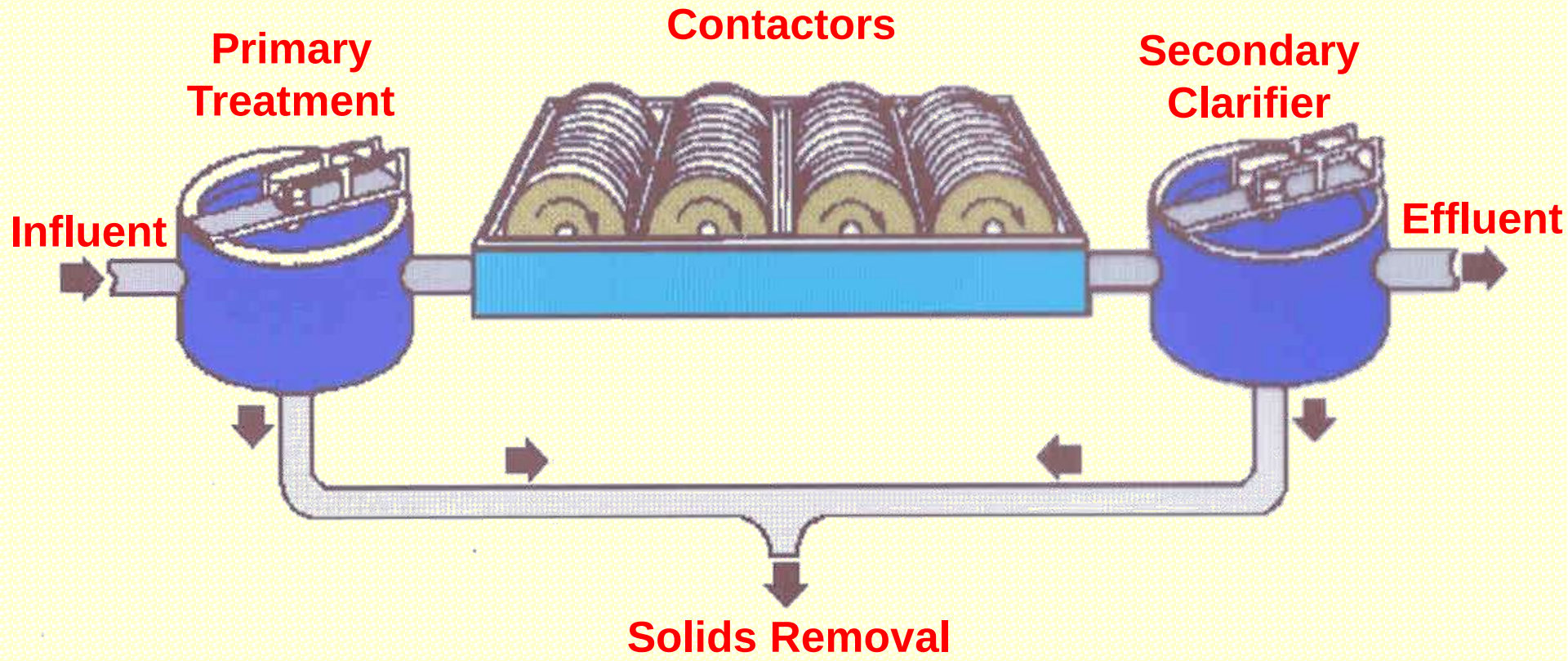
ROTATING BIOLOGICAL CONTACTOR (RBC) PROCESS

Prepared By
Michigan Department of Environmental Quality
Operator Training and Certification Unit

ROTATING BIOLOGICAL CONTACTORS

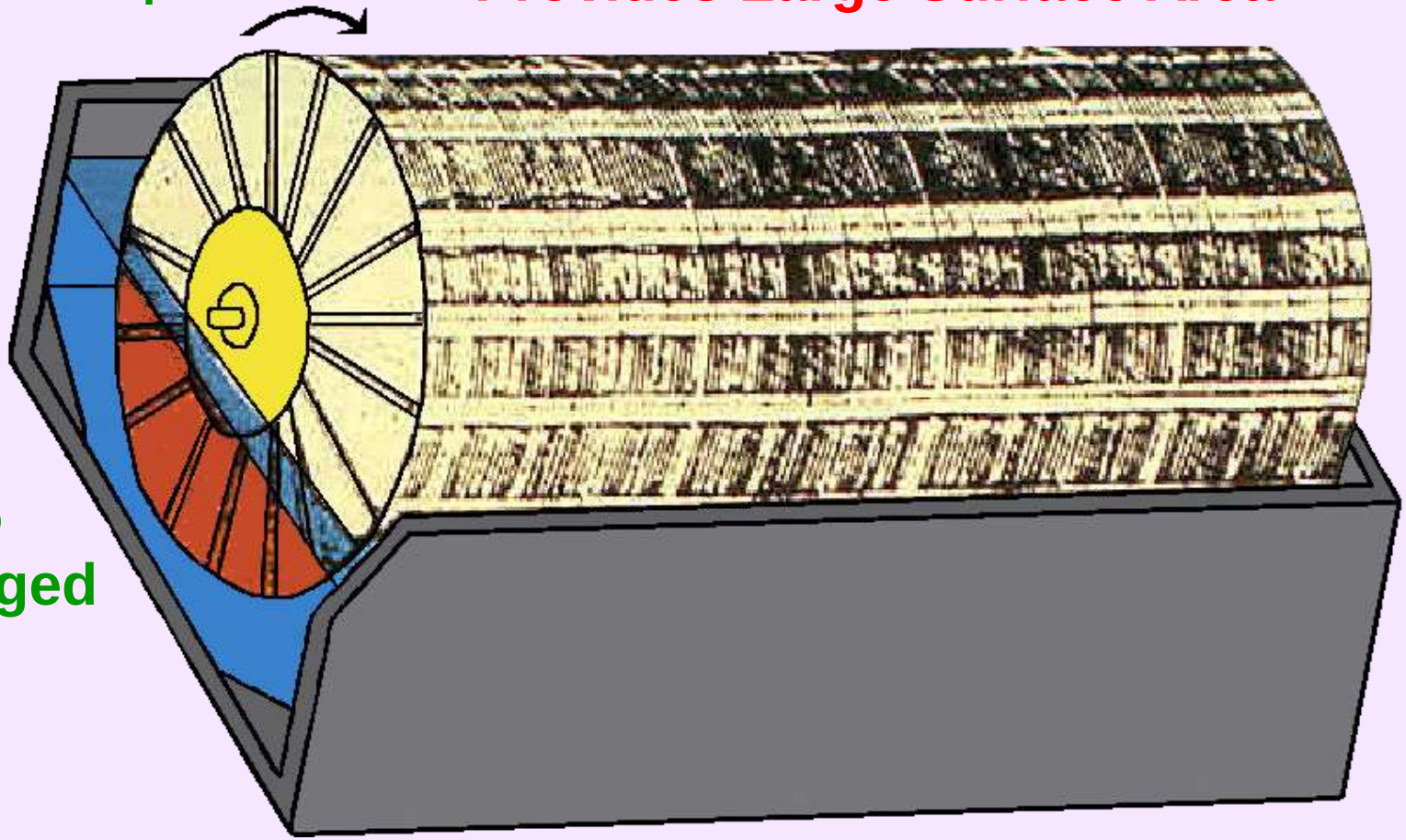


RBC Secondary Treatment

Rotating Plastic Media

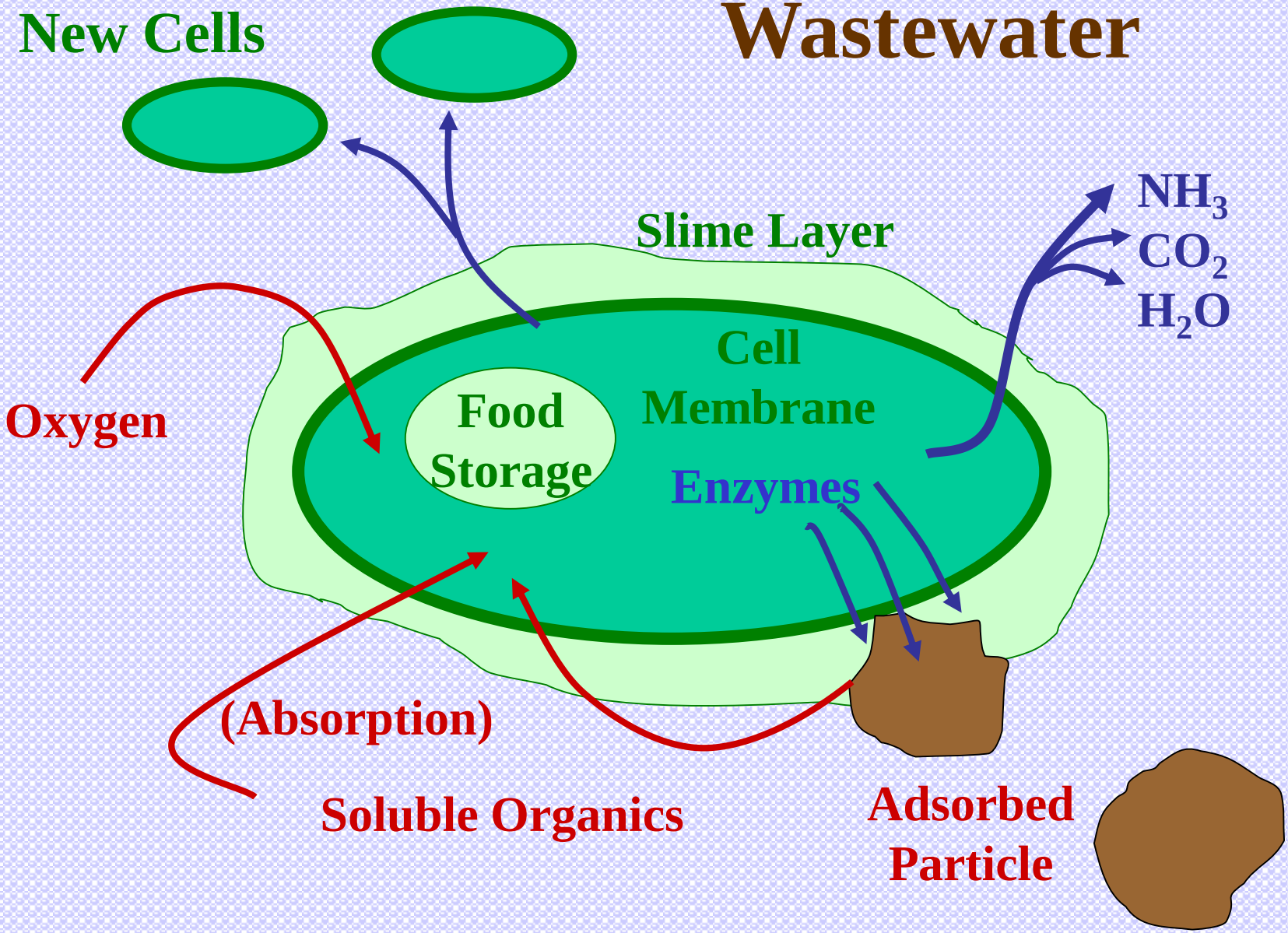
1.6 rpm

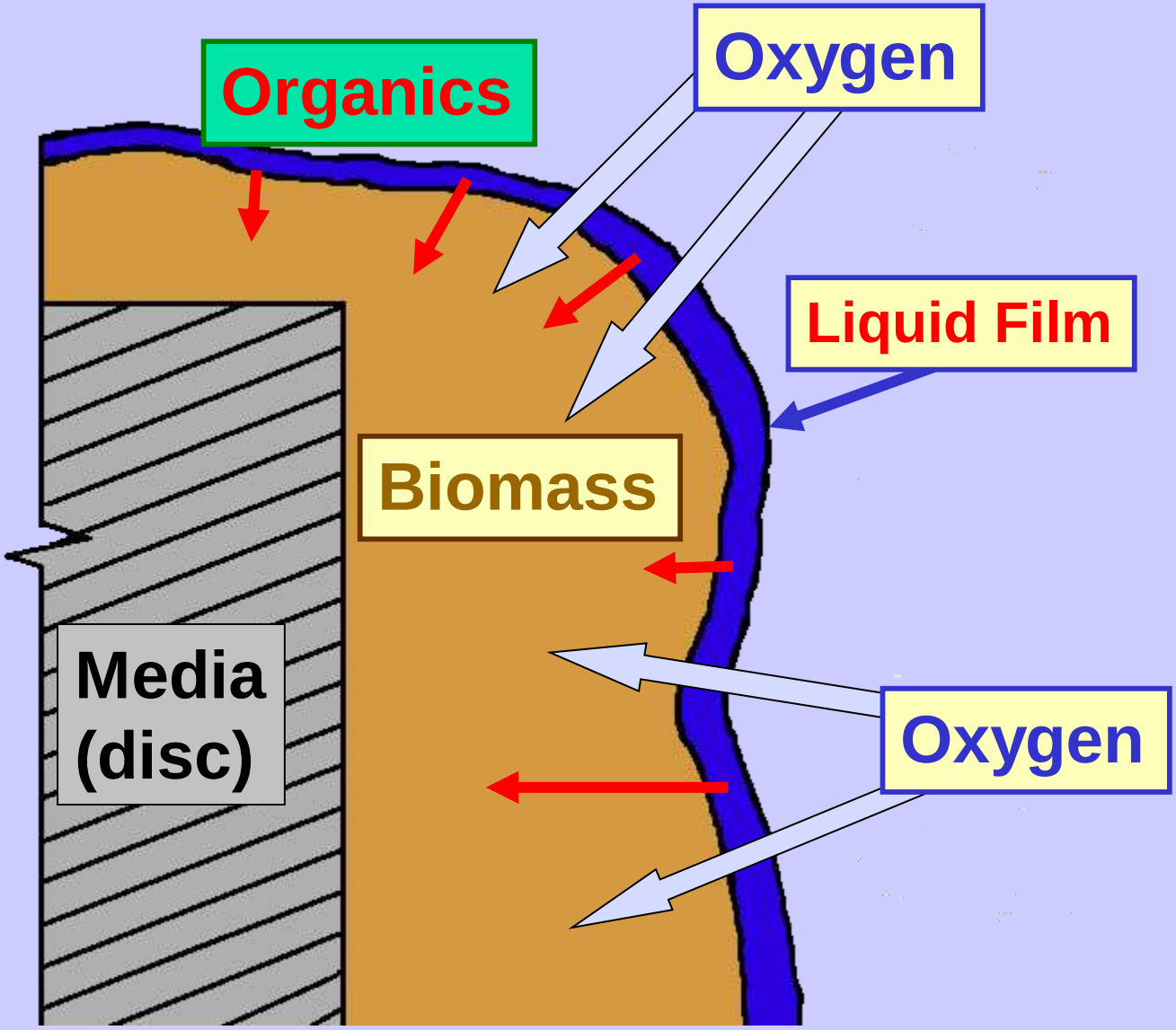
Provides Large Surface Area

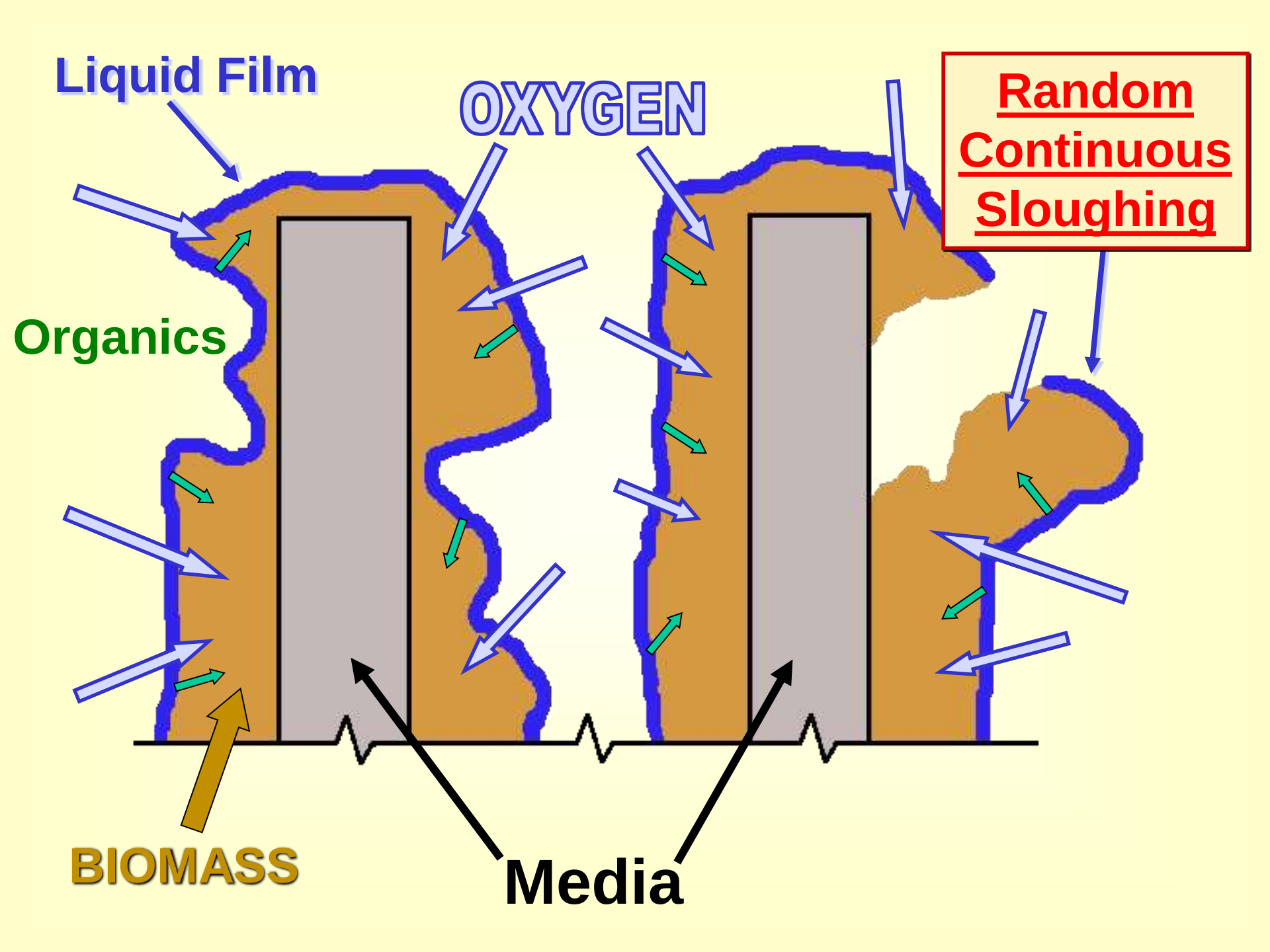


40 %
Submerged

Microorganisms “Treat” the Wastewater by Using Organics

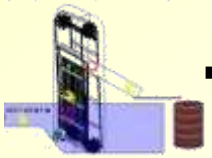

New Cells
Wastewater
Slime Layer
NH_3
CO_2
H_2O
Oxygen
Cell
Membrane
Food
Storage
Enzymes
(Absorption)
Soluble Organics
Adsorbed
Particle


