

MBR DESIGN CHALLENGE

SAWEA 2007 Workshop

INNOVATIVE Water and Wastewater Technologies

Presented by -

Vikrant Sarin

Peter Brechtelsbauer

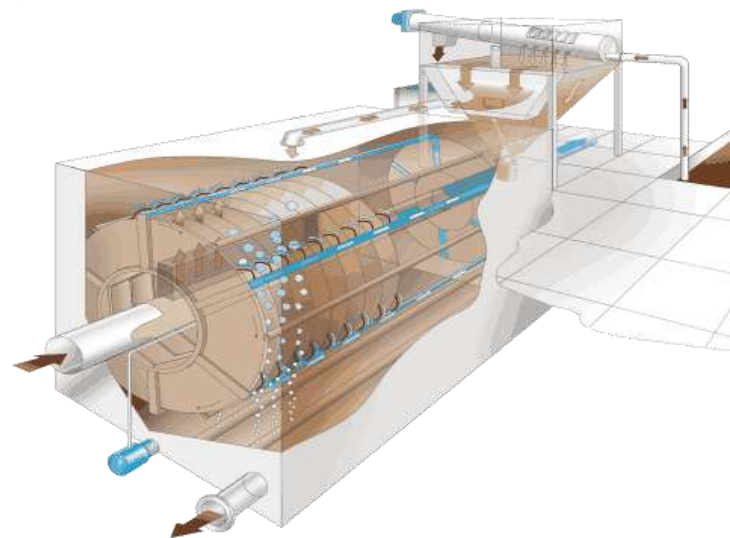
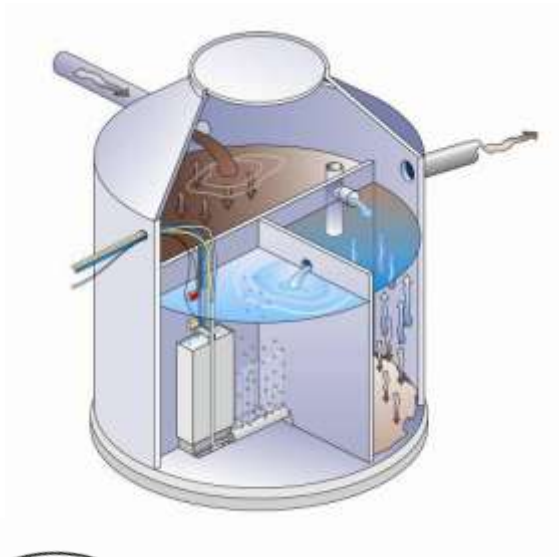
**Huber Technology Middle East (FZE),
SAIF Zone, Sharjah, UAE**



HUBER TECHNOLOGY



Membrane ClearBox® VRM Technology



The Quality
Company -
Worldwide

Content...

- Short Introduction of Huber company
- Objective
- Design Basis
- Huber MBR Solutions
- Plot Plan
- Process Flow Diagram
- List of Equipments with approx sizing
- Description of systems
- Utilities Consumption - Power, Chemicals etc.
- Huber System – Specifics, advantages etc.



INTRODUCTION...



Tradition – Quality - Innovation



Johann Schreiber
Master Coppersmith
1786

Anton Schreiber
Master Coppersmith
1830

Johann Wöhr
Master Coppersmith
1834

Johann Huber
Master Coppersmith
1872



Hans Huber
Master Coppersmith
1908



Josef Huber
Master Coppersmith
1948



Hans G. Huber
Karl-Josef Huber
1967

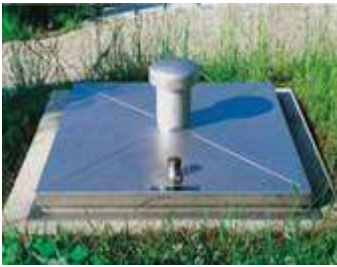


Copper



Breweries,
Distilleries

Steel



Potable
Water

Stainl. Steel



Waste
Water

Breweries, Distilleries

Potable Water

Wastewater



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High Tech for a better Environment



