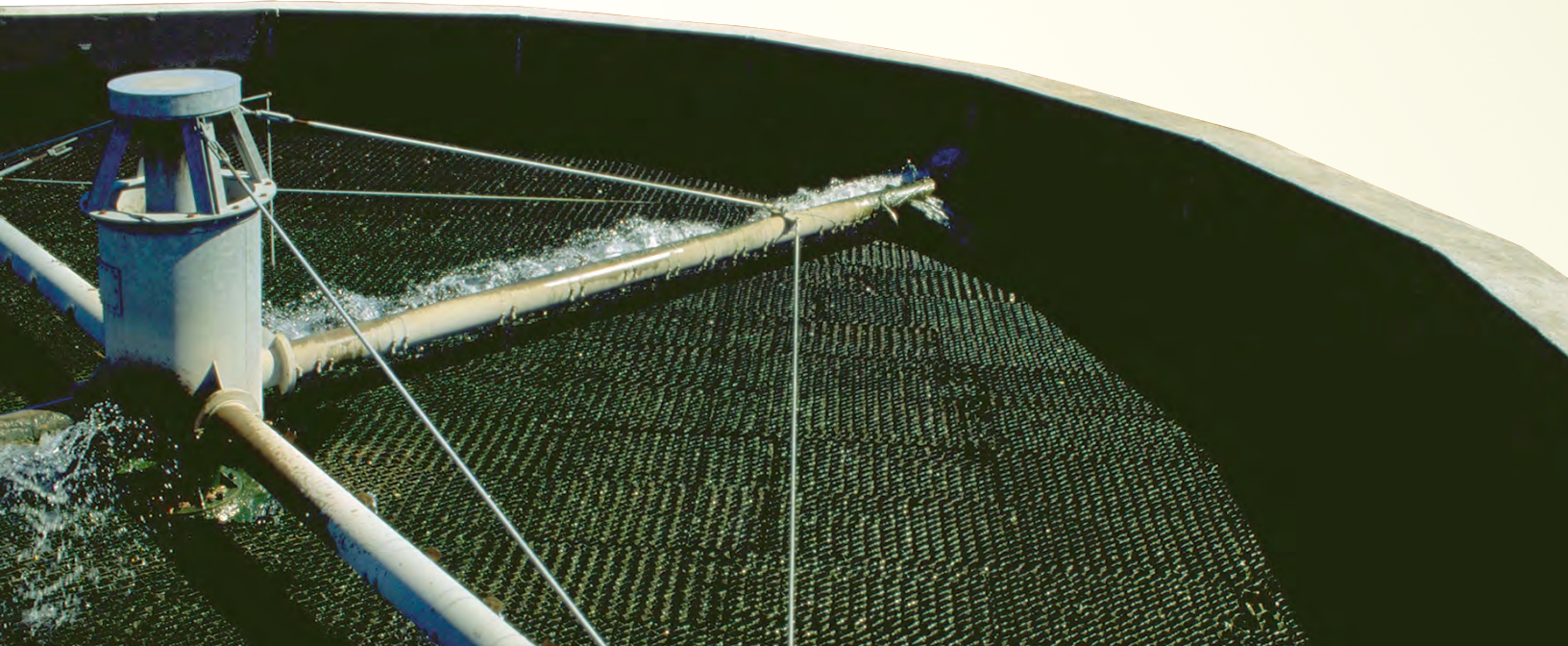
The advantage of the trickling filter process over other methods of treating wastewater include:

1. Lower energy consumption (Fig 3-1)
2. More resistant to hydraulic and organic shock loads
3. Simple operational procedures
4. Fewer personnel required to operate
5. Reduces sludge bulking problems

### Future

With the advent of the highly efficient modular 60° cross flow media (MARPAK MXF Series), the trickling filter is a viable alternative for complete secondary treatment (Fig 8-1 and 8-2) and nitrification (Fig 9-1) of municipal wastewater. As energy and labor costs continue to increase, the trickling filter process will become even more cost effective in wastewater treatment.