Organics
Oxygen
Liquid Film
Biomass
Media
(disc)
Oxygen


Liquid Film
OXYGEN
Random
Continuous
Sloughing
Organics
BIOMASS
Media

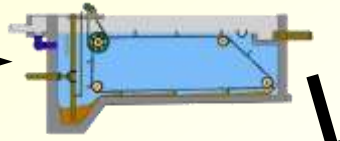
RBC Flow Scheme

INFLUENT

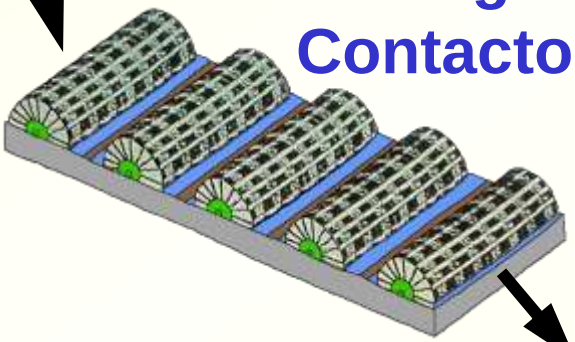


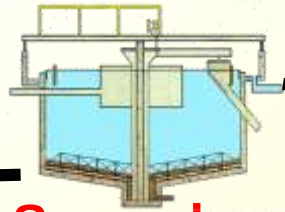
Pretreatment

Primary Treatment



Rotating Biological Contactors

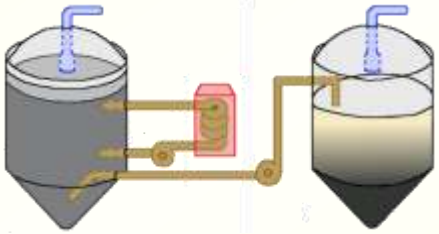




Secondary Clarifiers

Disinfection

EFFLUENT



Solids Handling

ADVANTAGES OF RBC PROCESS

Simple Operation

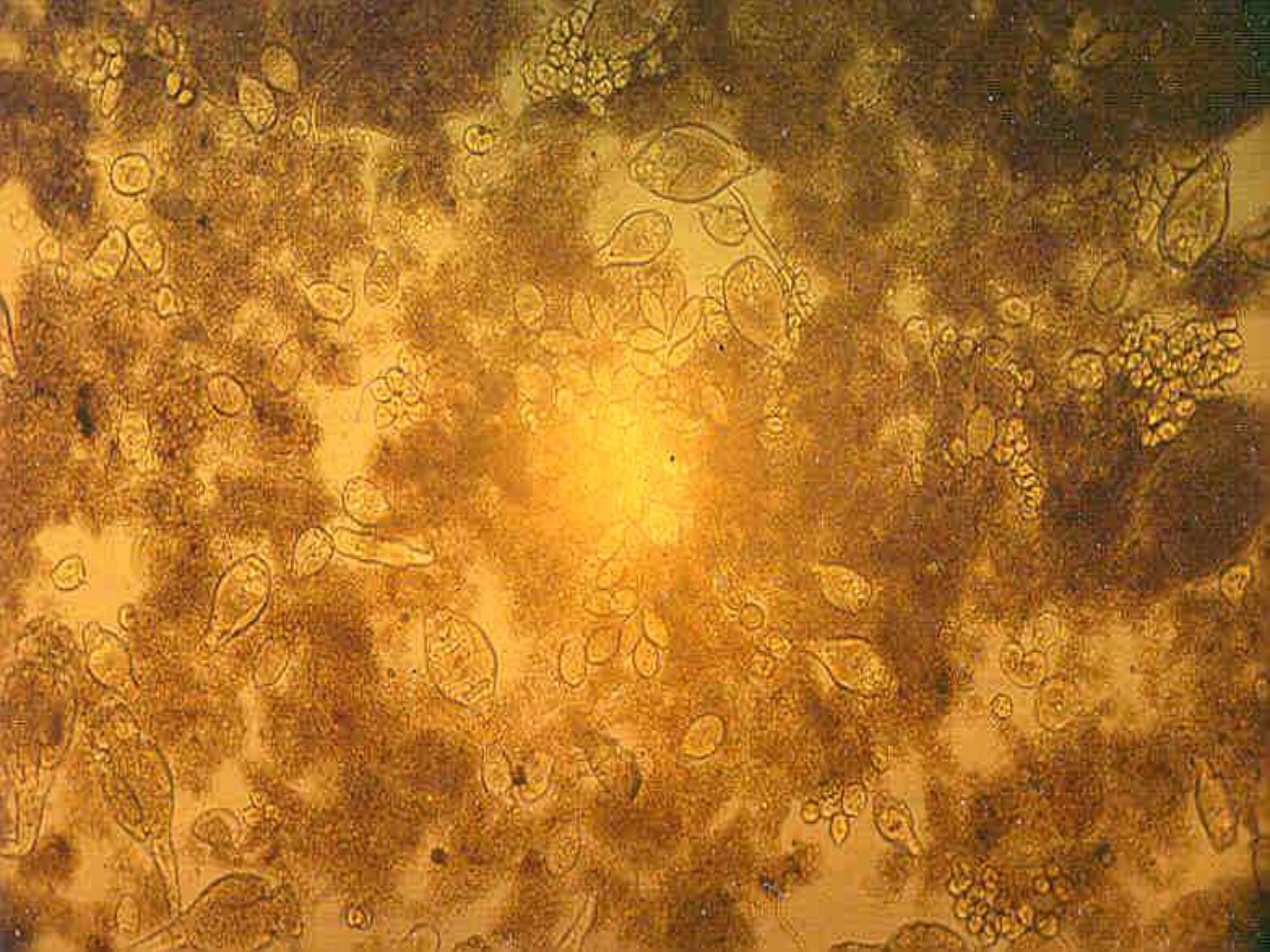
Low Energy Requirements

Nitrification

Few Nuisances

Wide Flow Range

Large Biological Population



ADVANTAGES OF RBC PROCESS

Simple Operation

Low Energy Requirements

Nitrification

Few Nuisances

Wide Flow Range

Large Biological Population

Handles Shock Loads

Low Head Loss

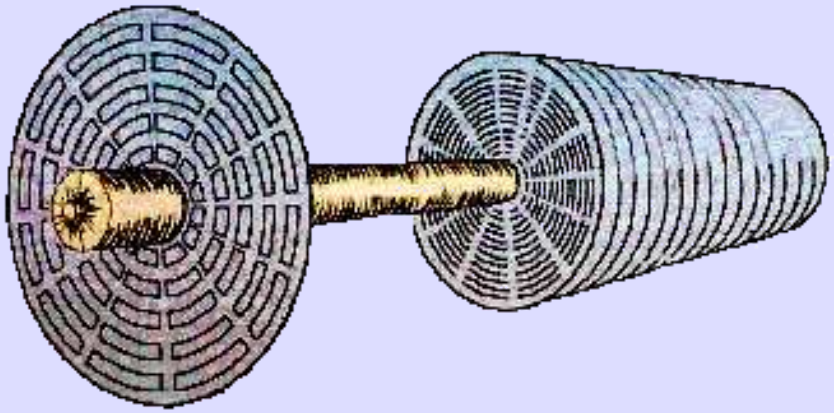
DISADVANTAGES OF RBC PROCESS

Limited Controls

Enclosures

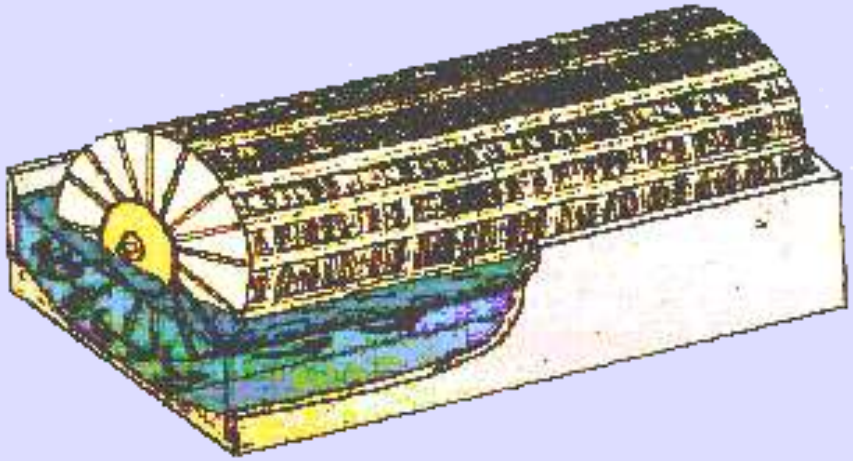
Limited Experience and Training

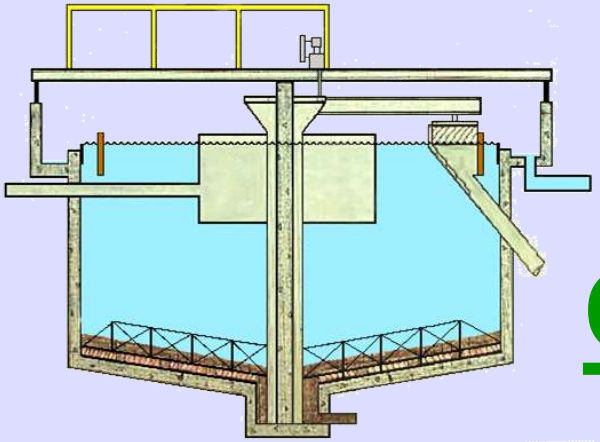
RBC COMPONENTS



CONTACTOR

TANK

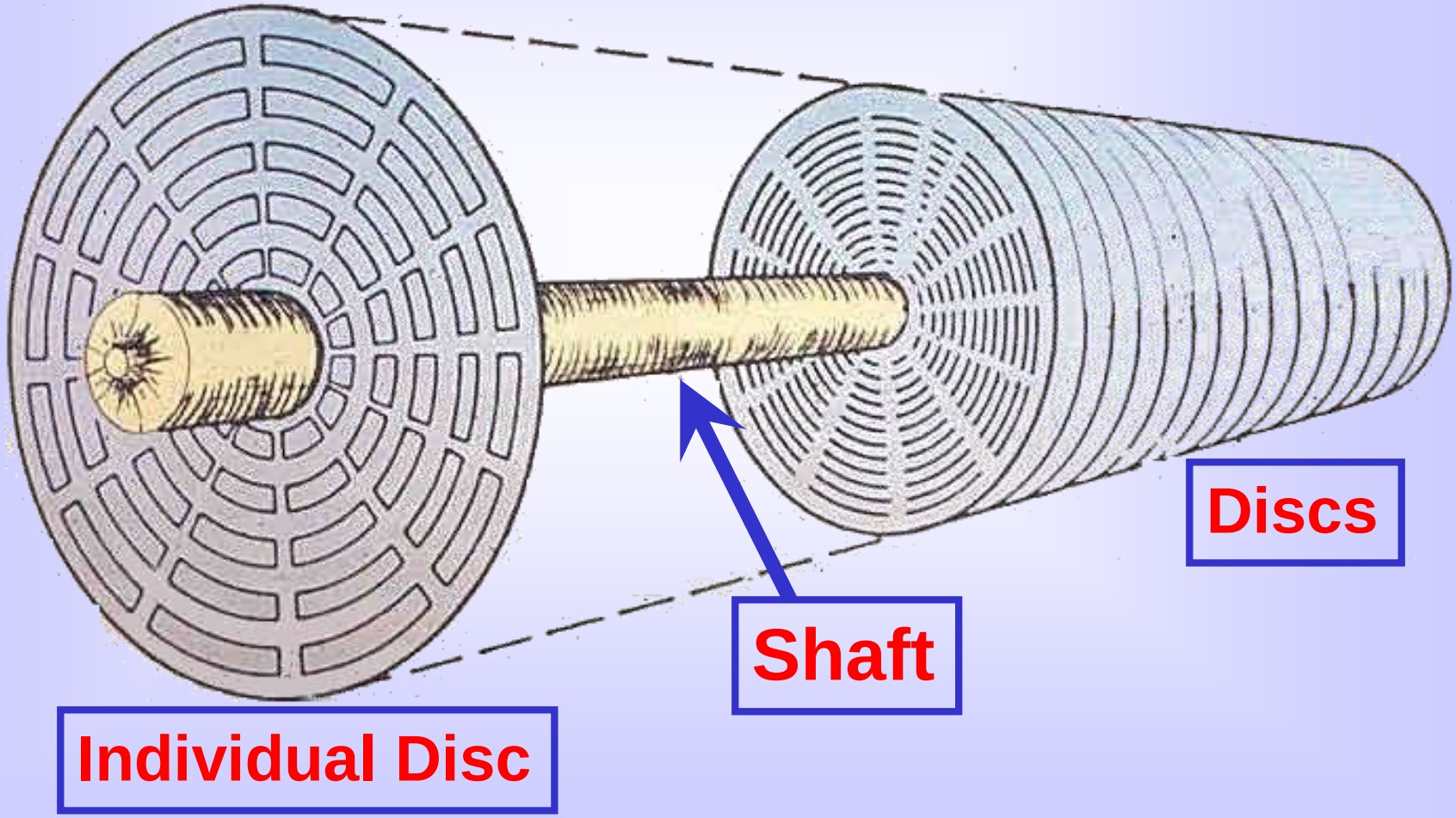




CLARIFIER

RBC COMPONENTS

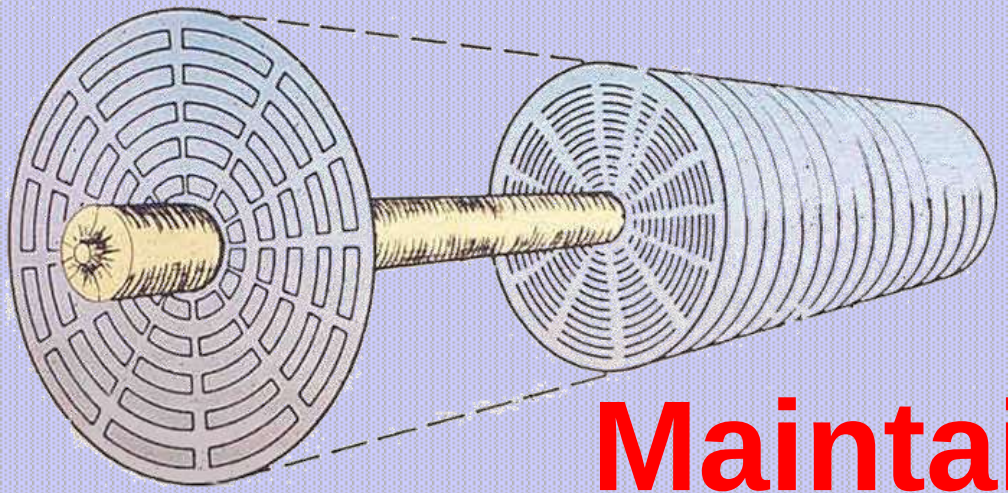
CONTACTOR



Media "High Density" Polyethylene

Carbon Black

Media – Irregular Surface



Maintain Spacing

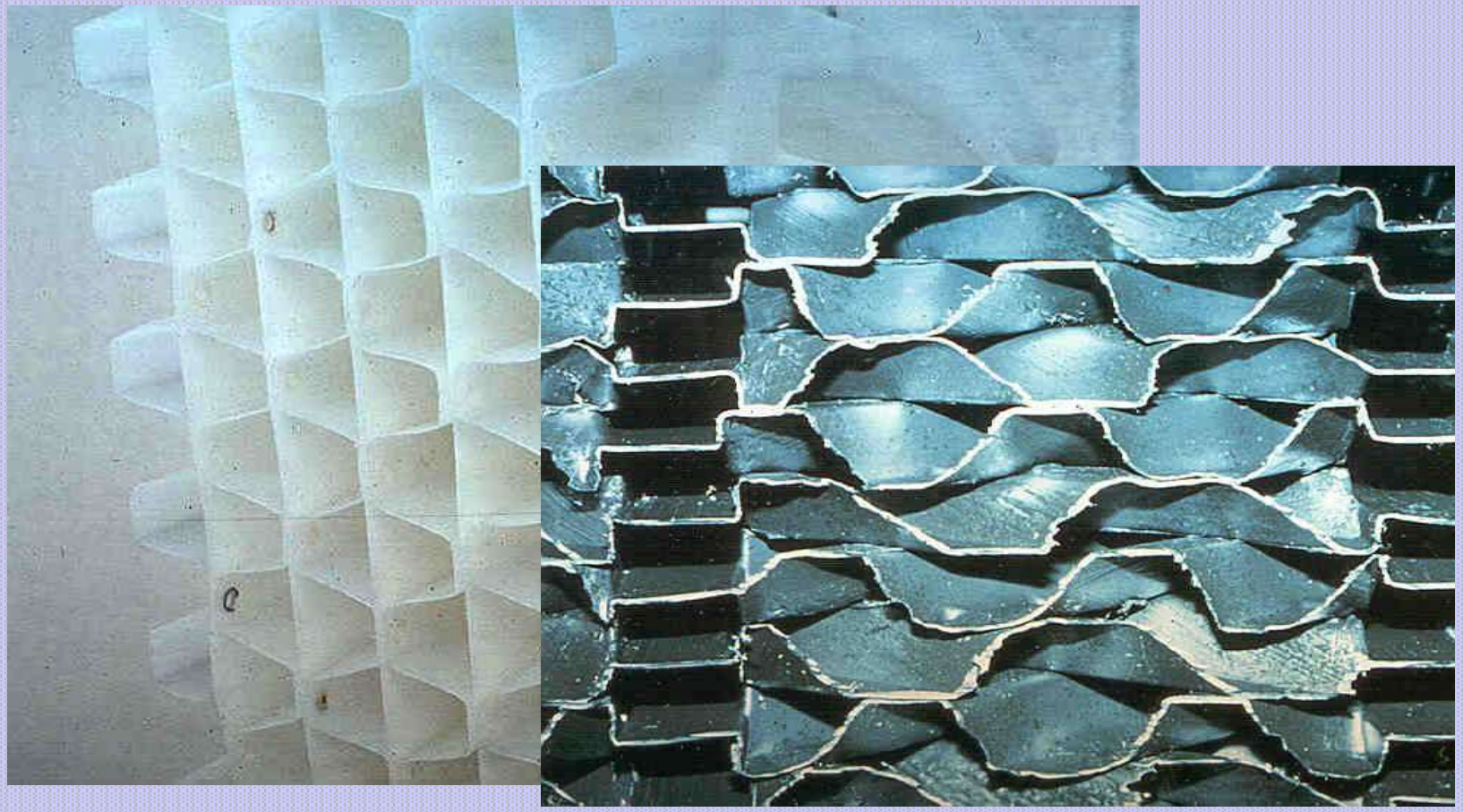
Increases Rigidity

Increases Surface Area

Increases Contact Time

Media – Irregular Surface

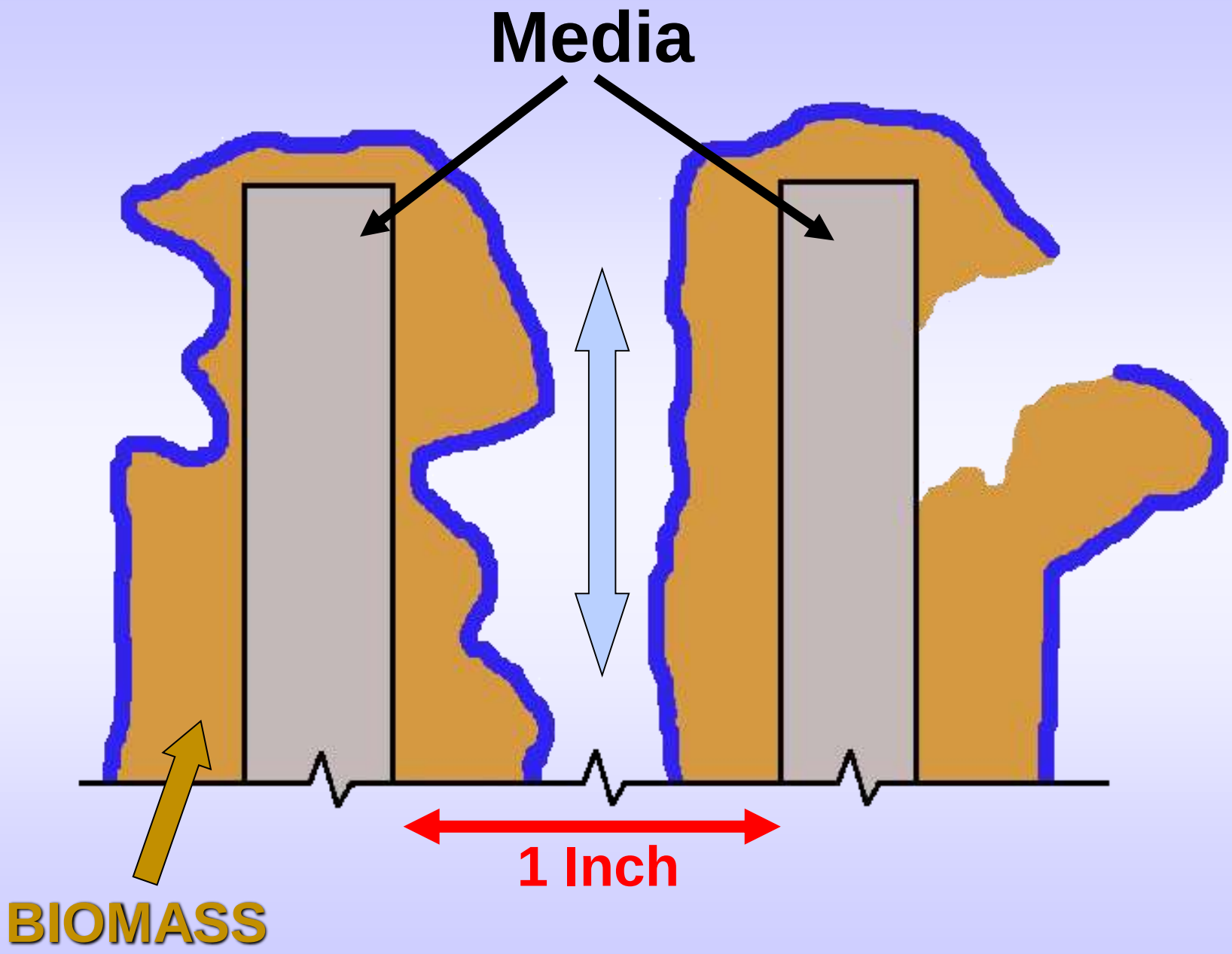
“Corrugated”

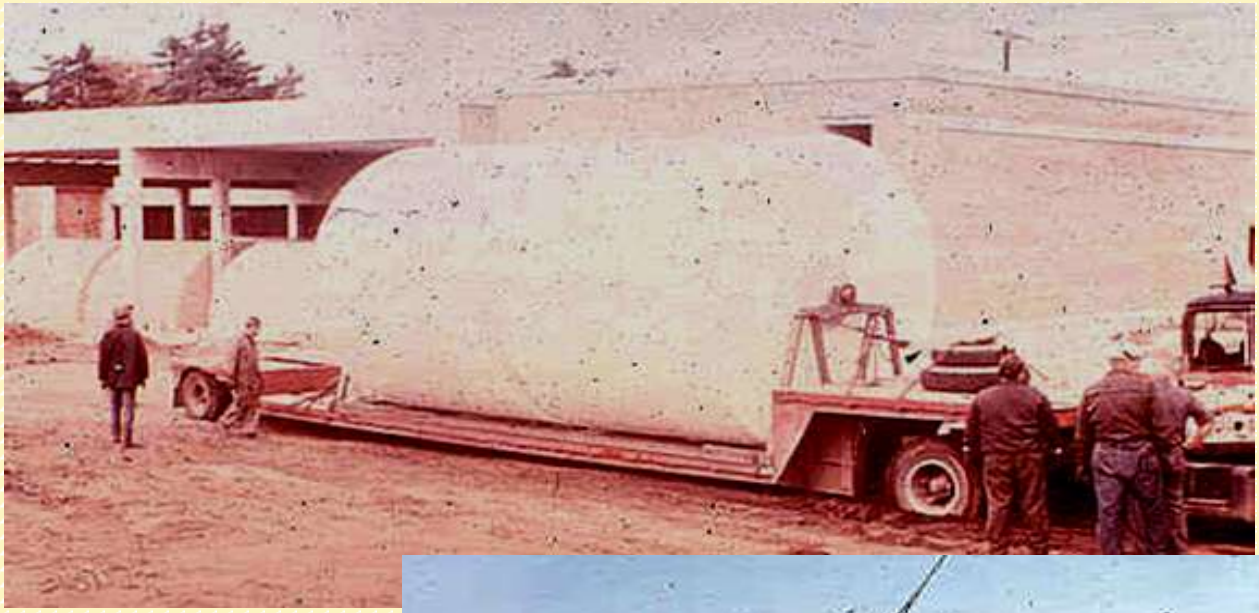


Media – Irregular Surface

“Dimpled”

“Random Fill”