Active on a global scale -



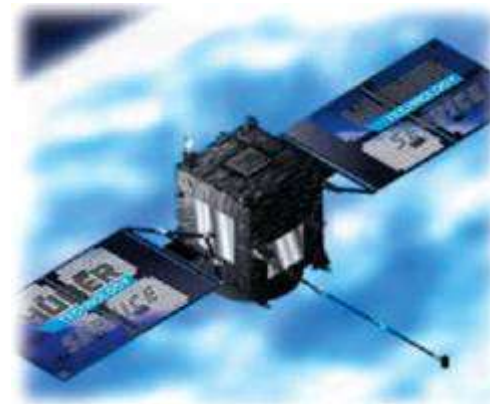
at home
in Bavaria,
Germany



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We combine all steps

- ➔ Research and Development
 - ➔ Manufacturing
 - ➔ Distribution
 - ➔ Service
- in one hand



Face the problems

Population without access to drinking water



Total unserved: 1.1 billion

"Water is life and because we have no water, life is miserable."

Farmer from Kenya

Population without sanitation



Total unserved: 2.4 billion

-  Asia
-  Africa
-  Latin America and the Caribbean
-  Europe



Industrial Applications

fruit processing industry

breweries

food industry

fish industry

agriculture

industrial kitchens

chemical industry

pulp & paper industry

Oil refinery Industry



waste disposal industry

power plants

slaughterhouses

dairies

sugar industry

car industry

composting plants

iron & steel industry



HUBER Installations for Mechanical Wastewater Treatment Worldwide!



Hans Huber AG
Maschinen- und Anlagenbau
Industriepark Erasbach A1
D-92334 Berching
Germany

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eMail info@huber.de
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HUBER Fine Screening Worldwide!

HUBER
TECHNOLOGY



Hans Huber AG

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Industriepark Erasbach A1
D-92334 Berching
Germany

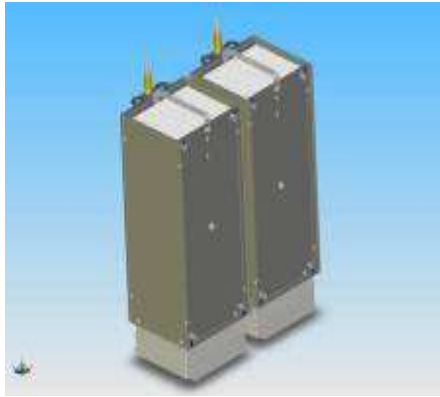
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HUBER Membrane Technology

HUBER
TECHNOLOGY



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Sludge Treatment



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Objective...

- Design of STP using HUBER Membrane Technology.



Design Basis...



Influent Wastewater characteristics

Parameter	Value
Average annual flow rate	9500 m ³ /d
Peak Flow	38,000 m ³ /d (Four times avg annual flow rate)
BOD5	150 mg/l
TSS	300 mg/l
NH3	35 mg/l
TKN	40 mg/l
Alkalinity	100 mg/l
Free Oil and Grease	< 30 mg/l
Total Phosphorus	4 mg/l



Parameters	MOMRA Max Allowable Limit
Biochemical Oxygen Demand	10 mg/l
Total Suspended Solids	5 mg/l
Total Kjeldahl Nitrogen (TKN)	5 mg/l
Ammonia Nitrogen (NH ₃ -N)	1 mg/l
Turbidity	2.5 NTU
E Coliform	2.2 counts/100 ml