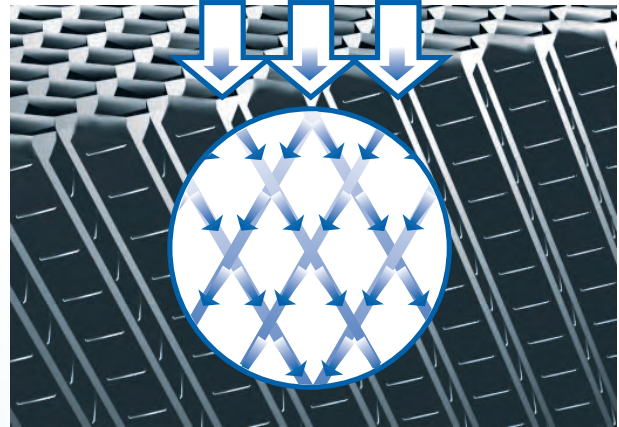
Source: *Water and Sewage Works*



## Modular Biological Treatment Media

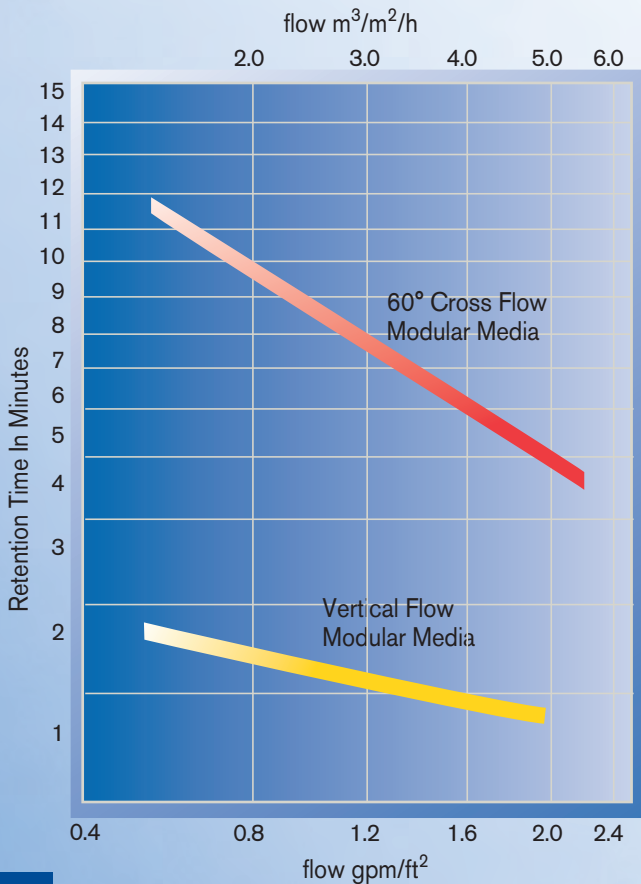
MARPAK is a modular PVC corrugated media specifically designed for biological treatment applications. MARPAK media is manufactured from rigid PVC sheets that are UV protected and resistant to rot, fungi, bacteria, acids and alkalis commonly found in wastewater. MARPAK modules are manufactured in various sheet thicknesses to meet specific structural requirements. MARPAK includes a full range of modular PVC media geometries for wastewater treatment including - complete secondary treatment (Fig 8-1 and 8-2), nitrification (Fig 9-1), denitrification, industrial roughing filters and anaerobic treatment.

### Flow Configuration of MARPAK MXF Series Media



4-1

### Retention Time versus Flow at a Media Depth Of 10'-0



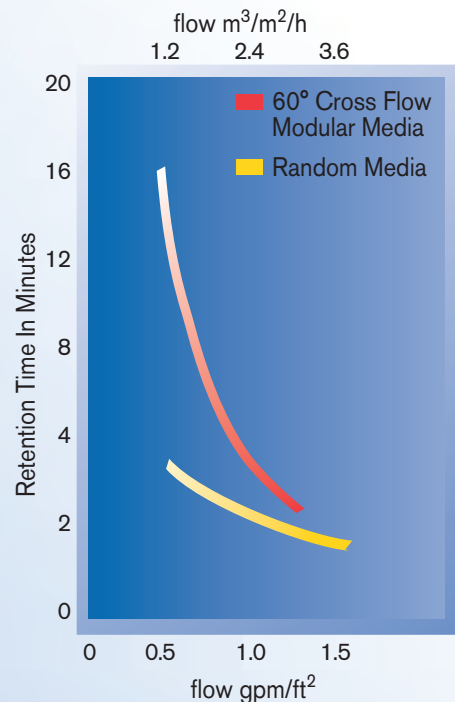
4-2

Source: "Plastic-Packed Trickling Filters" by E. Samer

### Faster Installation

Extensive testing has proven that taller modules produce the same water distribution as alternating 1'-0 modules. This means 4'-0, 6'-0, or even 8'-0 modules can be used to reduce installation time and minimize the number of clog-prone module interfaces.