Media
1 Inch
BIOMASS

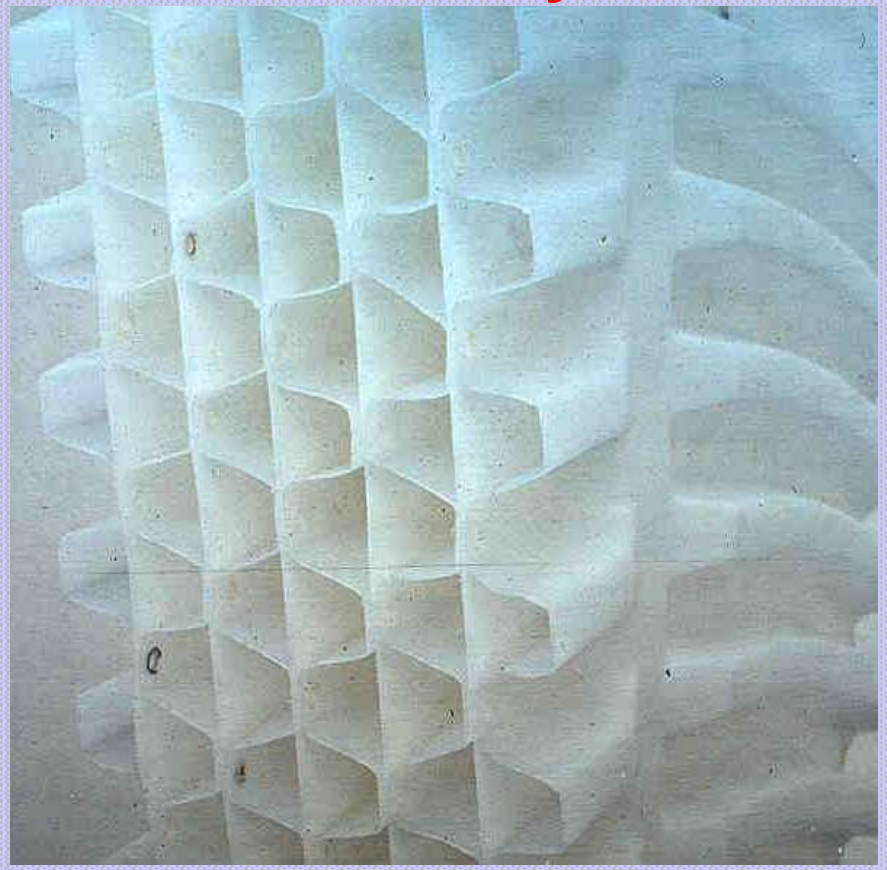


10 to 12 Ft Diameter

~ 25 Ft Long

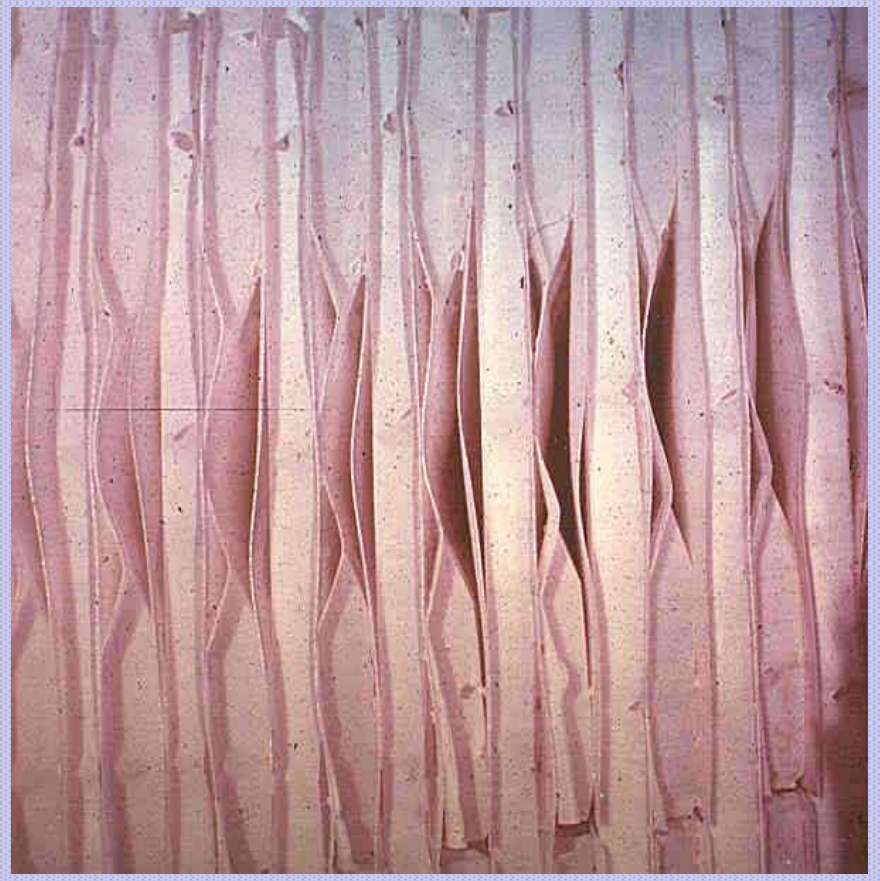
Media

Standard Density

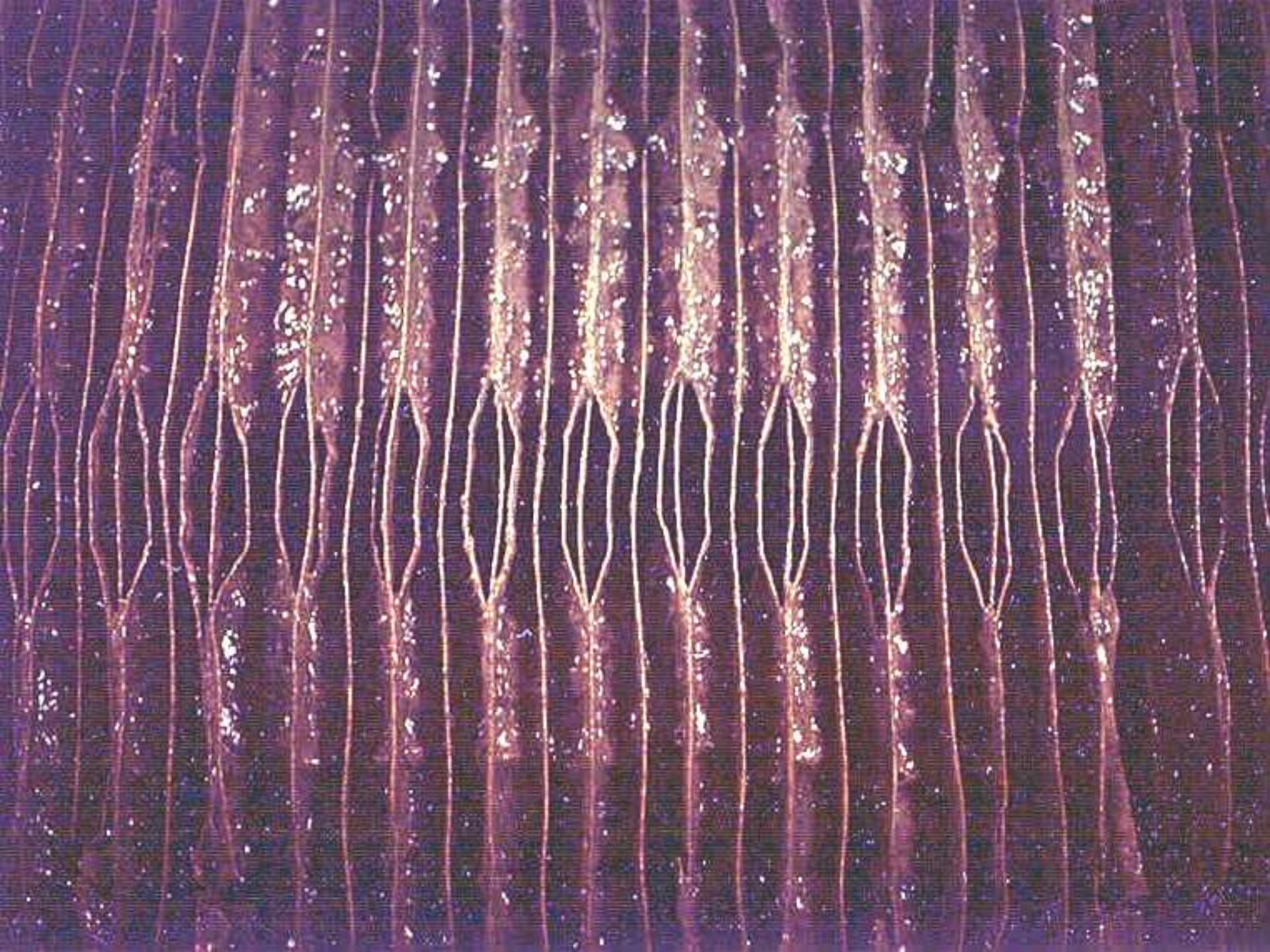


1 inch

High Density

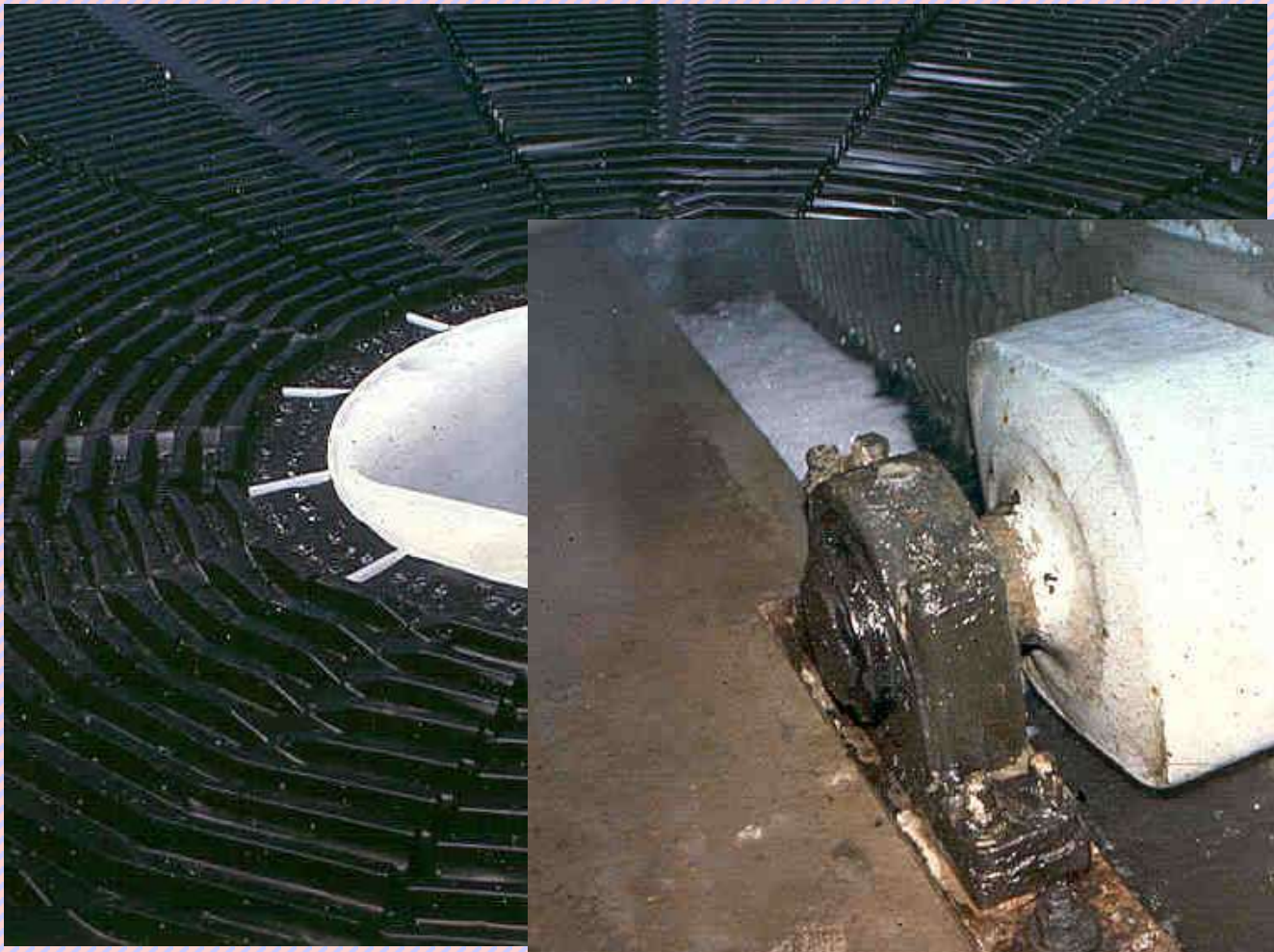


¾ inch

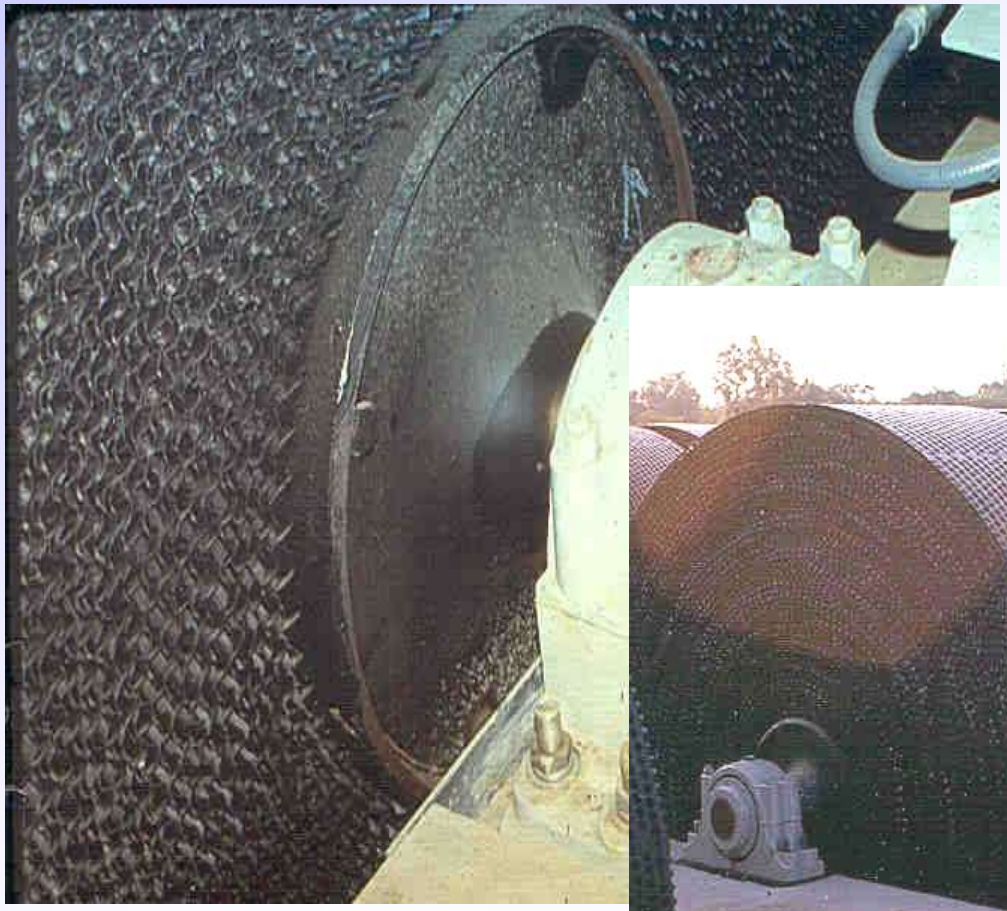


Shaft

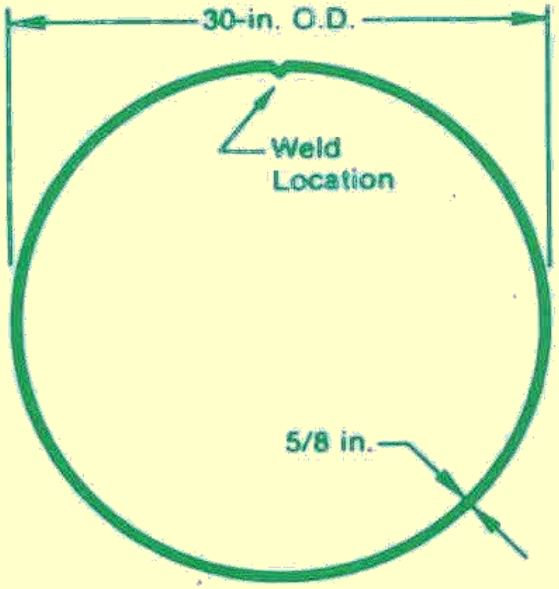
Square Shaft



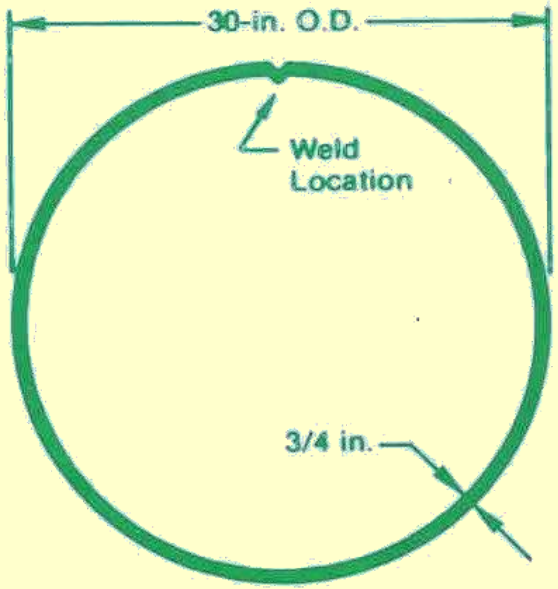
Round Shaft



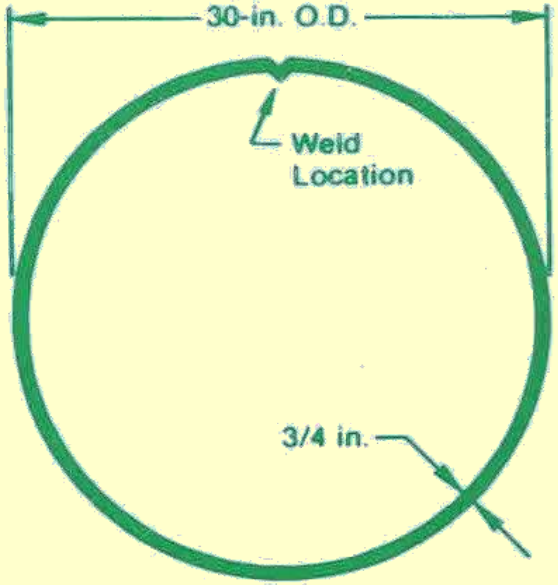
Octagonal Shaft



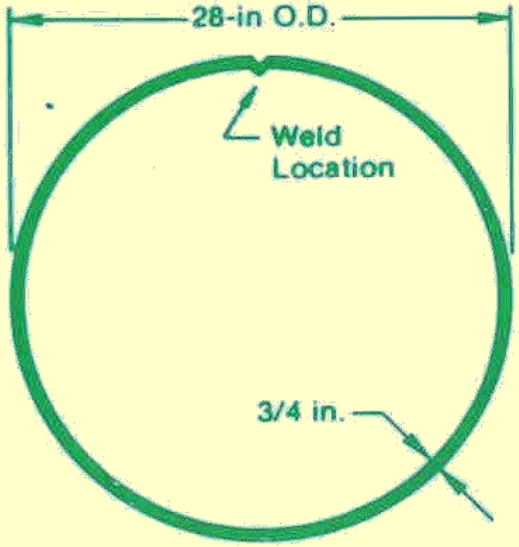