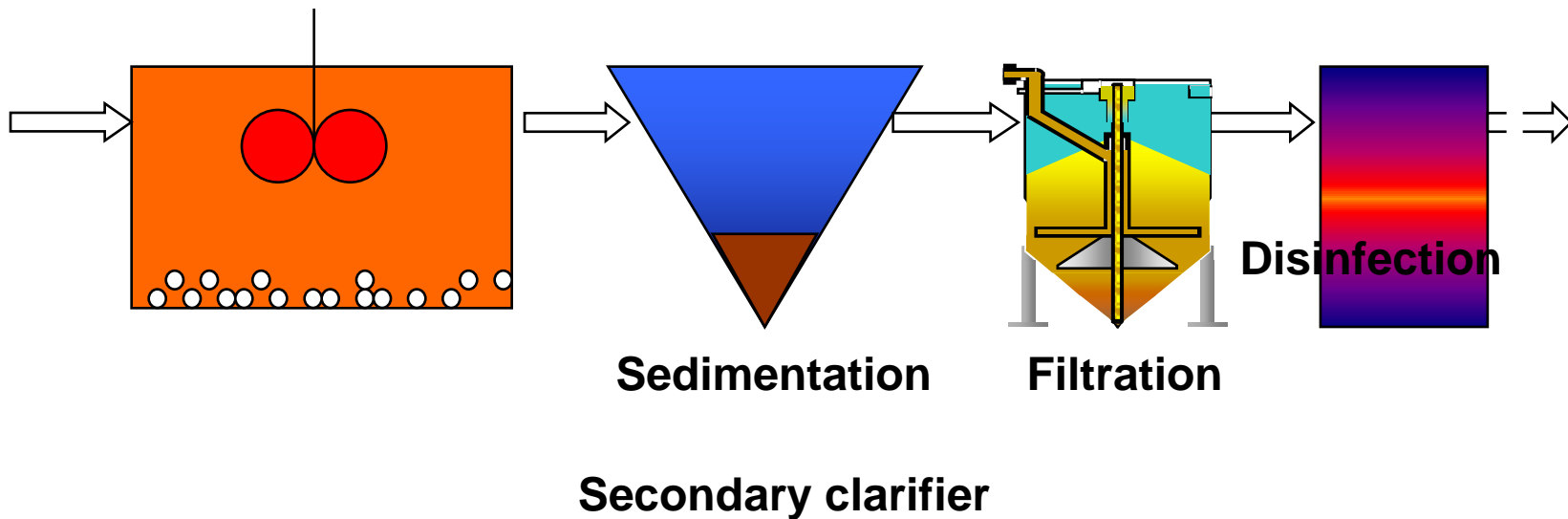


HUBER SOLUTIONS...



HUBER ... Solutions

Conventional activated sludge process



HUBER Membrane Technology

Principles of mechanical-biological wastewater treatment

- Mechanical stage
 - Coarse and fine screens
 - Grit and grease traps
 - Optional pre-clarification (solids separation and partial BOD degradation)
 - Biological stage
 - BOD/COD degradation (easily oxidisable compounds)
 - Nitrification (oxidation of ammonium nitrogen to nitrate nitrogen)
 - Denitrification (reduction of nitrate nitrogen to elementary nitrogen)
 - Biological partial phosphate degradation (Bio-P, 20 – 30 %)