### Retention Time versus Flow at a Media Depth of 10'-0



4-3

Source: "Evaluation of Plastic Media In Trickling Filters", by T. Richards and D. Reinhart

## MARPAK MXF Series

MARPAK MXF Series incorporates the well established 60° cross-corrugated (crossflow) design (Fig 4-1). This geometry has proven to be the most efficient for reducing BOD (biochemical oxygen demand) and for nitrification. Typical applications are shown in Figure 5-1. MXF Series media is available in modules 2'-0 wide, 2'-0 or 4'-0 high and 4'-0 or 6'-0 long.

5-1

Product Identification	Specific Surface Area ft <sup>2</sup> /ft <sup>3</sup>	Void Ratio %	Application
MXF3000	30	95	Secondary Treatment Anaerobic Treatment
MXF4800	48	95	Secondary Treatment Nitrification
MXF7400	74	95	Secondary Treatment Nitrification
MCR3100	31	95	High Strength Wastewater Anaerobic Treatment

## MARPAK MCR Series

MARPAK MCR Series is a vertically corrugated clog resistant media designed to minimize the potential for excessive solids buildup. The geometry is ideally suited for treating high strength wastewater. Typical applications are shown in Figure 5-1. MCR Series media is available in modules 2'-0 wide, 2'-0, 4'-0, 6'-0 or 8'-0 high and 4'-0 long.

## Advantages of MARPAK MXF Series 60° flow media:

### 1. Superior oxygen transfer

The MXF Series geometry allows for the continuous and uniform horizontal redistribution of air and water (Fig 4-1) maximizing oxygen uptake.

### 2. High Efficiencies at shallow depths

The MXF Series 60° cross corrugated geometry maximizes hydraulic retention time compared to other media types (Fig 4-2 and 4-3). MXF Series media can provide effective treatment at media depths as low as 3'-0 MXF Series media can be used as a direct replacement for rock media to increase both capacity and efficiency of existing trickling filters (Fig 7-1).

### 3. Wide hydraulic range

MXF Series is effective in reducing BOD and nitrification at hydraulic wetting rates of below 0.2 gpm/ft<sup>2</sup> to over 2.5 gpm/ft<sup>2</sup>.