CLOW



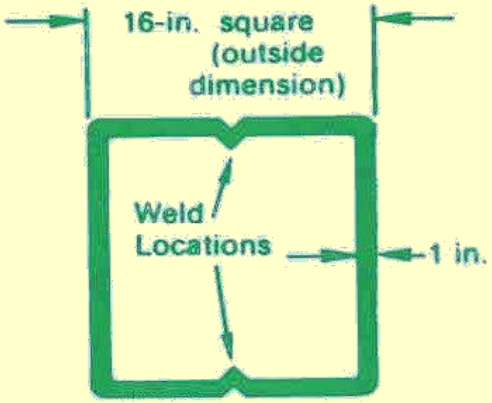
WALKER PROCESS



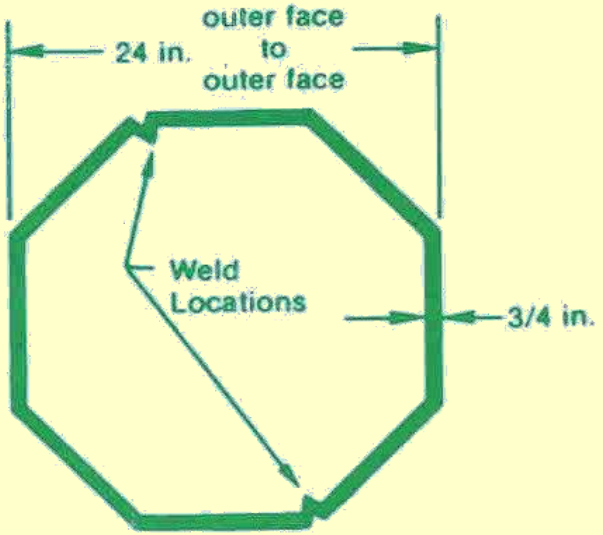
CRANE-COCHRANE



LYCO



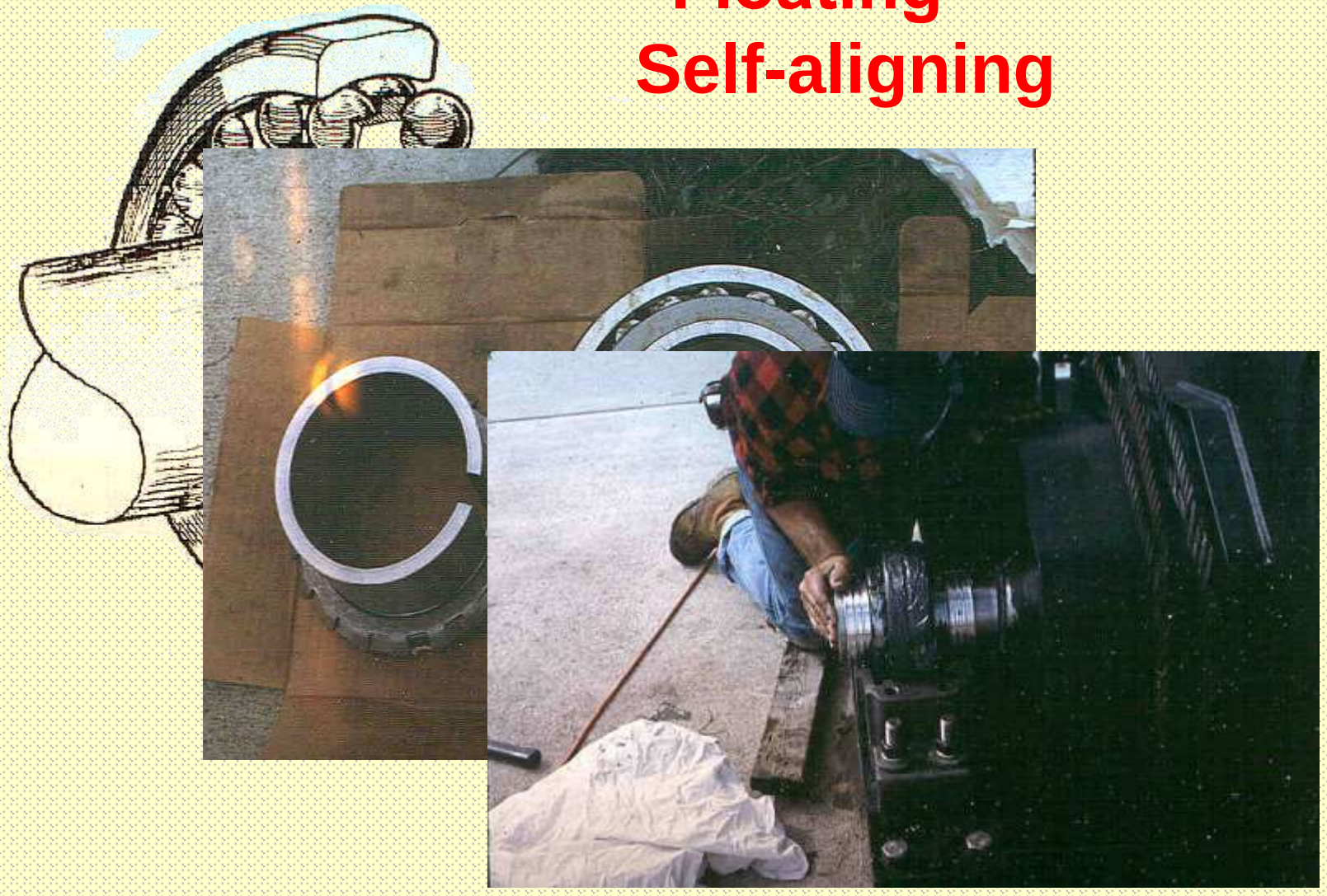
AUTOTROL



LYCO/HORMEL

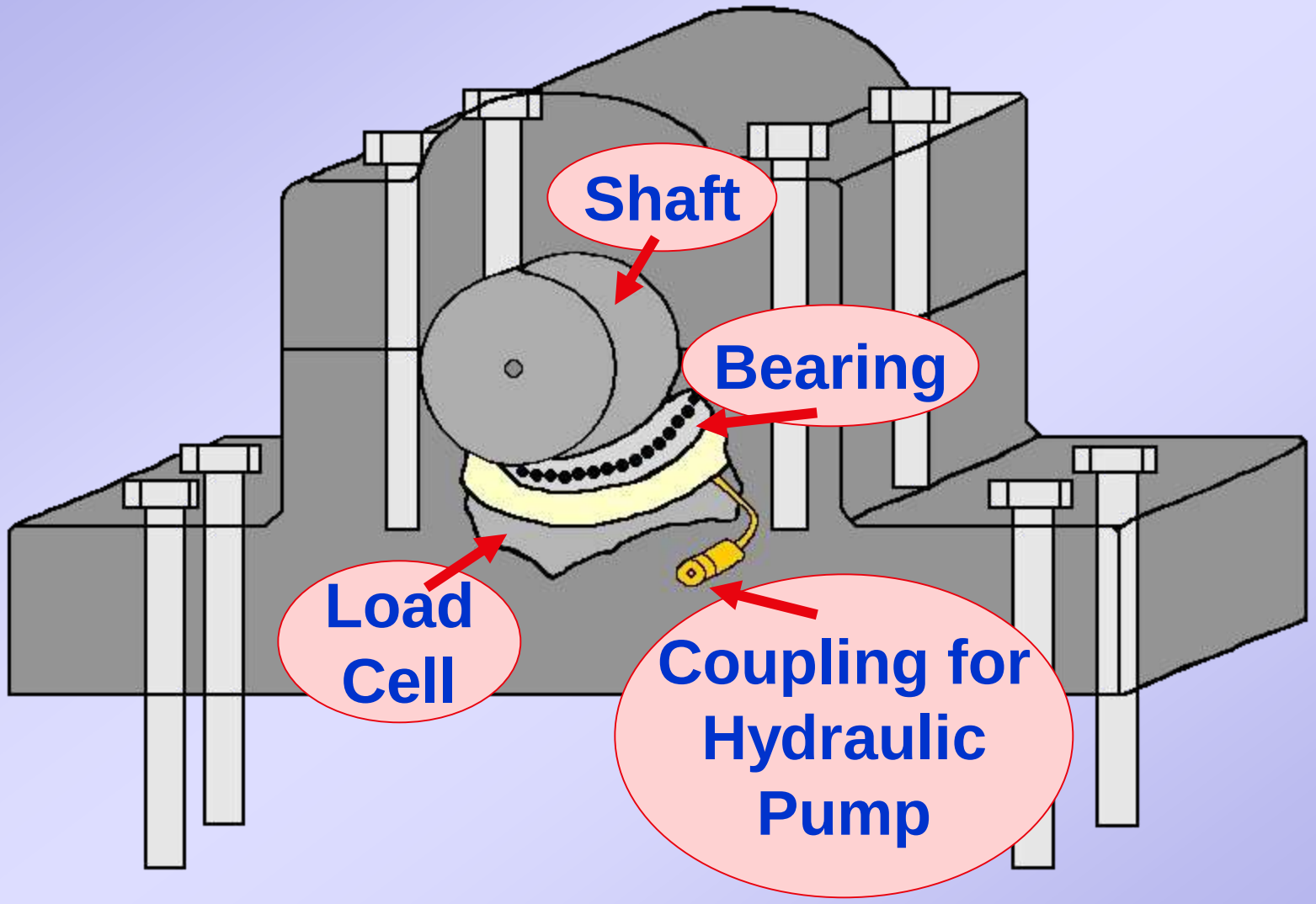
Bearings

“Floating”
Self-aligning

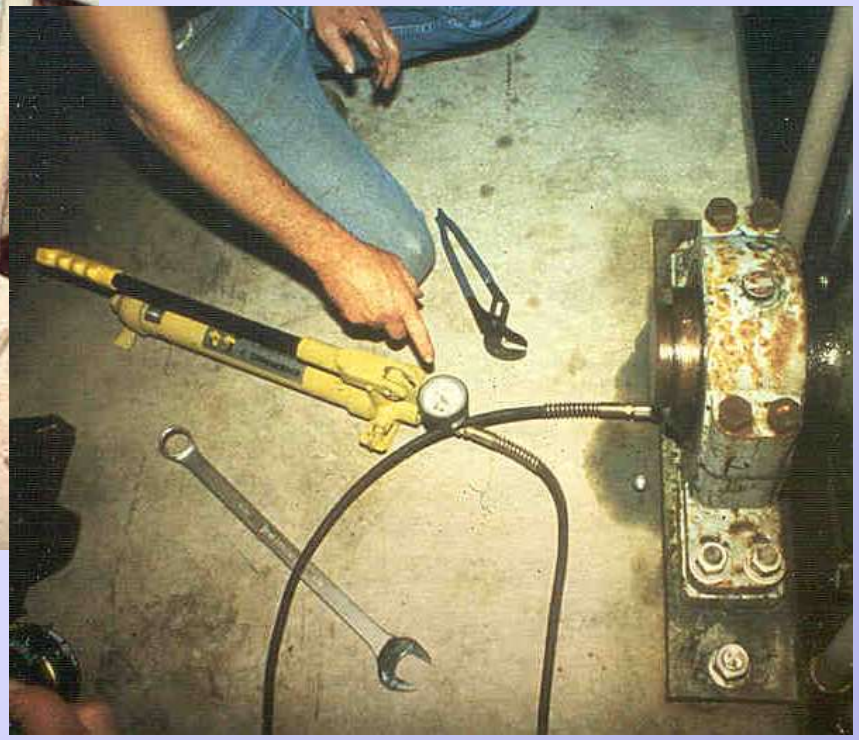


Bearings

Load Cells



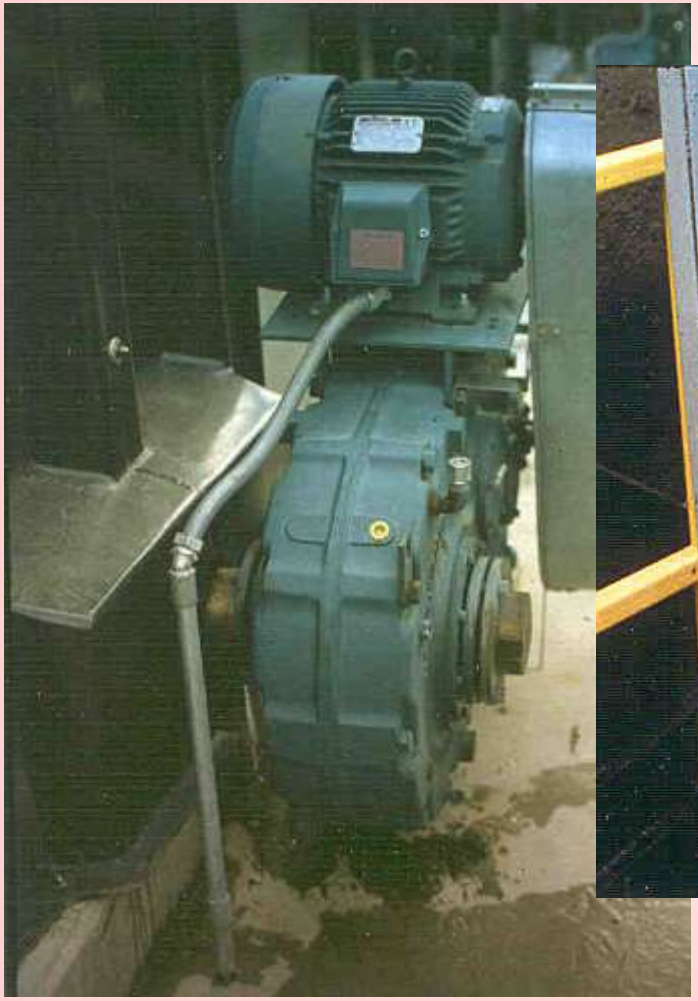
Load Cells

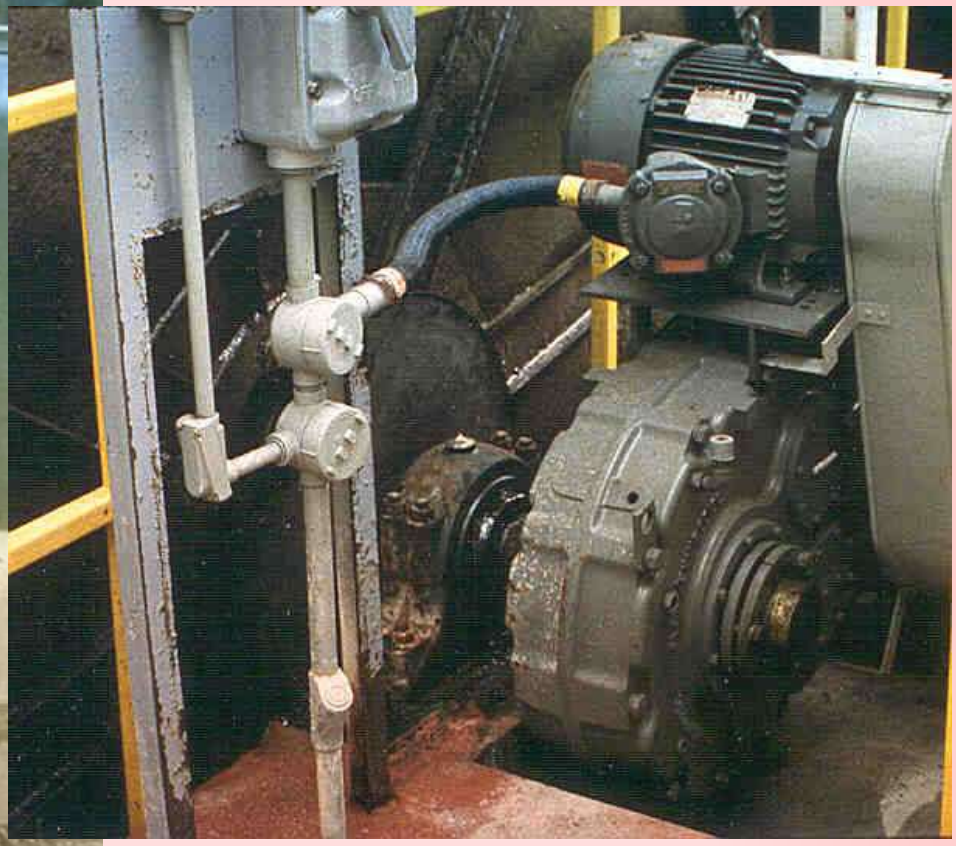


Purpose: Determine Weight of Contactor to Determine Amount (Thickness) of Biomass