 - Chemical phosphate precipitation (complete phosphate degradation)
 - Secondary clarification
 - Filtration and disinfection
- } or: MBR



HUBER Membrane Technology

The membrane bioreactor (MBR) process in general

**Membrane-activated sludge process =
conventional activated sludge process +
sludge separation with submerged membrane filters
(instead of secondary clarification tanks)**

**Sludge separation with ultrafiltration membranes
→ Retention of all bacteria and virtually all germs**

but important:

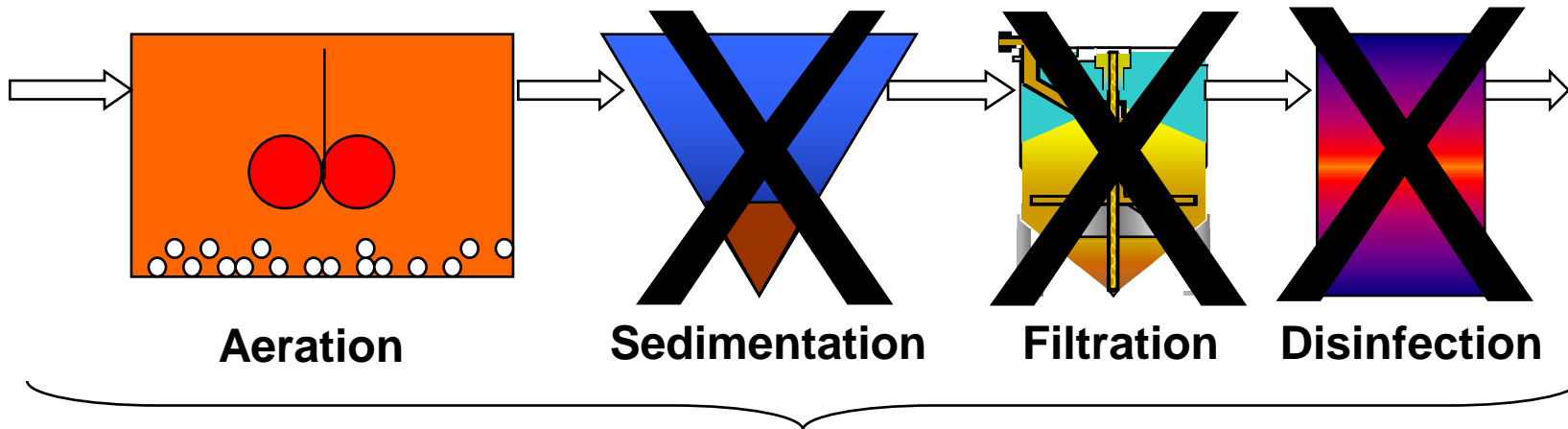
**ONLY in combination with an adequately dimensioned aeration
plant! Max. sludge load:
0.1 kg_{BOD}/kg_{DS}d
(industrial or municipal)**