## General Design Information

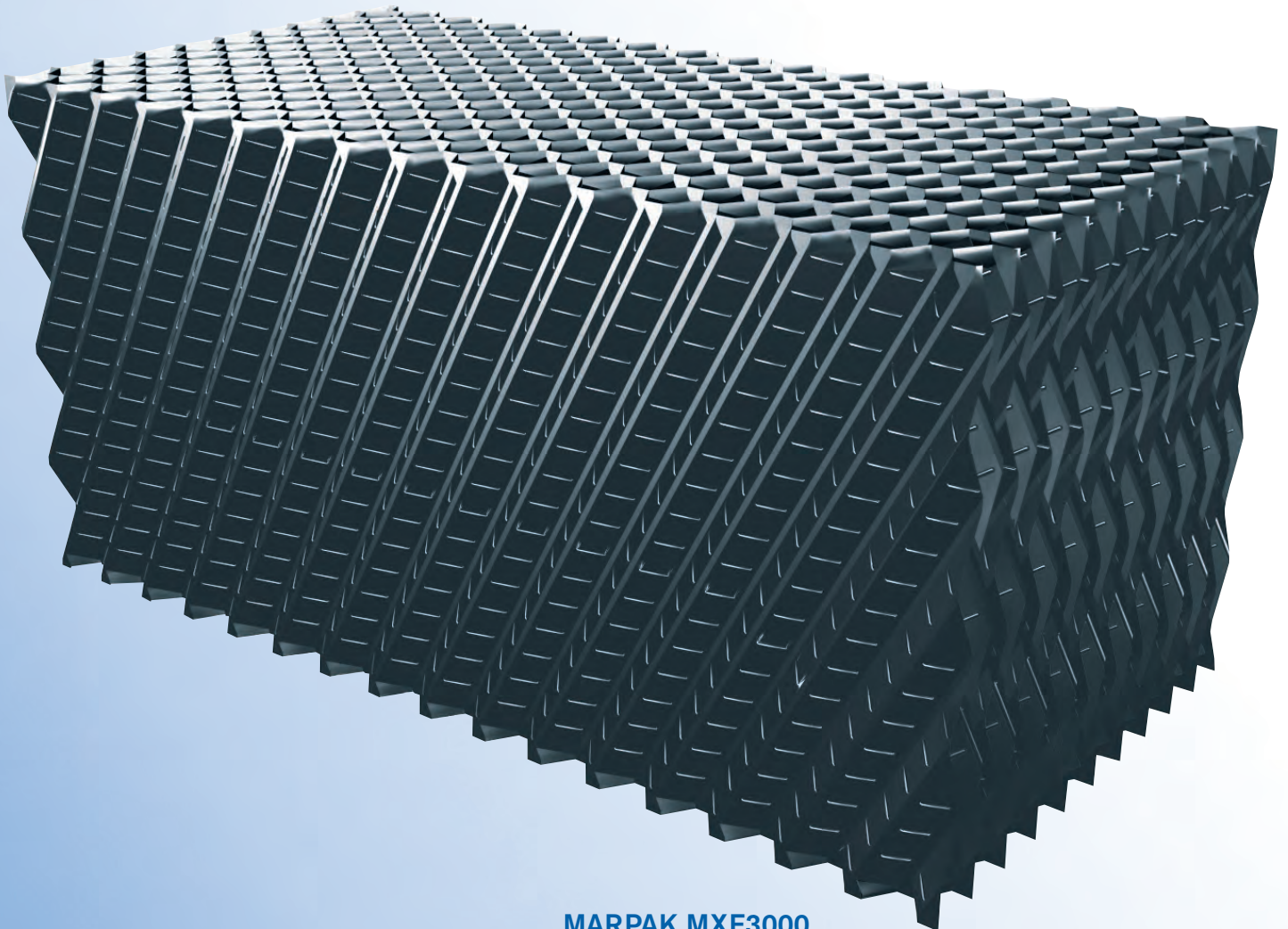
### Municipal Wastewater

Numerous empirical equations have been developed in an attempt to mathematically describe the reaction taking place in the trickling filter. The most common and generally accepted empirical equation in use today for predicting trickling filter performance in secondary treatment applications is the modified Velz equation. MARPAK MXF Series media performance for secondary treatment (Fig 8-1 and 8-2) can be evaluated using the modified Velz equation.

For information regarding the application of MARPAK MXF Series media for nitrification of municipal wastewater, please reference Fig 9-1 and 9-2.

### Industrial Wastewater

MARPAK MXF and MCR Series media can be used to treat a variety of industrial waste streams. Due to the wide variation in treat ability of industrial wastes, trickling filter performance is best determined from data from trickling filter installations treating similar wastewater; general design curves for various categories of industrial wastewater; or pilot studies. In addition to clarification, pretreatment including pH adjustment and nutrient addition may be required. The wastewater entering the trickling filter should have a pH between 6.0 and 8.5 and a nutrient balance among BOD, ammonia nitrogen and phosphorous of 100:5:1.