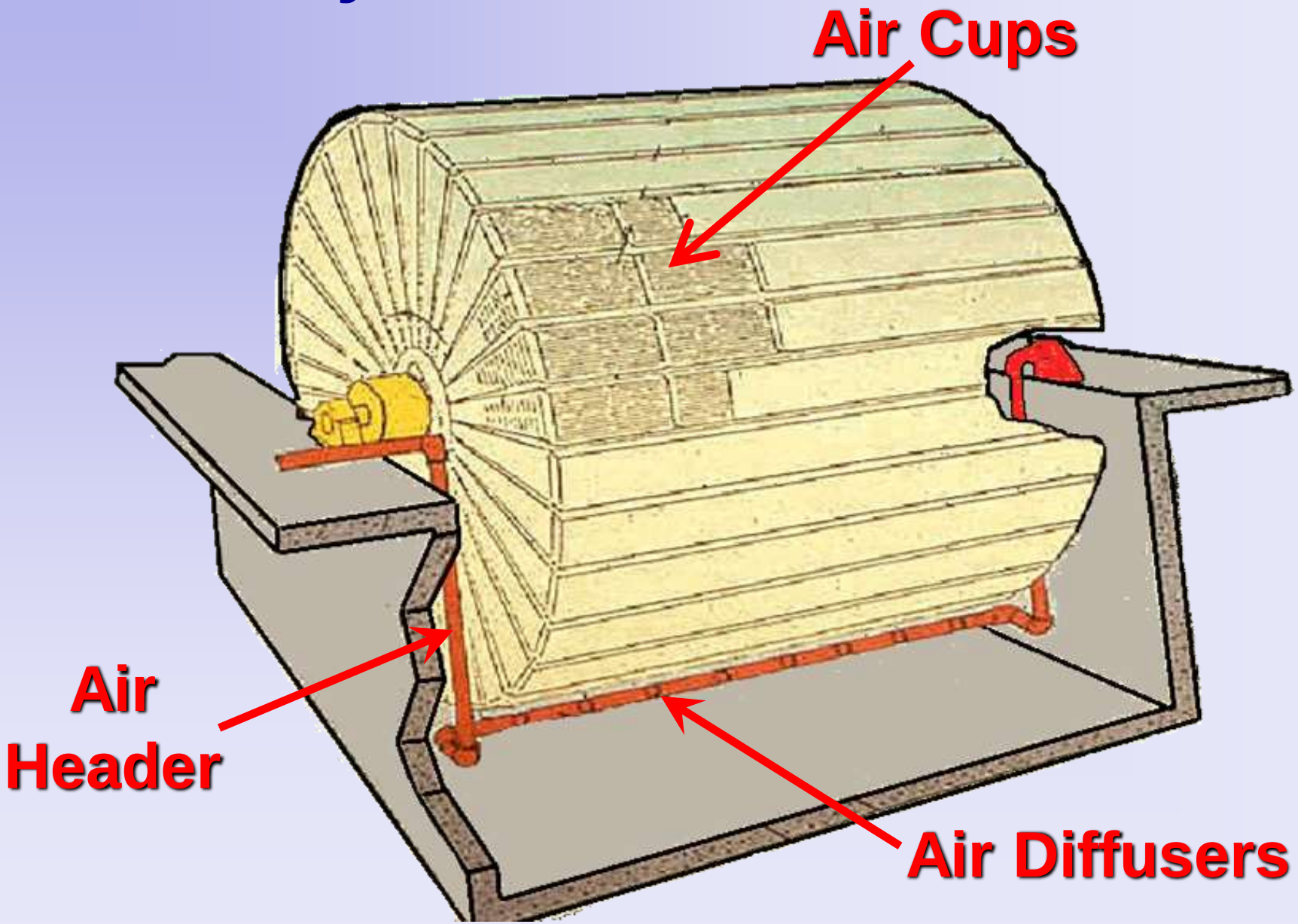
Drive Systems - Chain

Drive Systems - Direct

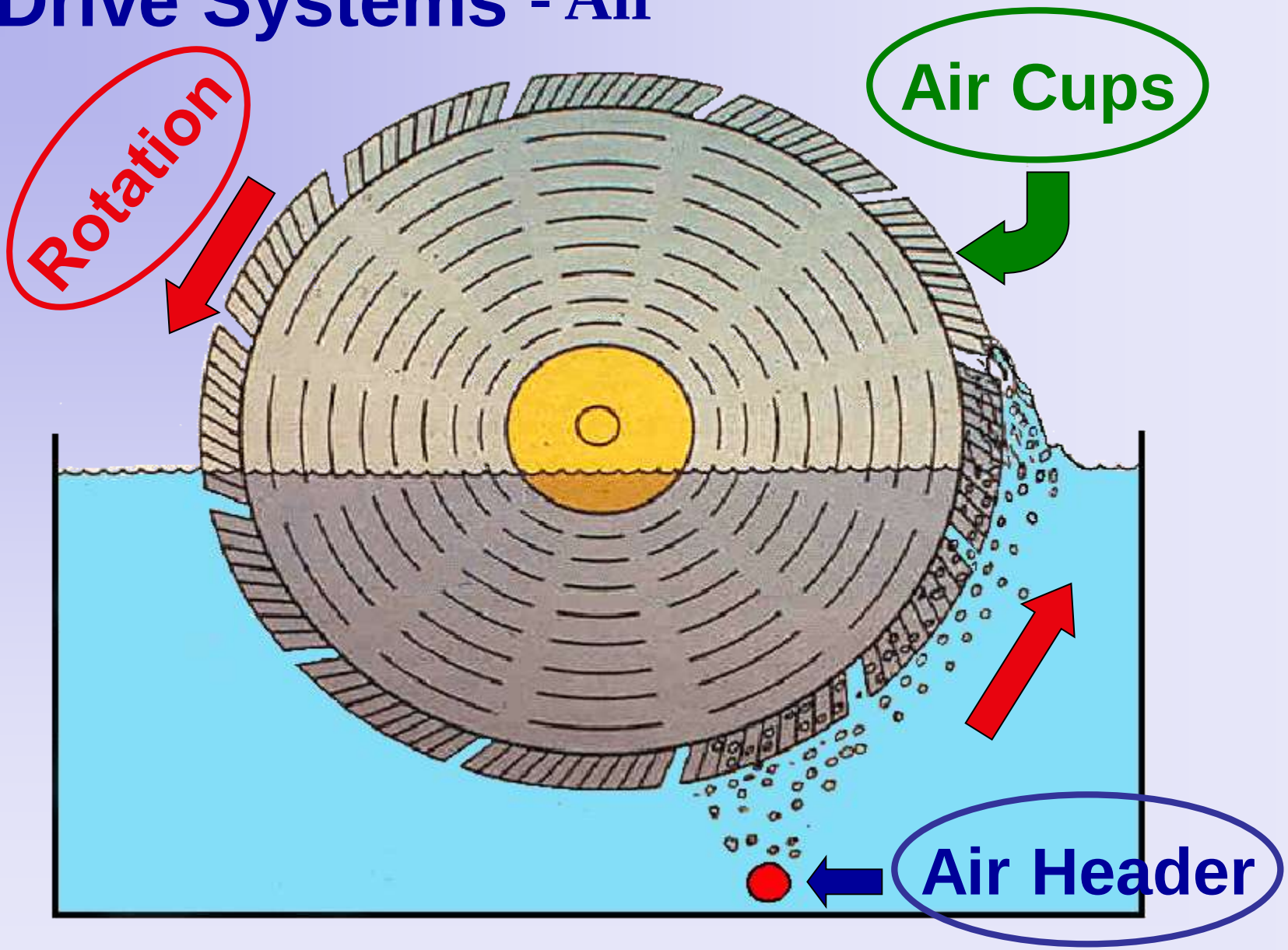




Drive Systems - Air



Drive Systems - Air

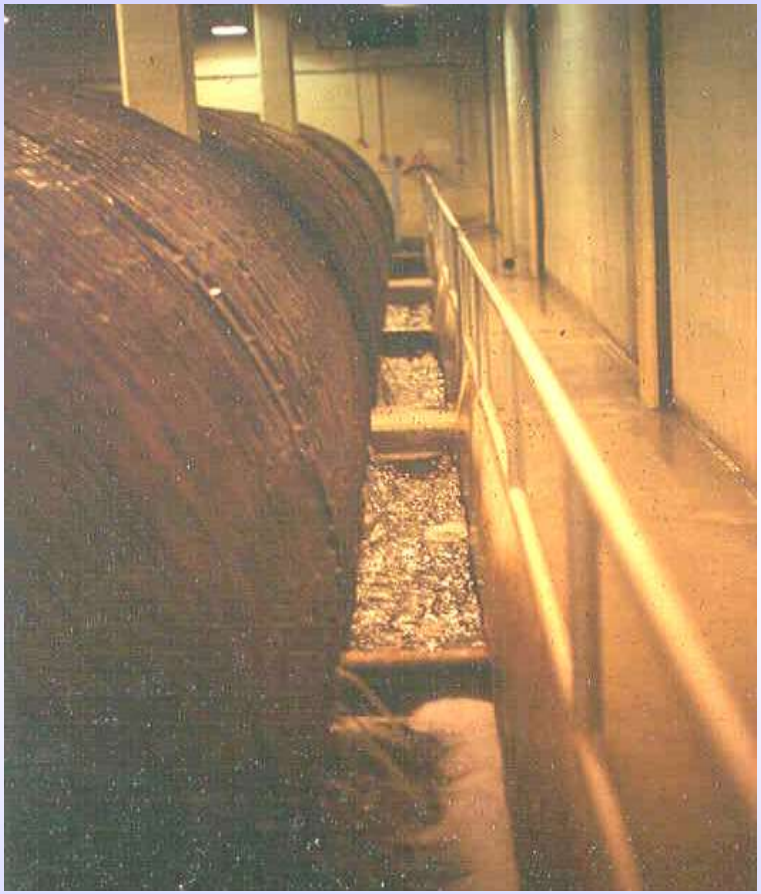


Drive Systems - Air

Drive Systems - Air

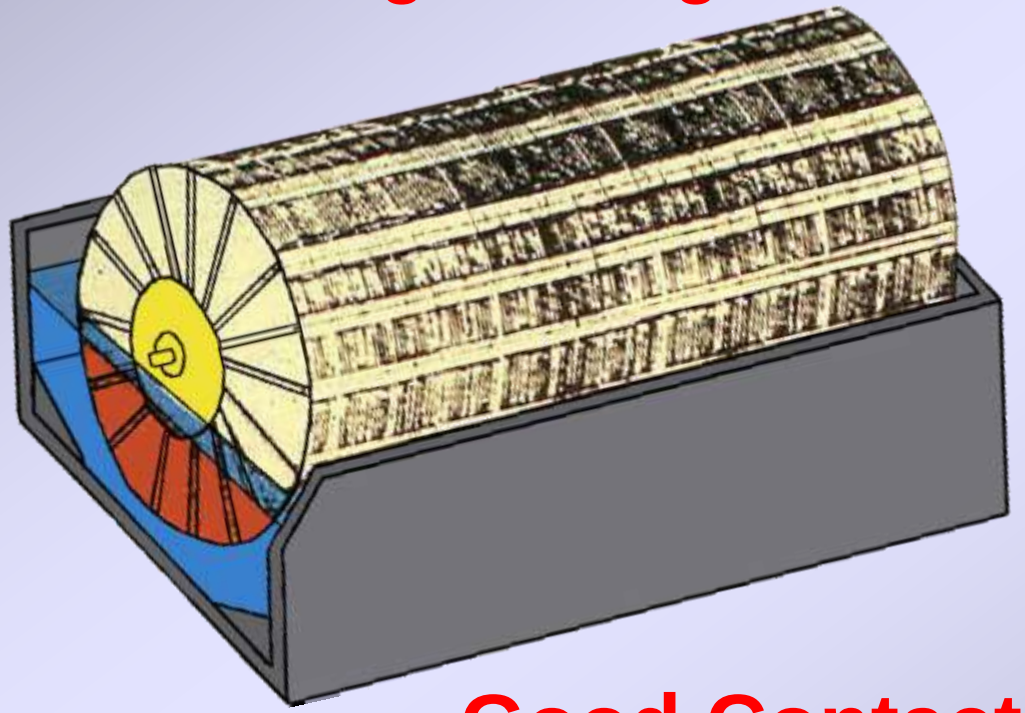
Drive Systems - Combination

Containment



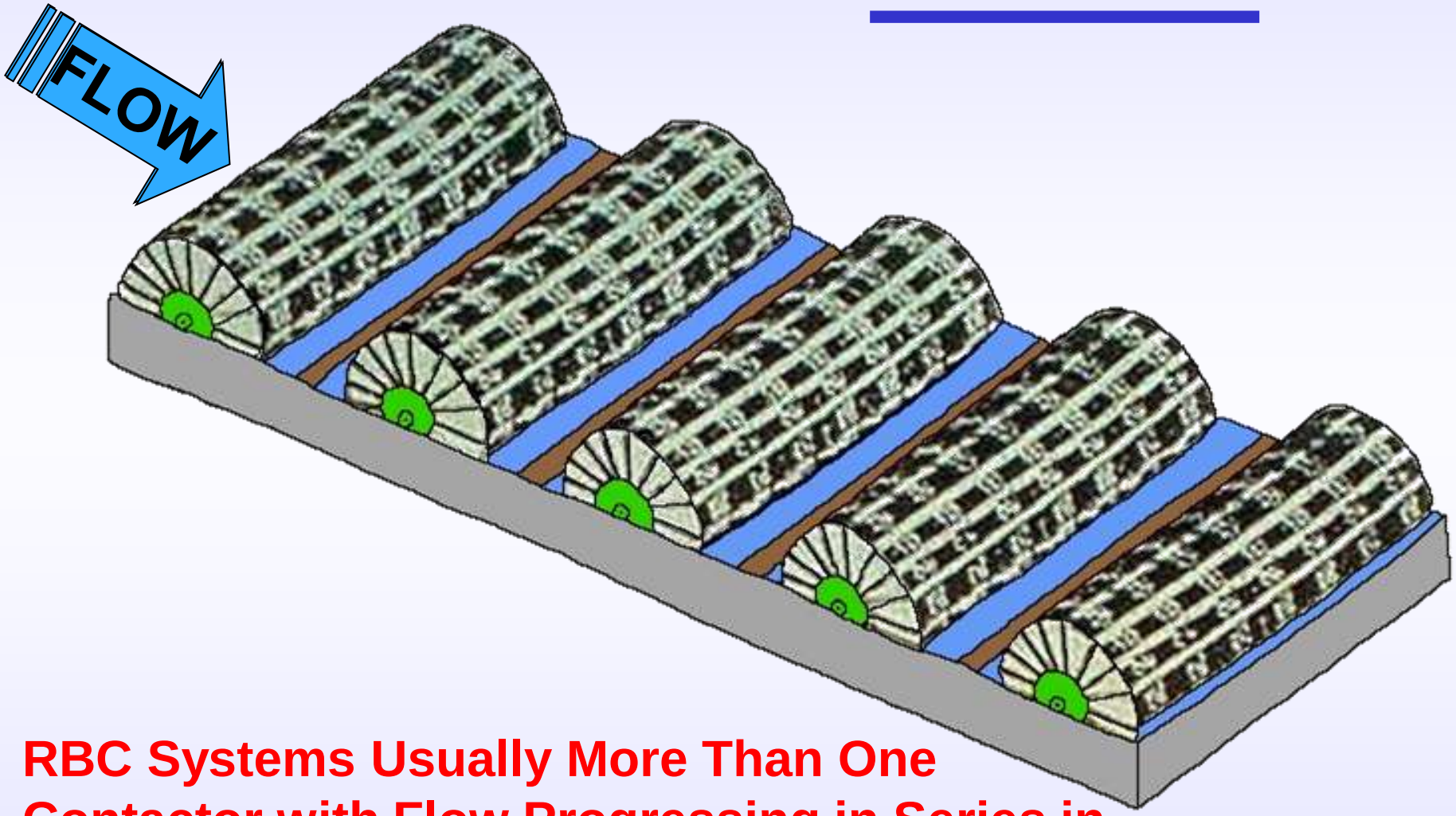
Containment

Just Large Enough



Good Contact
Minimal Short Circuiting
Good Mixing

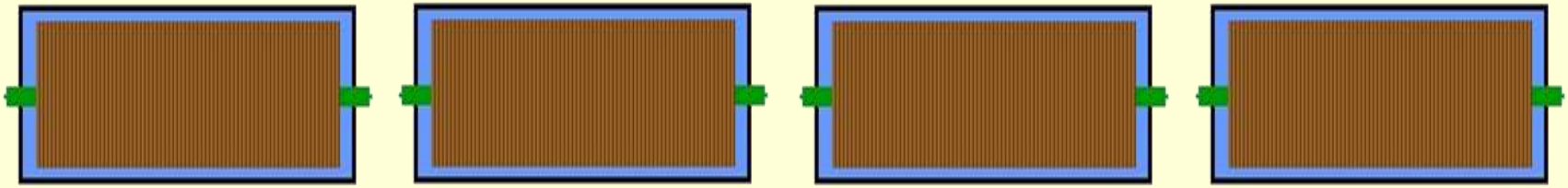
“Train”