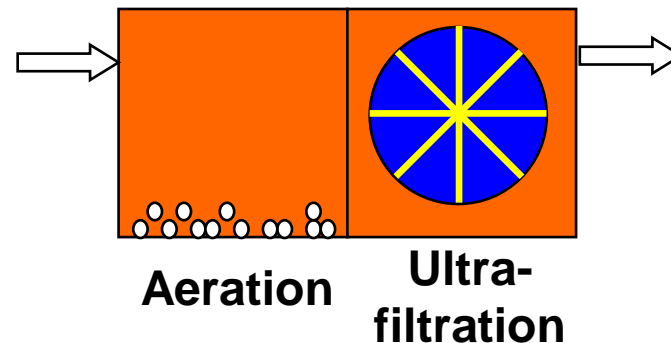
HUBER Membrane Technology

The membrane bioreactor (MBR) process in general

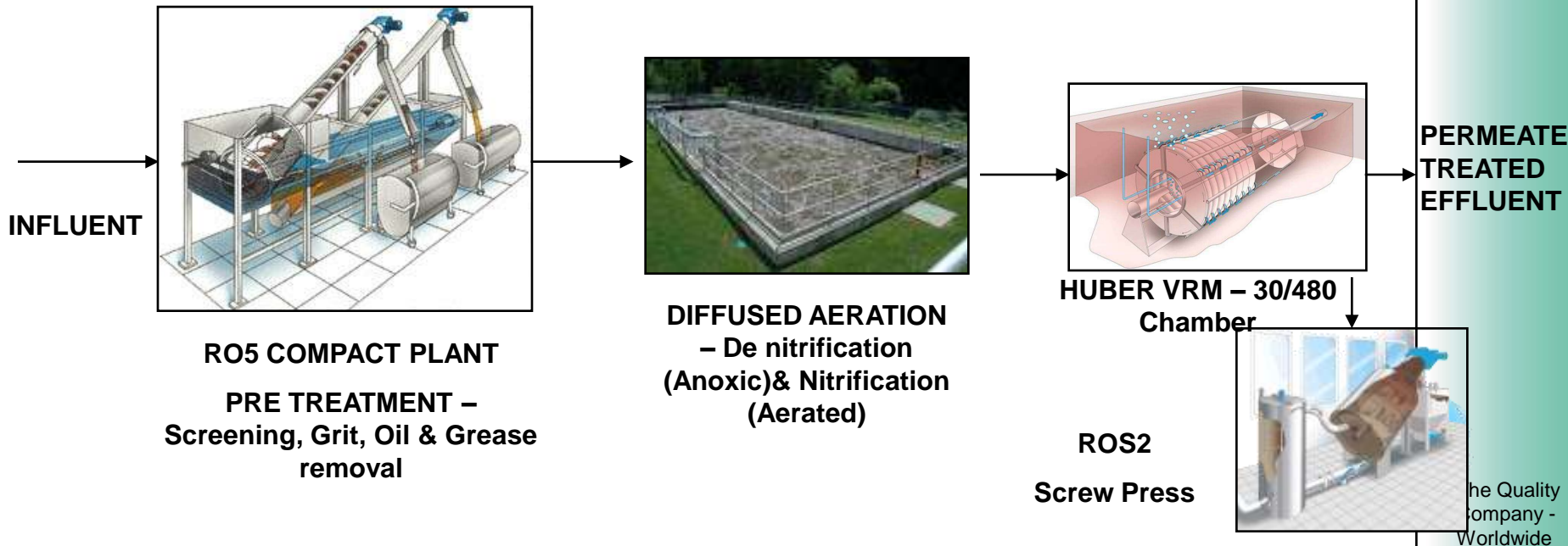
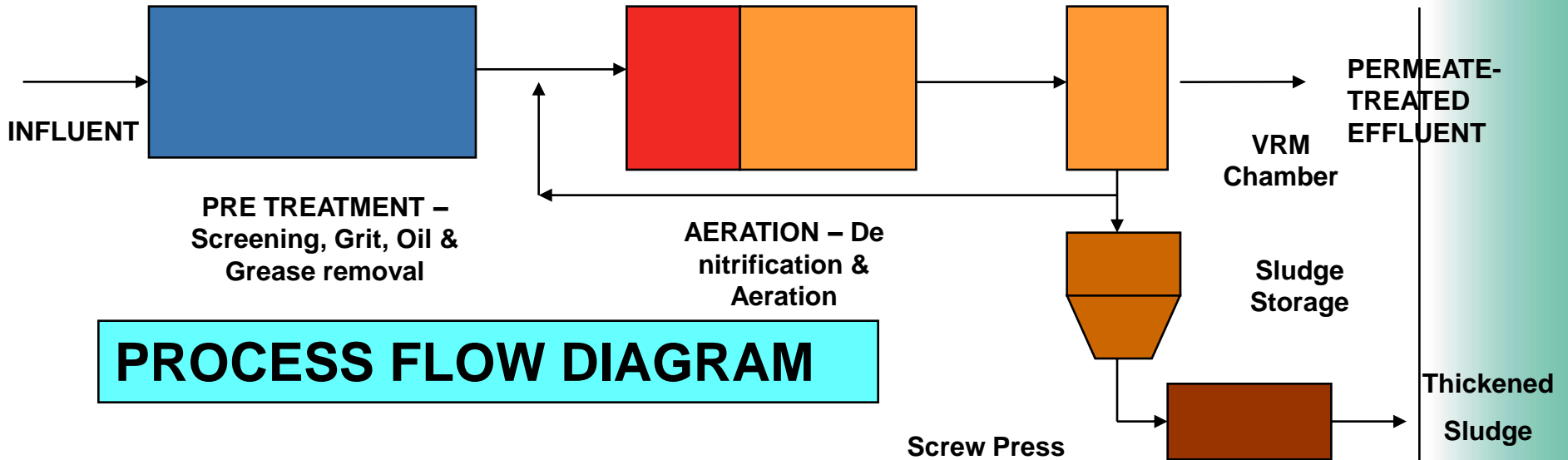
Conventional activated sludge process vs. MBR