**MARPAK MXF3000**

# Applications

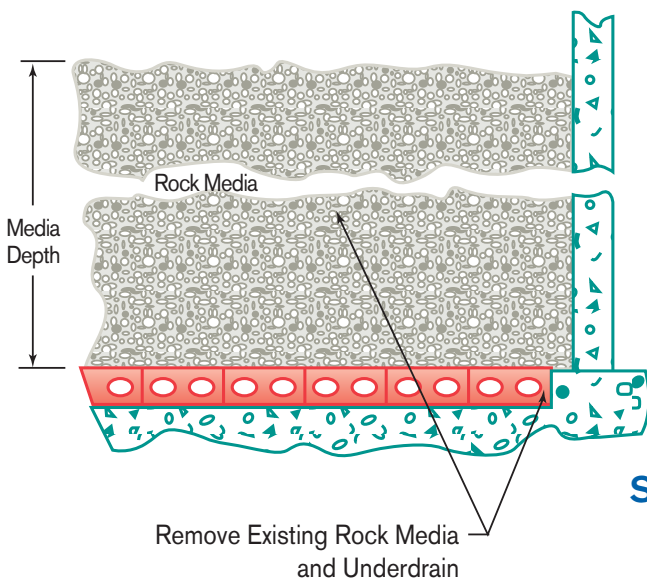
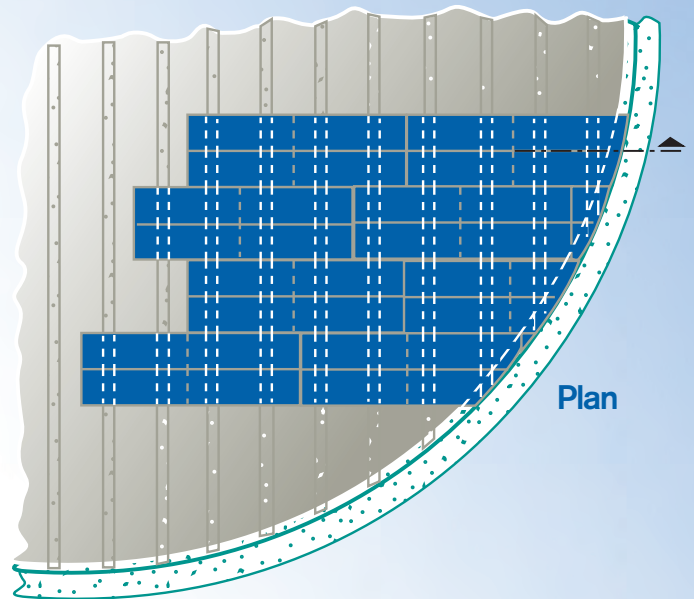
## Upgrading Existing Rock Trickling Filters

MARPAK MXF4800 with its 60° cross fluted geometry and high surface and void ratio is ideal for upgrading the performance of existing rock trickling filters.

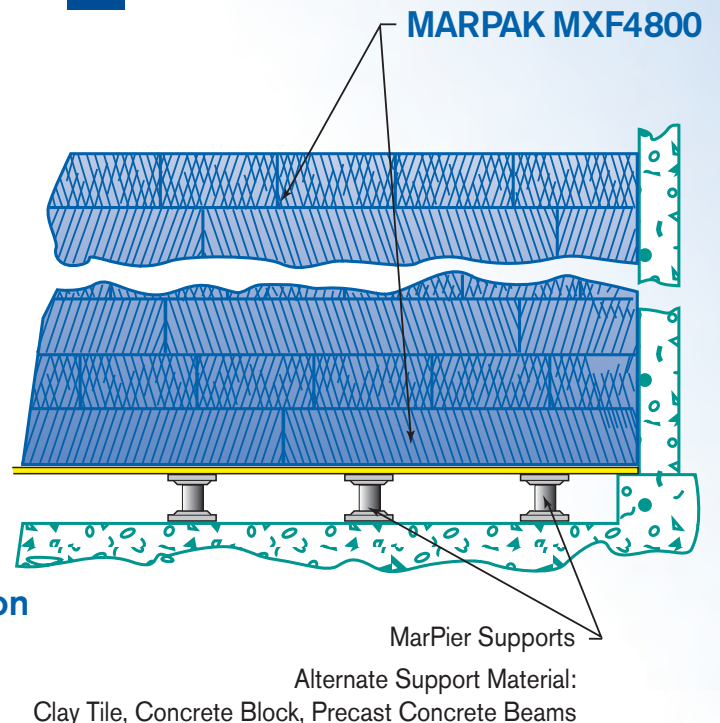
With a surface area and void ratio more than three times greater than rock, upgrading with MARPAK MXF4800 can more than double the organic capacity and improve effluent quality of an existing trickling filter. A significant amount of nitrification can also be achieved, depending on the organic loading.