RBC Systems Usually More Than One Contactor with Flow Progressing in Series in a “Train”

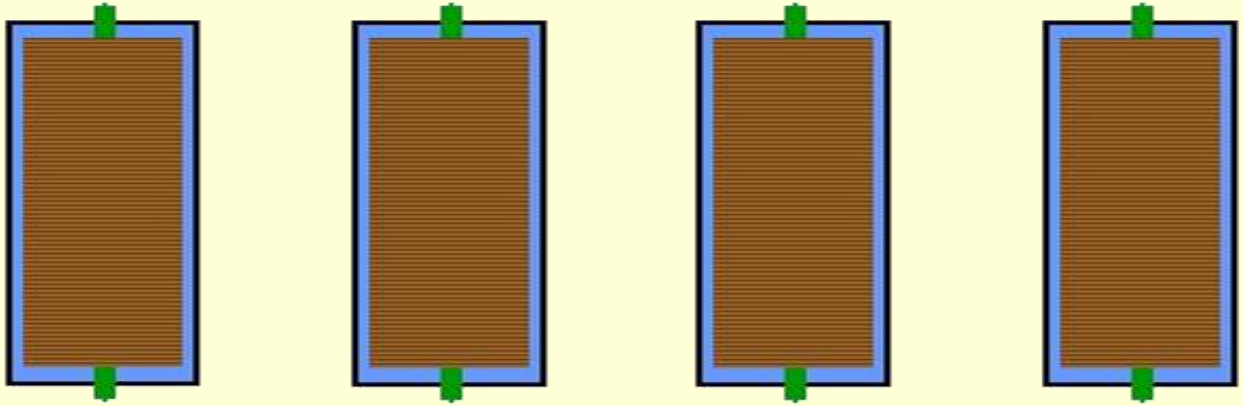
Flow Schemes

Parallel to Shaft



Direction of Flow

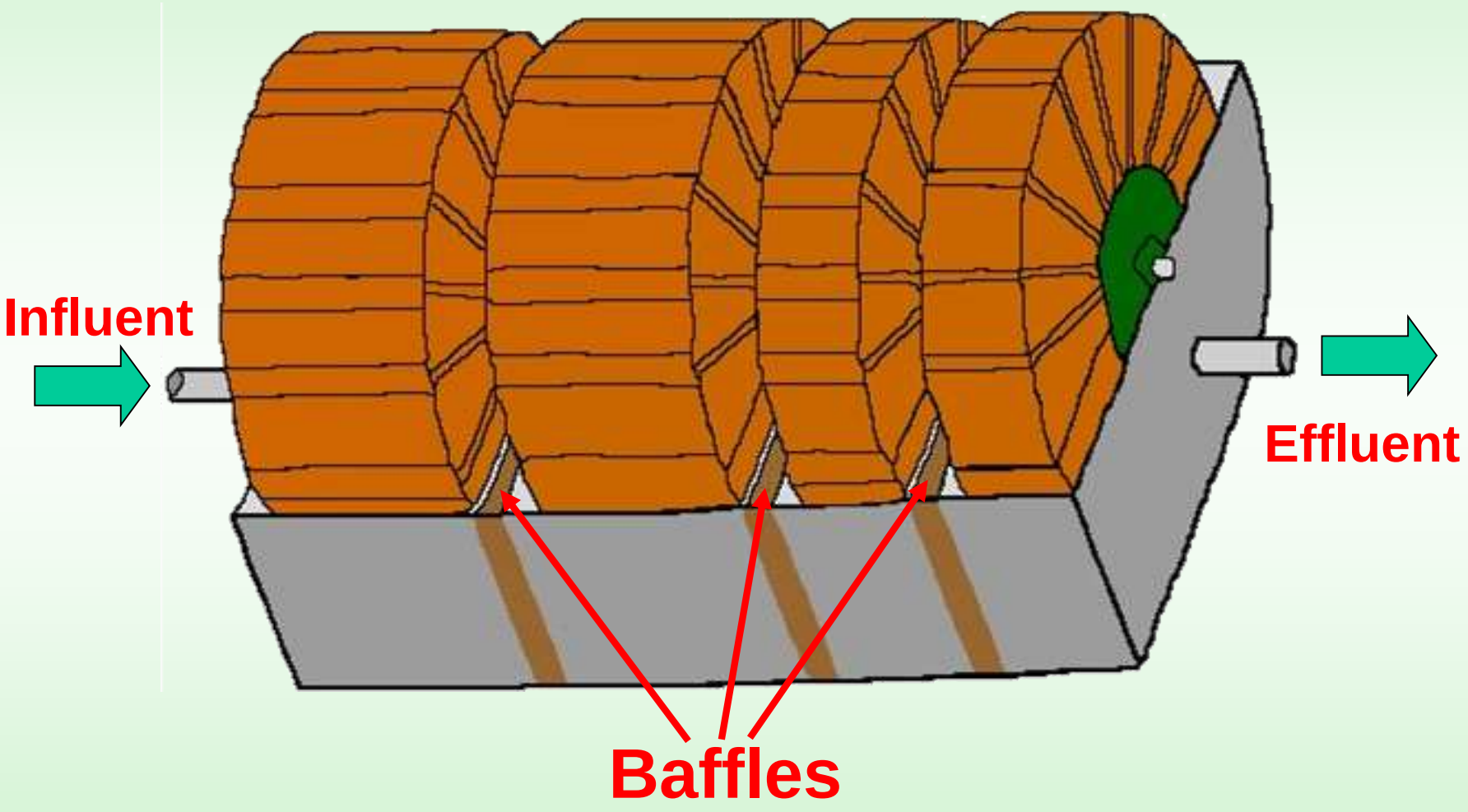
Perpendicular to Shaft



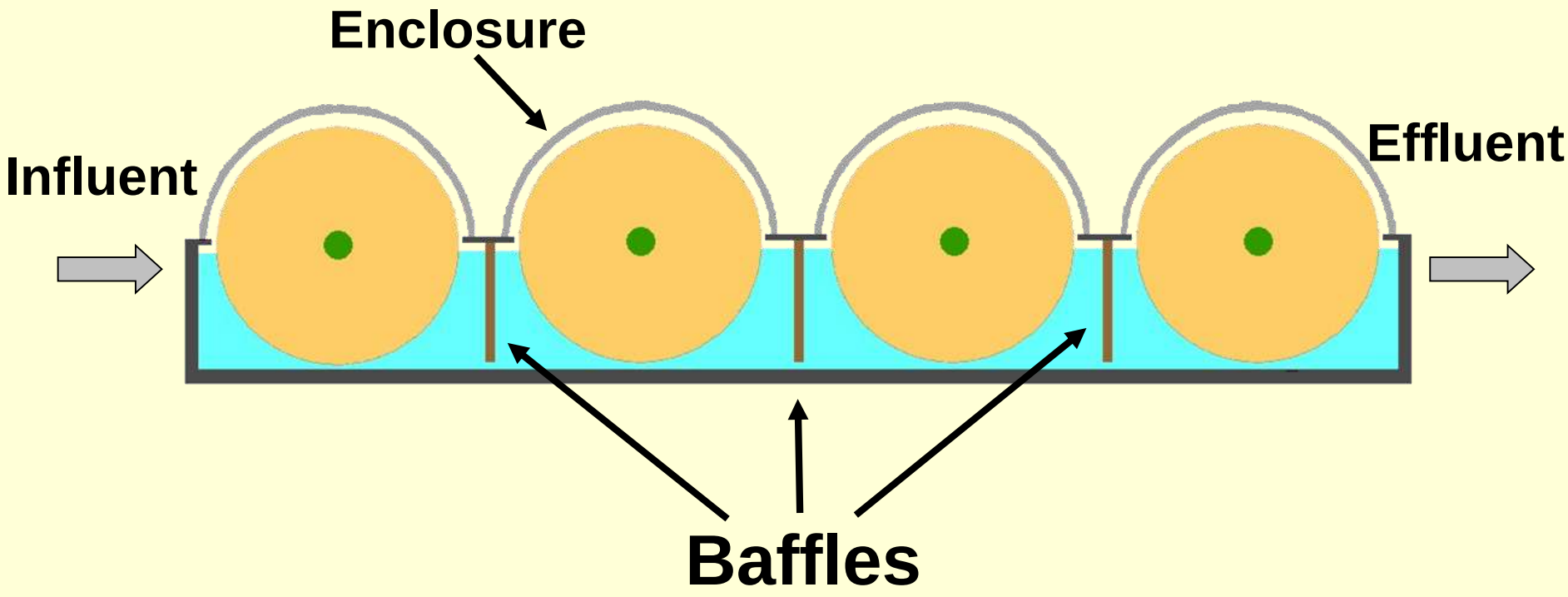
Contactors May be Arranged With Flow Either Parallel or Perpendicular to Shafts

“Train”

Small Systems – Train May be One Contactor with Separations and Baffles

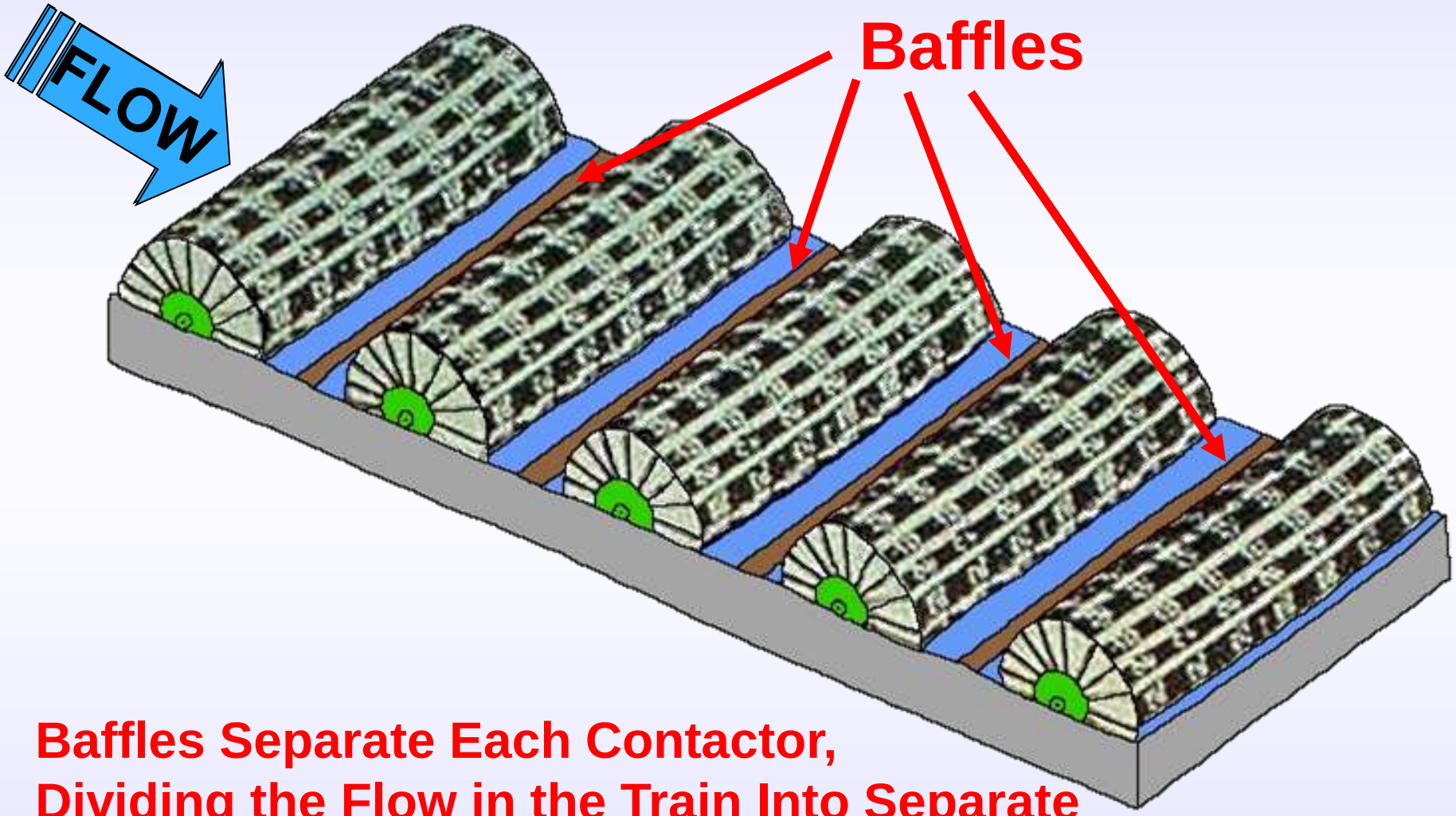


Larger Systems – Contactors are Set in Series in Separate Tanks or in One Tank With



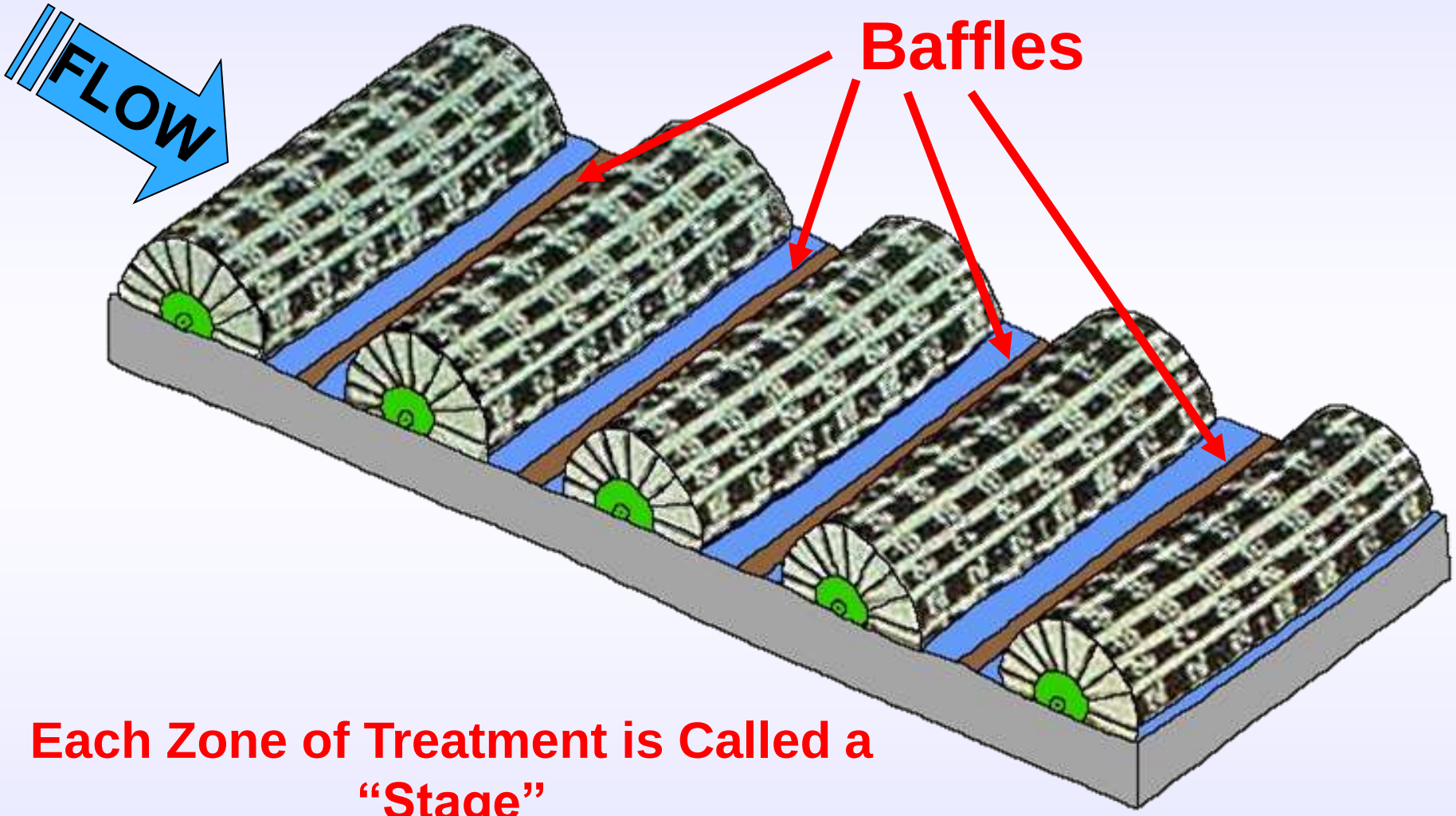
Baffles

Train



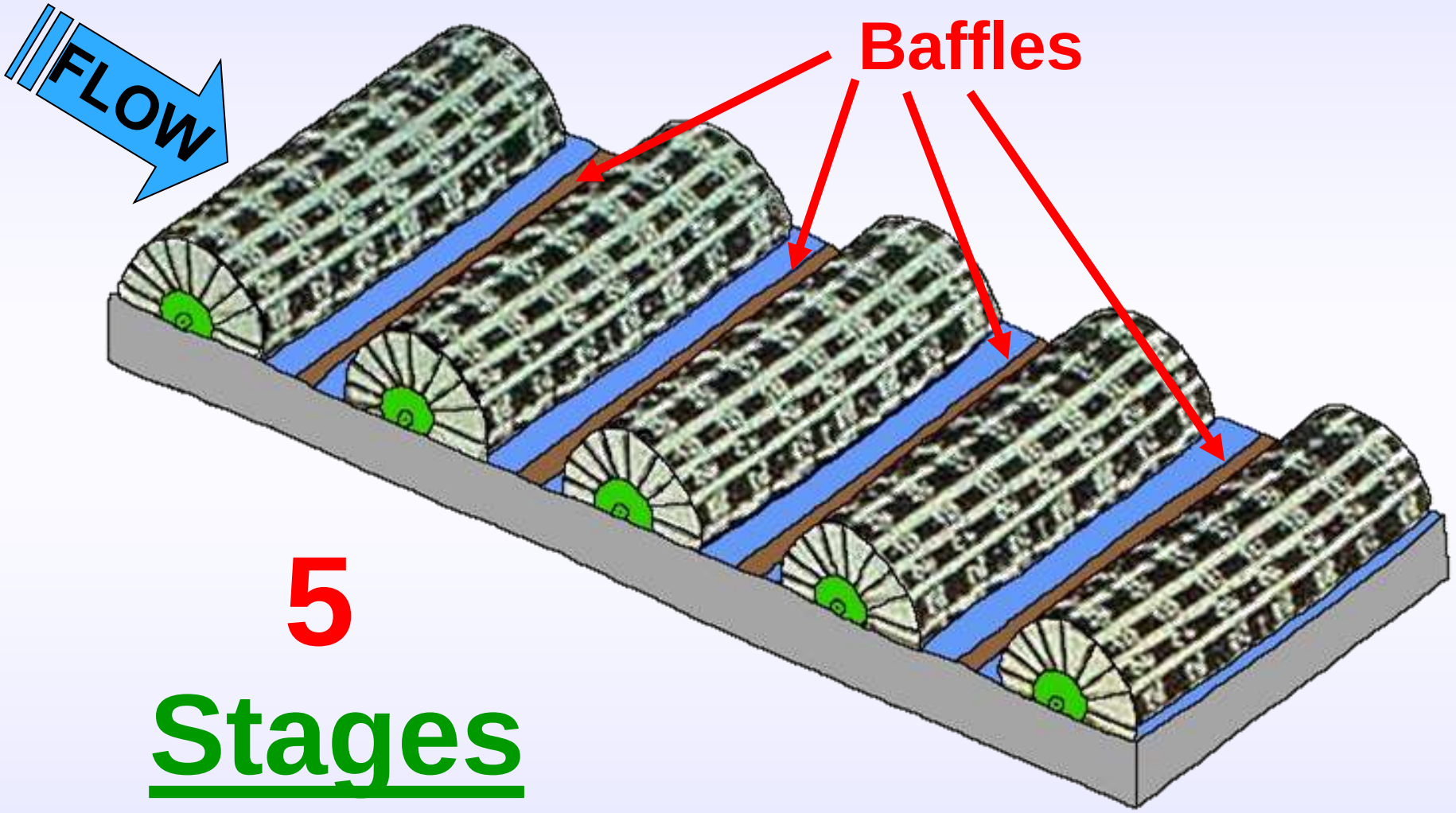
Baffles Separate Each Contactor, Dividing the Flow in the Train Into Separate Complete Mix Zones of Treatment