Membrane Bioreactor

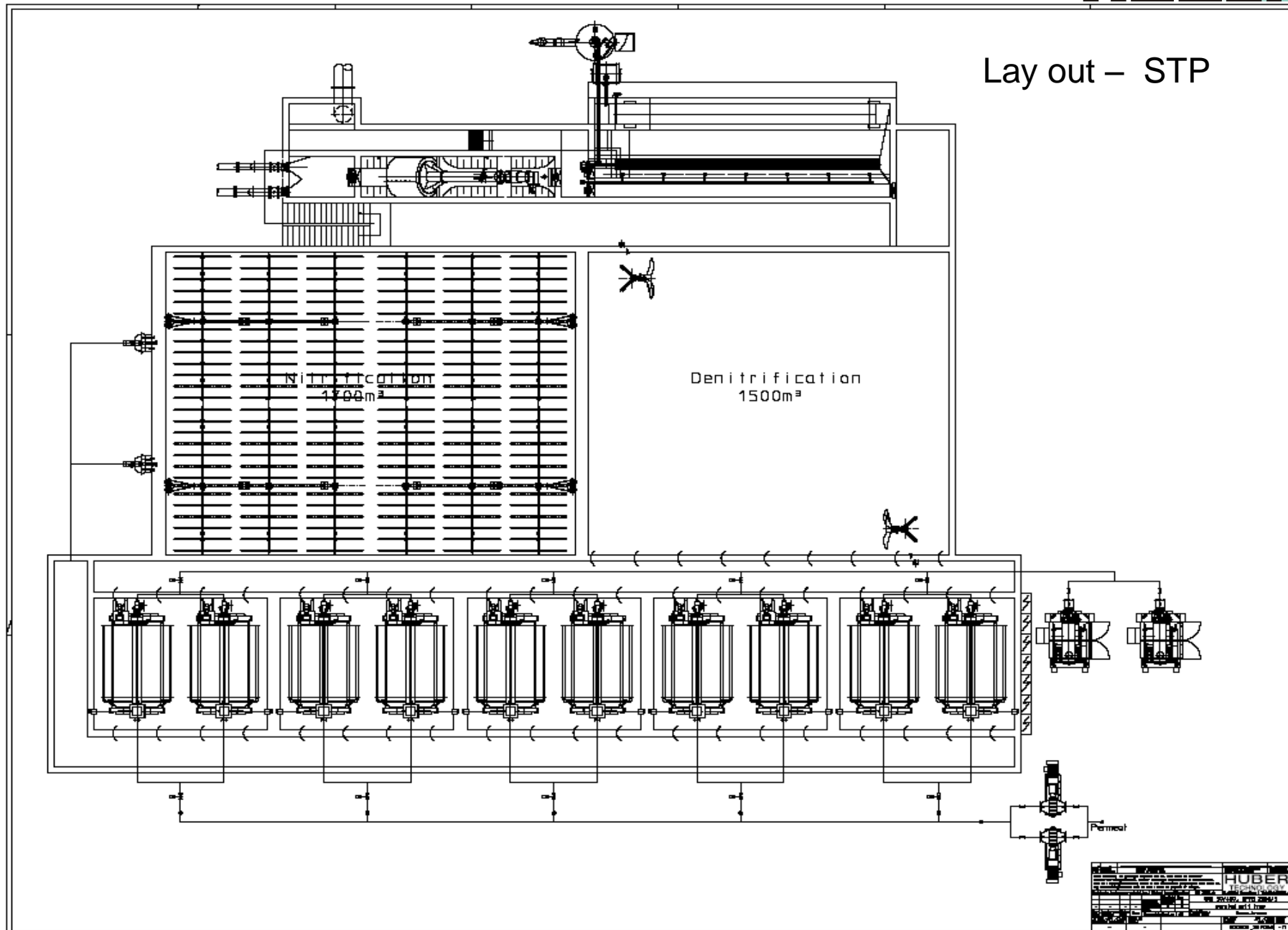


Huber Solutions...



Process Flow Diagram...

Lay out - STP



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/-
e

Treated Waste Water Characteristics From HUBER SYSTEM

TESTS	UNITS	RESULT
pH Value @ 25 deg C	-	7-8
B.O.D.	mg/l	<5
C.O.D	mg/l	<20
Total Suspended Solids	mg/l	<1
Ammonical Nitrogen as N	mg/l	<1
Phosphate as P	mg/l	1-2
Total Phosphate as P	mg/l	1-2
Oil & Grease	mg/l	NIL
MEETS MOMRA STANDARDS		
MEETS CALIFORNIA TITLE 22 REQUIREMENT		



List of Equipments – With Sizing...