Unlike rock or random plastic media, MARPAK MXF4800 provides continuous and uniform horizontal redistribution of air and water, with no short-circuiting. In addition, MARPAK MXF4800 has no horizontal surfaces, thus minimizing the potential for excessive solids buildup and plugging.

MARPAK MXF4800 modules can be placed directly on rows of supports (Fig 7-1) Removal of the existing clay tile along with the rock media is recommended. Modifications to the existing trickling filter structure are generally not required.



7-1



## Applications

### Complete Secondary Treatment

MARPAK MXF Series fixed film biological reactors used in conjunction with primary and secondary clarification (Fig 8-1) can reduce BOD<sub>5</sub> and suspended solids to above 90%.

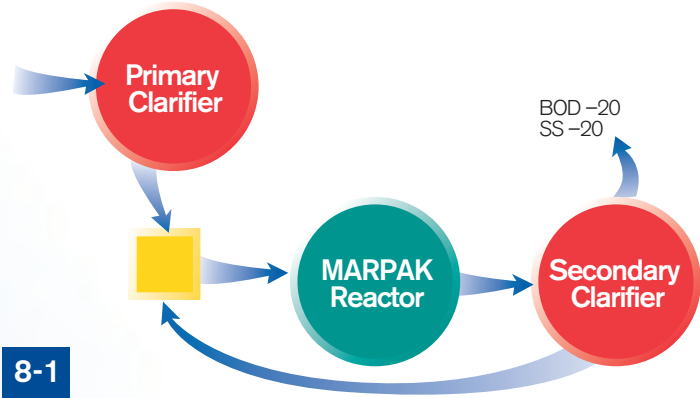
### Trickling Filter/Solids Contact (TF/SC)

The TF/SC process utilizes the trickling filter followed by short term aeration (Fig 8-2). The recirculation of sludge to the aerated contact basin enhances the agglomeration of fine particles and improves settling characteristics. At the same time the aeration continues to remove soluble organics. The aerated contact basin, combined with a center-well final clarifier can readily achieve a 95-plus percentage reduction in BOD<sub>5</sub> and total suspended solids.

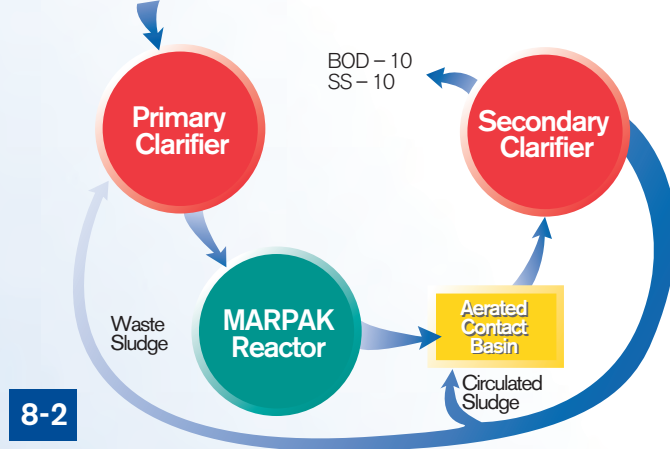
### Roughing or Pretreatment

MARPAK MXF and MCR Series fixed film biological reactors (Fig 8-3) are an effective method of pretreating difficult wastes and reducing the organic load on subsequent biological treatment steps.