Train



Each Zone of Treatment is Called a "Stage"

Train



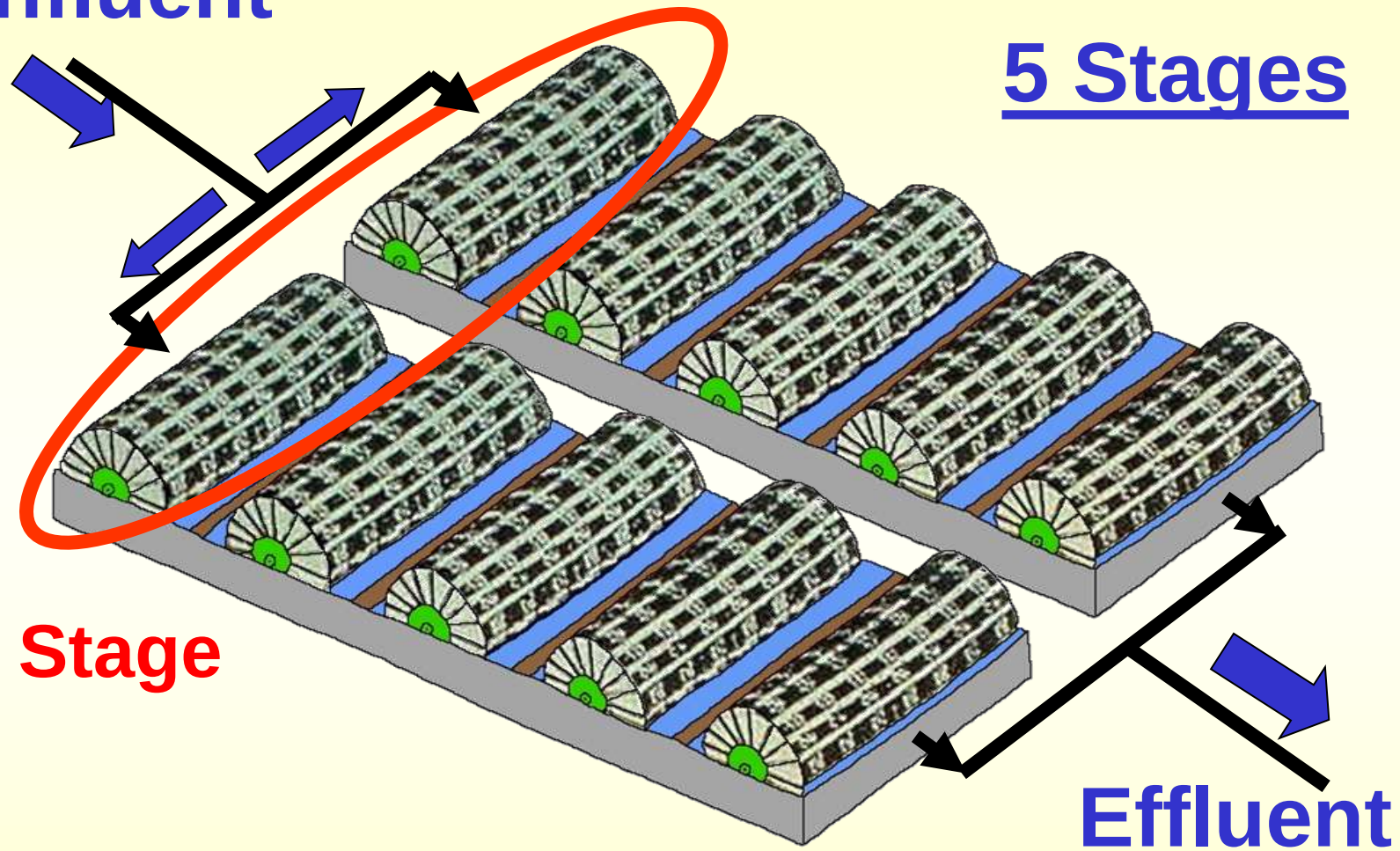
5

Stages

(Zones of Treatment)

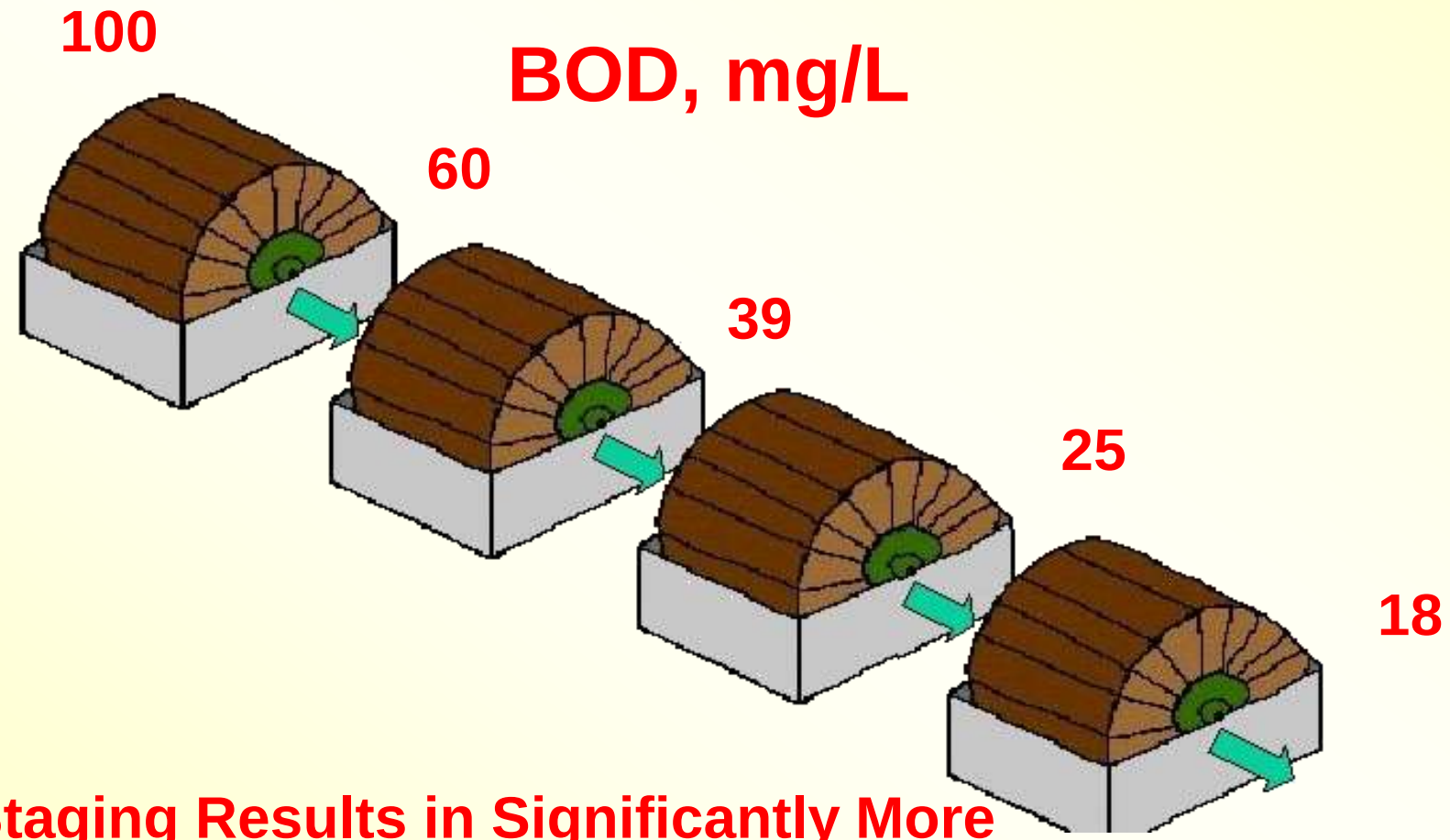
2 Trains

5 Stages



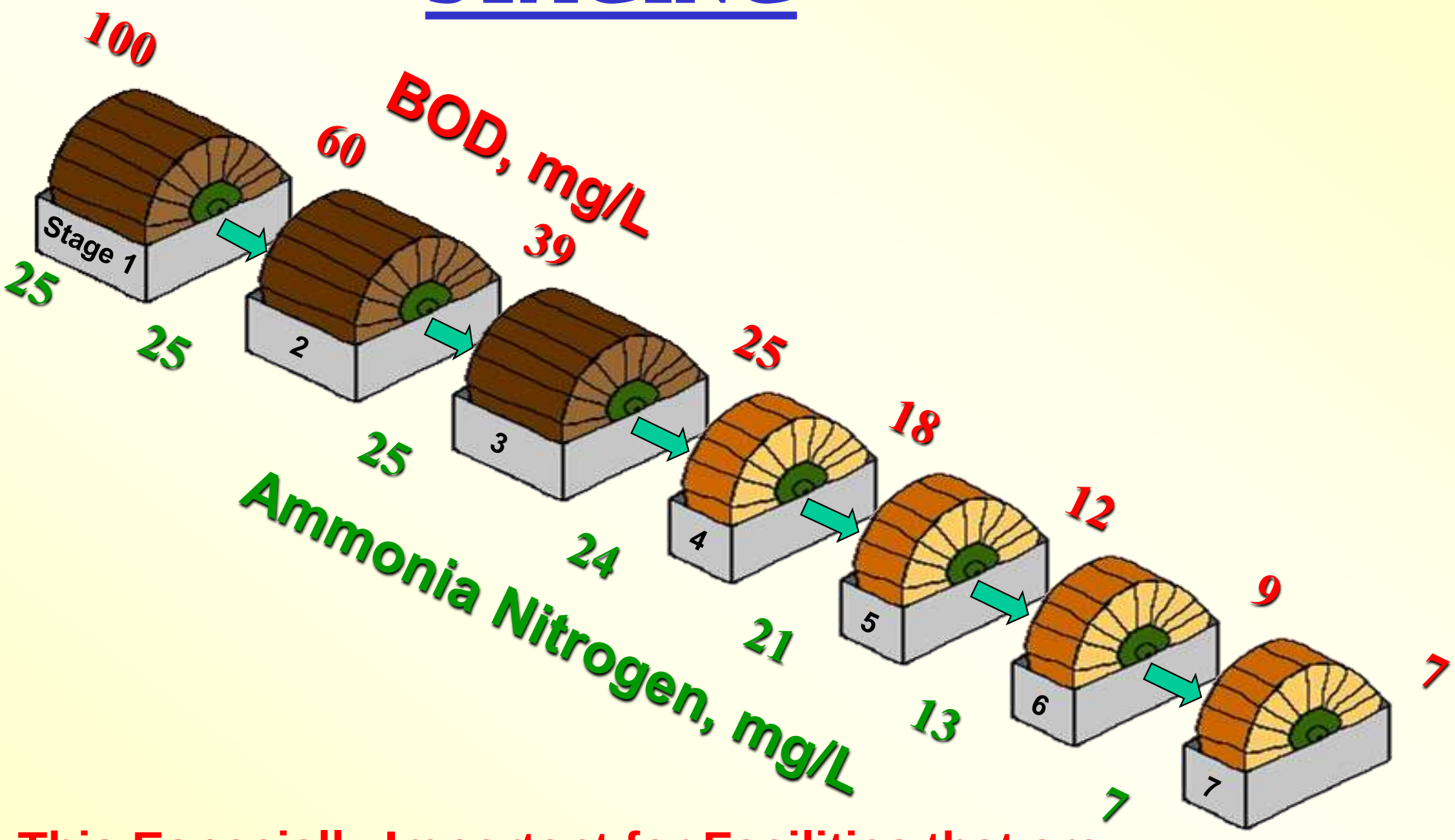
When a System Has More Than One Train, Each Zone in the System That Receives the Same Loading is Considered One "Stage"

STAGING



Staging Results in Significantly More Efficient Treatment

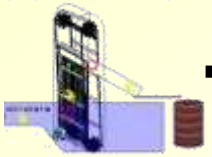
STAGING



This Especially Important for Facilities that are Required Nitrify Ammonia

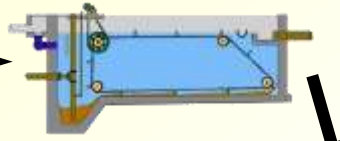
RBC Flow Scheme

INFLUENT

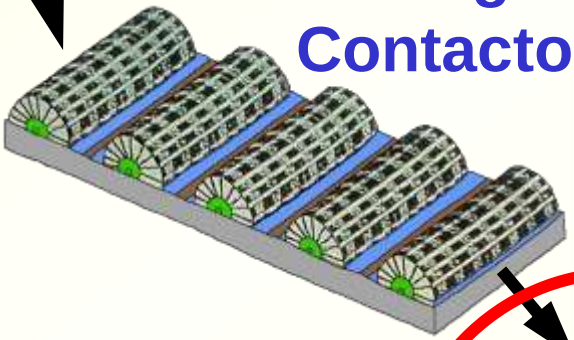


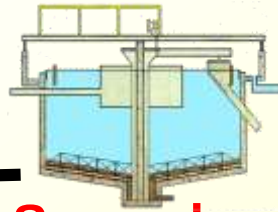
Pretreatment

Primary Treatment



Rotating Biological Contactors

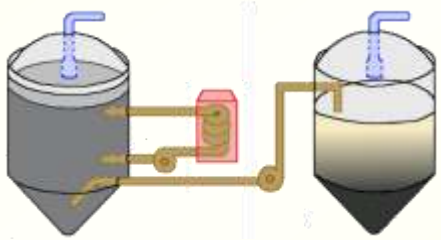




Secondary Clarifiers

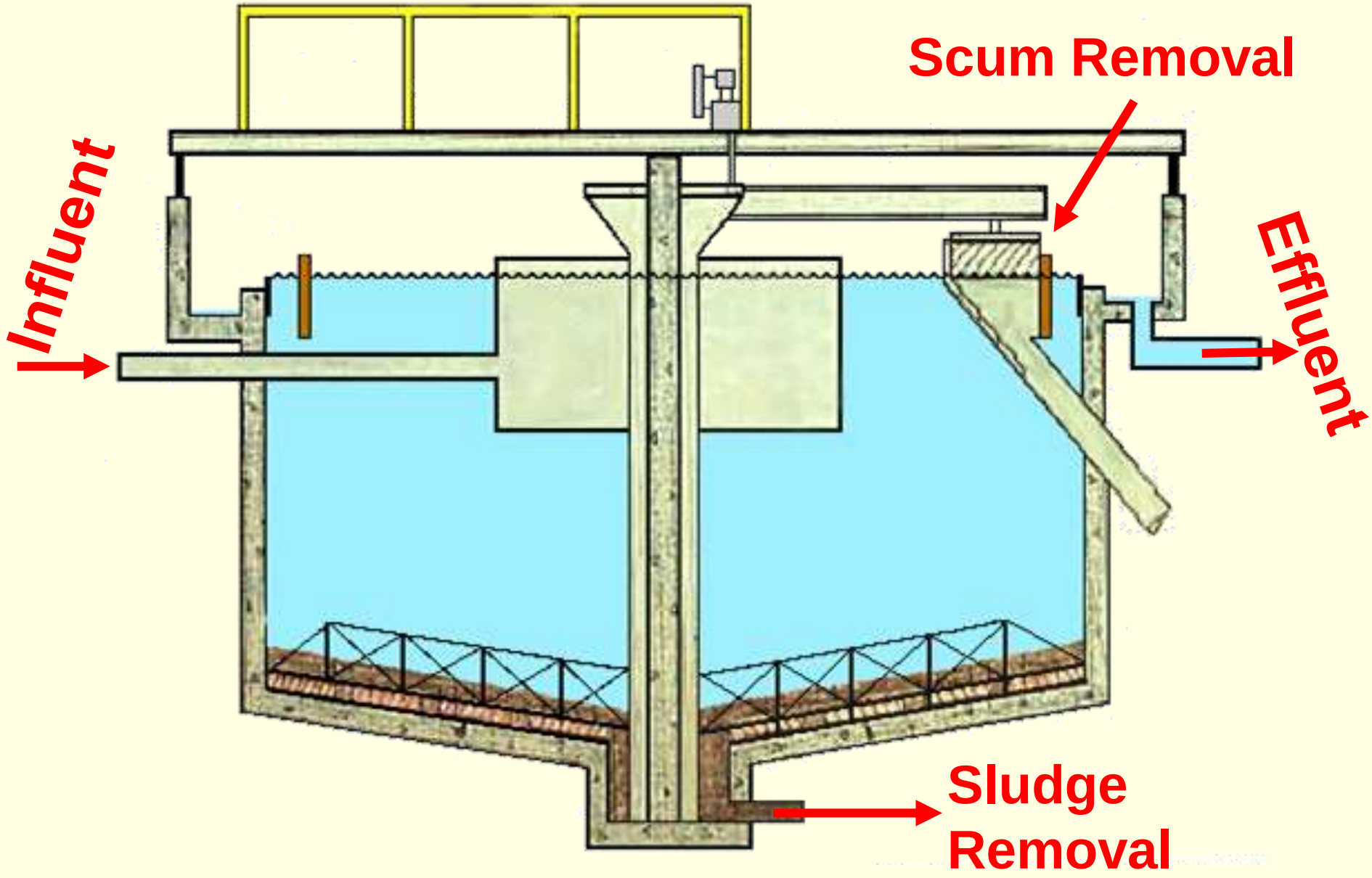
Disinfection

EFFLUENT



Solids Handling

Secondary Clarifier



Clarifier

500 to 800 gpd/sq.ft.