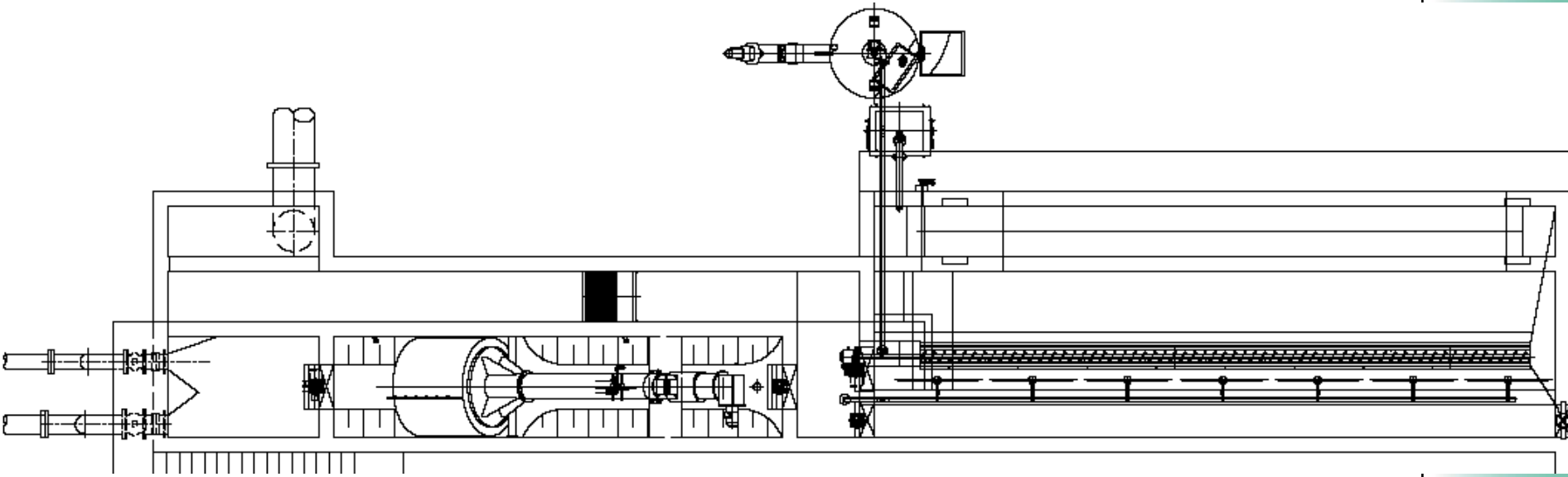
LIST OF EQUIPMENTS	TYPE	SIZING
Screen – Huber Rotamat Perforated Plate Screen	Huber Rotamat RPPS – 2000	Dia – 2000 mm Perforation – 3 mm
HUBER - Grit and Grease Removal	Huber Rotamat – RO6	Length – 12.4 m Width – 2.8 m Depth – 2.6 m
HUBER - Grit Classifier	Coanda effect type Huber ROSF 3	Length – 4250 mm Dia – 1785 mm
De nitrification Tank	Anoxic Type	Volume – 1500 m ³
Nitrification Tank	Aerated – Diffused Aeration	Volume – 1700 m ³
HUBER - Membrane Module	Type – ROTARY Huber VRM 30/480 – 10 no modules	Each module Dia – 3320 mm Length – 4538 mm
Blower – For Scouring and Aeration	Type – Positive Displacement,	Air flow rate – 100 m ³ /min (approx)
Sludge Thickener	Huber Screw Press RO S2 Size 2	Length – 4949 mm Width – 1800 mm Height – 2284 mm



Description of Equipments...