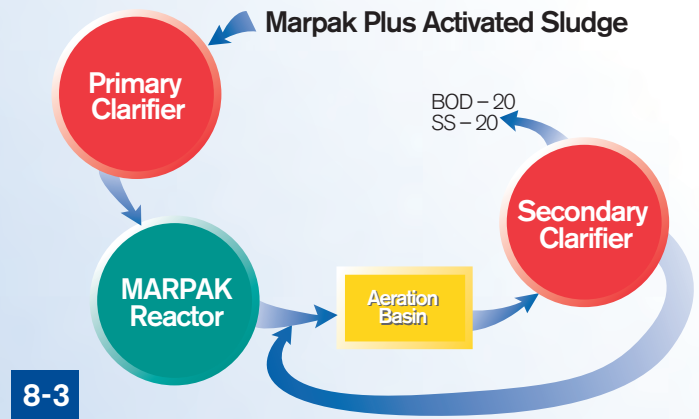
Complete Secondary Treatment



TF/SC Process



Marpak Plus Activated Sludge





# Applications

## Nitrification

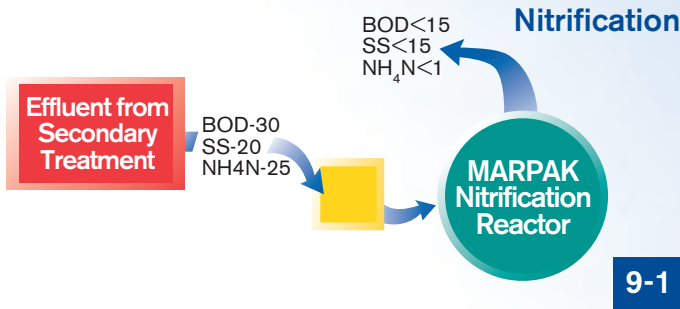
In the nitrification process (Fig 9-1) MARPAK MXF Series fixed film reactor provides an effective means of oxidizing ammonia nitrogen of secondary treated wastewater.

Nitrifying trickling filters require less mechanical equipment, less operating power and less attention than the activated sludge process (Fig 9-3).

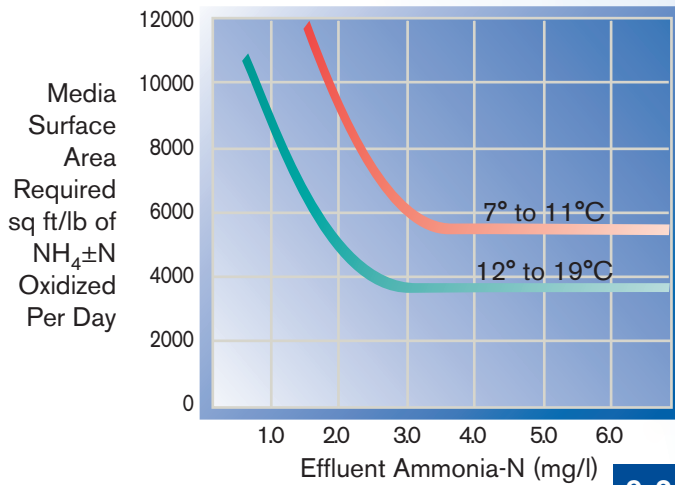
Nitrifying trickling filters are less effected by cold temperature than the activated sludge process (Fig 9-4).

MARPAK nitrification fixed film reactor, when preceded by clarified secondary effluent with the BOD<sub>5</sub> below 35 mg/l, will continue to reduce suspended solids and BOD<sub>5</sub> to a level below 20 mg/l.

A performance curve for nitrification is shown in Fig 9-2.



9-1



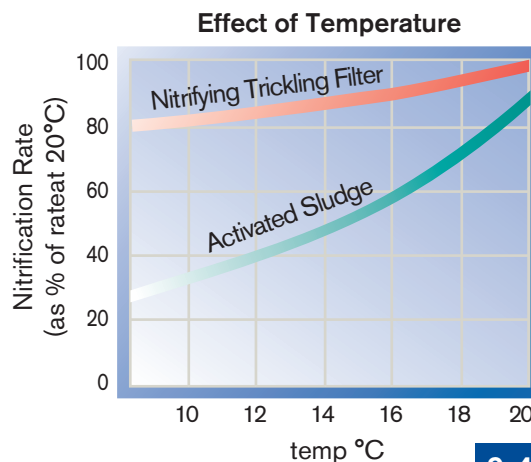
9-2

Source: Process Design Manual For Nitrogen Control, U.S. EPA

Cost Comparison		
Cost	Activated Sludge	Nitrifying Trickling Filter
Project	\$ 8,497,000	\$ 4,870,000
Energy (10 year)	3,450,000	1,175,000
Project - present worth	7,423,000	4,250,000
Energy - present worth	2,847,000	971,000
Total - present worth	\$10,270,000	\$ 5,221,000

9-3

Source: Water Engineering and Management



9-4

Source: Water Engineering and Management

## The MARPAK Advantage

Fixed film media has traditionally been made in 2'-0 height increments due to production limitations (sizes of thermoformers and molds to create the media sheets). Marley cooling tower fill has been produced for over 30 years and the advantage of taller fill heights has been recognized. This has resulted in the development of larger thermoformers to product fill media up to 6'-0 tall.