Chemical Phosphorus Removal

Sludge Removal

Enclosures

Protect Contactors

Ultraviolet Light

Hard Rains

Freezing

Algae

Equipment

Security

Enclosures

Types of Structures

Roof Only

Prefabricated Covers

Permanent Building

Enclosures

Prefabricated Covers

Enclosures

Permanent Building

Enclosures Permanent Building

Enclosures

Operational Considerations

Ventilation

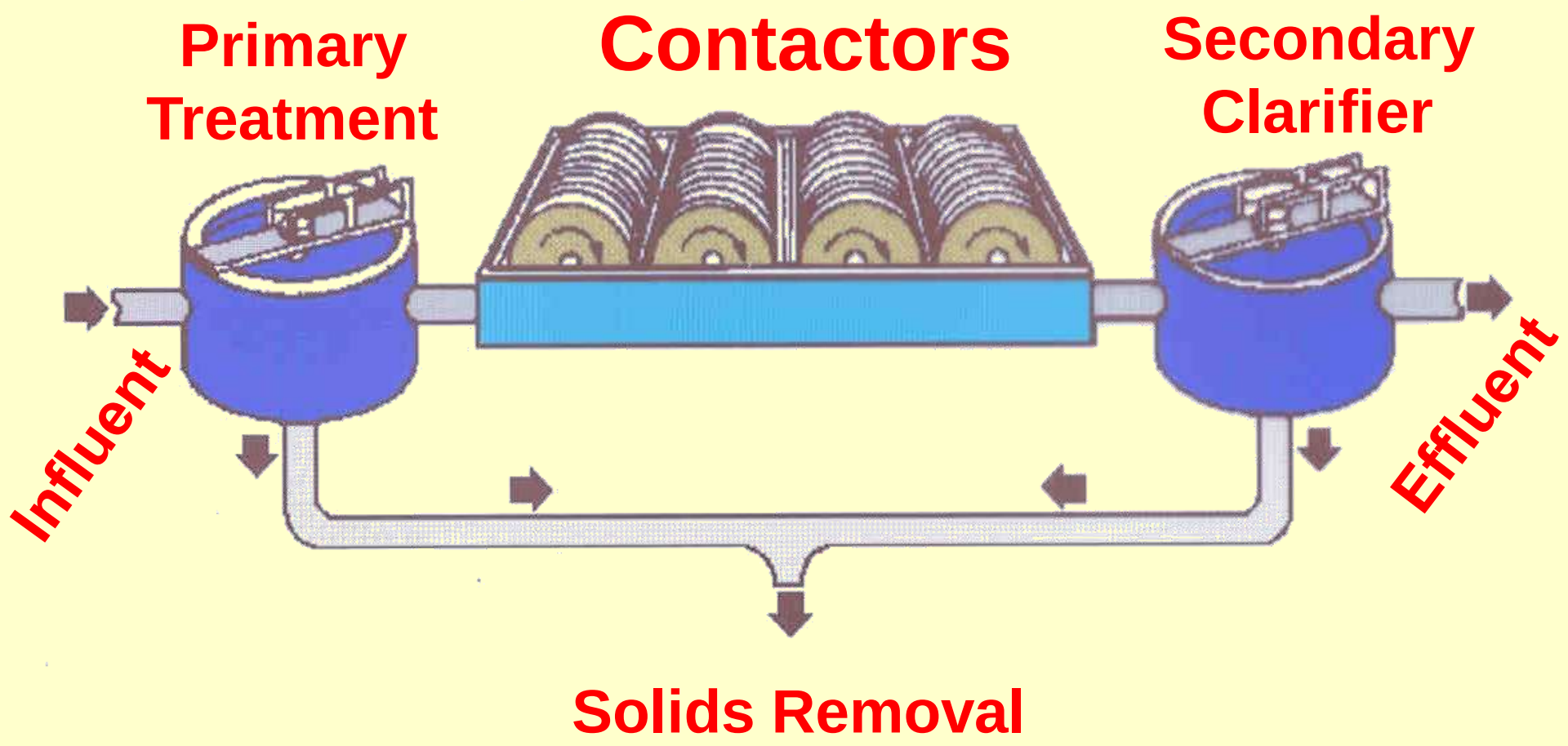
Humidity Control

Heat Loss

Observation

Maintenance

Basic Principles of Process



“LOADING”

Amount Applied to the Treatment Process

(Related to the SIZE of the System)

Hydraulic Loading

Amount of Liquid Volume (gallons)

Organic Loading

Amount of BOD Weight (pounds)

(Calculation of Loading is Specific for Each Type of Treatment Process)

RBC LOADINGS

HYDRAULIC

Liquid Volume -
Applied to the Media surface

Use Plant Flow - No Recirculation

Complete Available Surface Area

Area is Not Calculated - from Manufacturer

RBC LOADINGS

HYDRAULIC

Liquid Volume -
Applied to the Media surface

GALLONS PER DAY PER SQUARE FOOT

gpd / Ft^2

RBC LOADINGS

HYDRAULIC

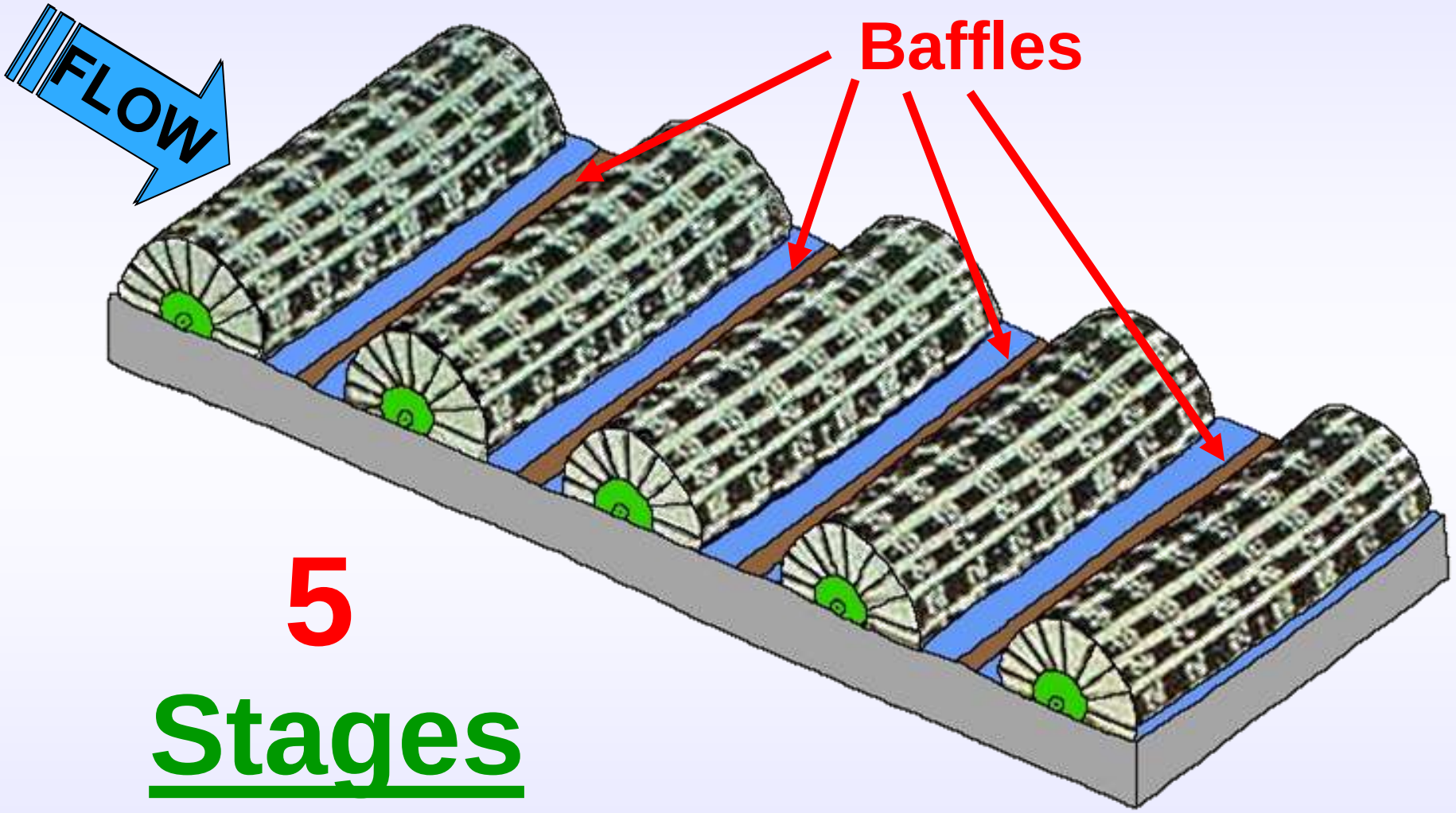
FORMULA:

$$\text{Hydraulic Loading, gpd/ft}^2 = \frac{\text{Flow Rate, gpd}}{\text{Media Surface Area, ft}^2}$$

EXAMPLE:

Plant Flow	2.4 MGD
Trains in Service	2
Contactors in Each Train	5
Baffles Between All Contactors	
Each Contactor Surface Area	100,000 ft^2 (from manufacturer)
Primary Effluent Soluble BOD	55 mg/L

Train



5

Stages

(Zones of Treatment)

RBC LOADINGS

HYDRAULIC

FORMULA:

$$\text{Hydraulic Loading, gpd/ft}^2 = \frac{\text{Flow Rate, gpd}}{\text{Media Surface Area, ft}^2}$$

EXAMPLE:

Plant Flow	2.4 MGD
Trains in Service	2
Contactors in Each Train	5
Baffles Between All Contactors	
Each Contactor Surface Area	100,000 ft^2 (from manufacturer)
Primary Effluent Soluble BOD	55 mg/L

Total Surface Area =

2 trains X 5 contactors/train X 100,000 ft^2/contactor

= 1,000,000 ft^2

RBC LOADINGS

HYDRAULIC

FORMULA:

$$\text{Hydraulic Loading, gpd/ft}^2 = \frac{\text{Flow Rate, gpd}}{\text{Media Surface Area, ft}^2}$$

$$\text{Hydraulic Loading, gpd/ft}^2 = \frac{2.4\ \text{MGD} \times 1{,}000{,}000\ \text{gal/MG}}{1{,}000{,}000\ \text{ft}^2}$$

$$= \frac{2{,}400{,}000\ \text{gpd}}{1{,}000{,}000\ \text{ft}^2}$$

$$= 2.4\ \text{gpd/ft}^2$$

RBC LOADINGS

ORGANIC

Organic Matter - BOD

Applied to the Media Surface

Soluble BOD

Media Surface Area – (Not Volume)

Area in 1000 Ft^2

RBC LOADINGS

ORGANIC

Organic Matter -
Applied to the Media surface

Pounds Soluble BOD per Day per 1000 ft^2

#Sol. BOD/Day/1000 ft^2

RBC LOADINGS

ORGANIC

FORMULA:

$$\text{Organic Loading, \# Sol. BOD/Day/1000 ft}^2 = \frac{\text{Soluble BOD Applied, \# Sol. BOD/Day}}{\text{Media Surface Area in 1000 ft}^2}$$

RBC LOADINGS

ORGANIC

FORMULA:

$$\text{Organic Loading, \# Sol. BOD/Day/1000 ft}^2 = \frac{\text{Soluble BOD Applied, \# Sol. BOD/Day}}{\text{Media Surface Area in 1000 ft}^2}$$

EXAMPLE:

Plant Flow	2.4 MGD
Trains in Service	2
Contactors in Each Train	5
Baffles Between All Contactors	
Each Contactor Surface Area	100,000 ft^2 (from manufacturer)
Primary Effluent Soluble BOD	55 mg/L

Pounds Soluble BOD/Day = 55 mg/L x 2.4 MGD x 8.34 #/gal

= 1100 # Sol. BOD/Day

RBC LOADINGS

ORGANIC

Total Surface Area =

2 trains X 5 contactors/train X 100,000 ft^2/contactor

= 1,000,000 ft^2

$$\text{Surface Area in 1000 } ft^2 = \frac{\text{Total Surface Area } ft^2}{1000}$$

$$= \frac{1{,}000{,}000\ ft^2}{1000} = 1{,}000 \ \ (1000\ ft^2)$$

RBC LOADINGS

ORGANIC

FORMULA:

Organic Loading, # Sol. BOD/Day/1000 ft^2 =

$$\frac{\text{Soluble BOD applied, \# Sol. BOD/Day}}{\text{Media Surface Area in 1000 } ft^2}$$

$$\text{Total System Org. Ld.} = \frac{\text{1100 \# Sol. BOD/Day}}{\text{1,000 (1000 } ft^2\text{)}}$$

= 1.1 # Sol. BOD/Day/1000 ft^2

RBC LOADINGS

FIRST STAGE ORGANIC

EXAMPLE:

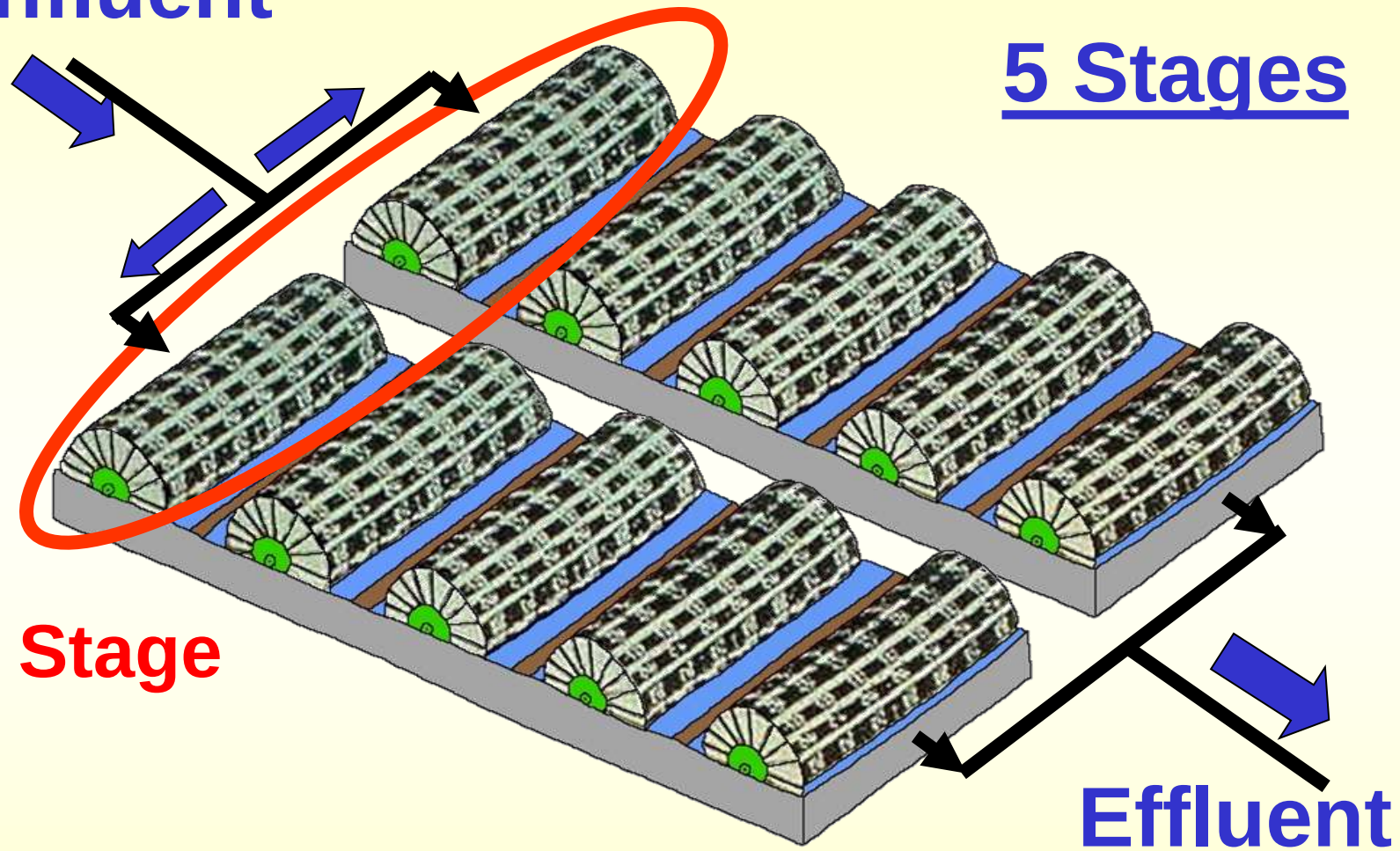
Plant Flow	2.4 MGD
Trains in Service	2
Contactors in Each Train	4
Baffles Between All Contactors	
Each Contactor Surface Area	100,000 ft^2 (from manufacturer)
Primary Effluent Soluble BOD	55 mg/L

Pounds Soluble BOD/Day = 55 mg/L x 2.4 MGD x 8.34 #/gal

= 1100 # Sol. BOD/Day

2 Trains

5 Stages



When a System Has More Than One Train, Each Zone in the System That Receives the Same Loading is Considered One "Stage"

RBC LOADINGS

FIRST STAGE ORGANIC

First Stage Surface Area =

2 contactors X 100,000 ft^2/contactor

= 200,000 ft^2

First Stage Surface Area in 1000 ft^2 =

$$\frac{\text{First Stage Surface Area } ft^2}{1000}$$

$$= \frac{200{,}000\ ft^2}{1000} = 200\ \ (1000\ ft^2)$$

RBC LOADINGS

ORGANIC

FORMULA:

Organic Loading, # Sol. BOD/Day/1000 ft^2 =

$$\frac{\text{Soluble BOD applied, \# Sol. BOD/Day}}{\text{Media Surface Area in 1000 } ft^2}$$

$$\text{First Stage Org. Ld.} = \frac{\text{1100 \# Sol. BOD/Day}}{\text{200 (1000 } ft^2\text{)}}$$

= 5.5 # Sol. BOD/Day/1000 ft^2

TYPICAL RBC LOADINGS

HYDRAULIC

CARBONACEOUS BOD REMOVAL

2 to 4 gpd/Ft^2

NITRIFICATION

1.0 to 1.5 gpd/Ft^2

TYPICAL RBC LOADINGS

Organic

(For Typical 30 mg/L Requirements)

All Media

2.0 #Sol. BOD/DAY/1000 ft^2

First Stage

2.5 to 4.0 #Sol. BOD/DAY/ 1000 ft^2

3.0 for mechanical drive
EPA - “caution over 2.5”

ROTATING BIOLOGICAL CONTACTOR (RBC) PROCESS

Prepared By
Michigan Department of Environmental Quality
Operator Training and Certification Unit