There are several advantages of taller media, primarily due to the presence of fewer interfaces between modules:

- Less deflection under load because the edge-to-edge interface between modules deforms more than the internal structure of the media.
- Less clogging by biosolids because module interfaces produce a blockage location due to exposed media edges.
- Less air blockage (pressure drop) for better air distribution.
- Less installation time.

Just as with a cooling tower, water and air distribution efficiency is critical to the performance of a trickling filter. For that reason, SPX advocates minimizing the number of module interfaces by using taller modules in any media installation, whether for a cooling tower or for a trickling filter.

## MARPAK Advantages

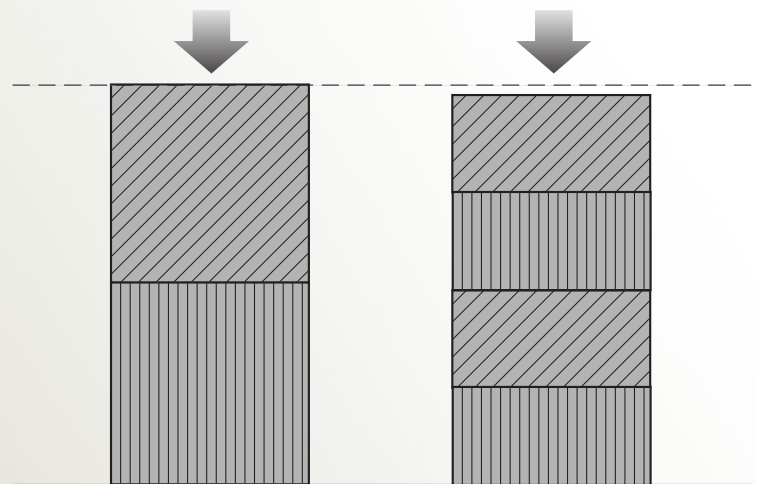
Taller heights of 4'-0 (MXF4800 and MXF3000) and 6'-0 (MCR3100).

Taller MARPAK modules mean:

- Stability—Less settling over you filter's life
- Efficiency—Less clogging by biomass at module interfaces
- Performance—Less air blockage due to interfaces
- Quicker Installation—Fewer modules to handle

In third-party test of MXF 3000 media, two 2'-0 tall modules deflected nearly 70% more than two 4'-0 tall modules\*. For example, if filter media with 2'-0 tall modules settle by 4" during its lifetime, 4'-0 tall modules in the same filter will settle less than 2 3/8".

\*Based on percentage of height.



# General Specification and Installation Information

## Media

MARPAK is a Modular PVC media specifically designed for fixed film biological treatment applications.

MARPAK is available in both the highly efficient 60° cross flow design (MXF Series) for complete secondary treatment and nitrification and the vertical flow design (MCR Series) for treating high strength industrial wastewater.

MARPAK media is available in specific surface areas from 30 to 74 sq ft /cu ft with a 95% void to volume ratio.

The MARPAK modules are manufactured in various PVC sheet thicknesses to meet specific structural requirements.

## Material

MARPAK polyvinyl chloride (PVC) sheets are resistant to rot, fungi, bacteria growth and other forms of microorganisms and are chemically resistant to normal concentrations of sewage acids, alkalis, organic solvents and organic compounds.

The PVC compound is UV resistant and specifically formulated to resist long-term fatigue cracking under continuous loading.

## Installation

MARPAK is installed so that the sheets of all modules in a particular layer are parallel.

Special care should be taken during installation of the media to protect the modules from damage. Where necessary, cutting and trimming of the modules may be performed within the fixed film reactor. Adequate protection and precaution should be taken to insure that no damage is done to the placed media and that no debris from the cutting process is allowed to lodge in the placed media.

## Warranty

The media supplier shall certify to the general contractor and the engineer in writing that the media to be supplied will meet or exceed the specifications. Limited warranty shall be provided by the manufacturer for a period of one year after installation against defects in material and workmanship.

**For a more detailed specification for your specific application, please contact SPX Cooling Technologies at 800 462 7539 and ask for MARPAK.**



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MARPAK-08 | ISSUED 07/2017  
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