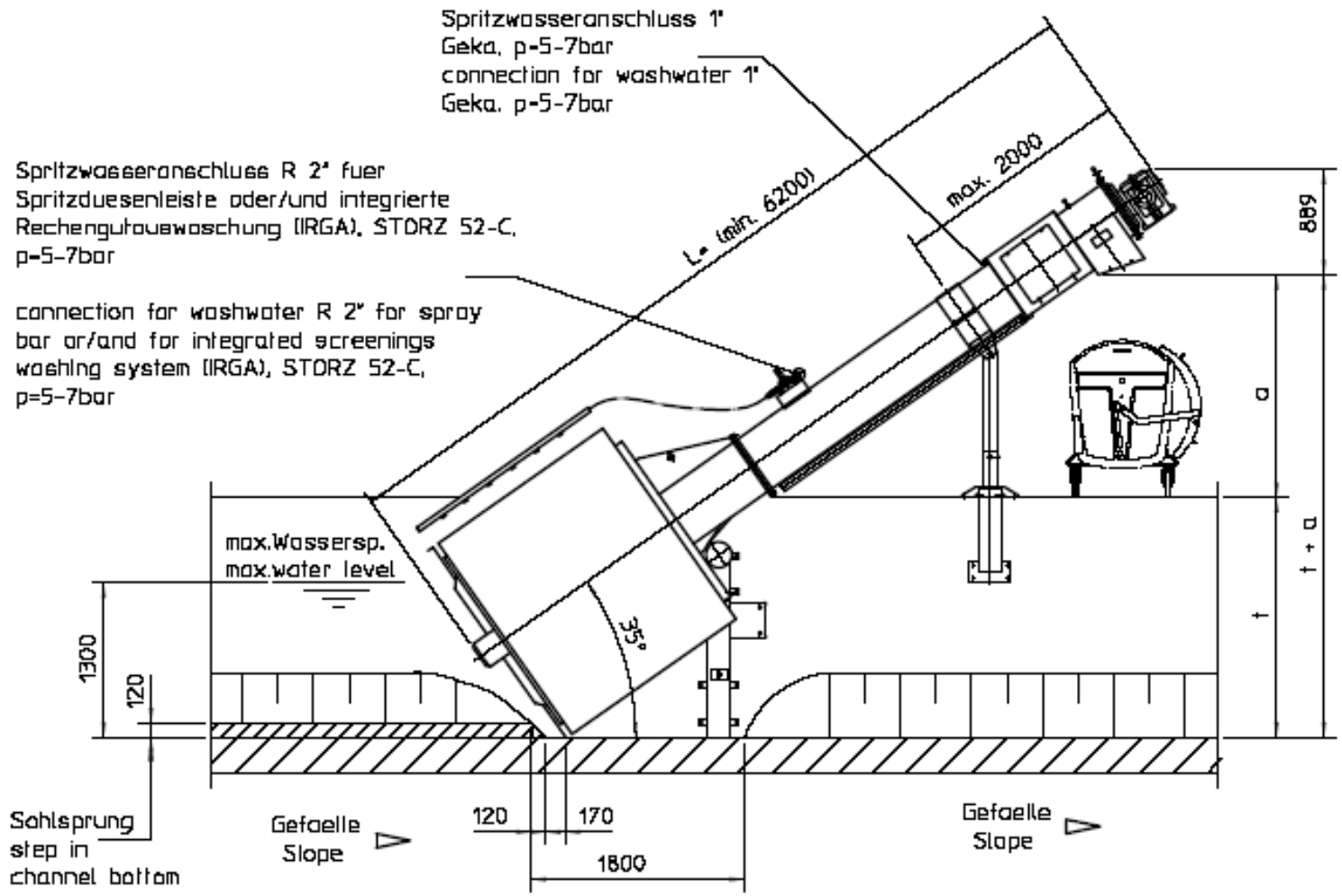


Pretreatment Facility



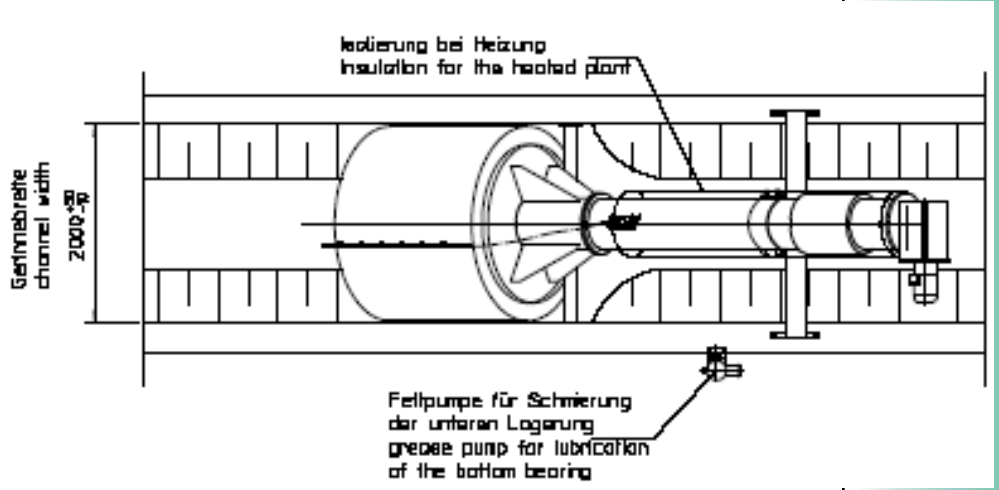
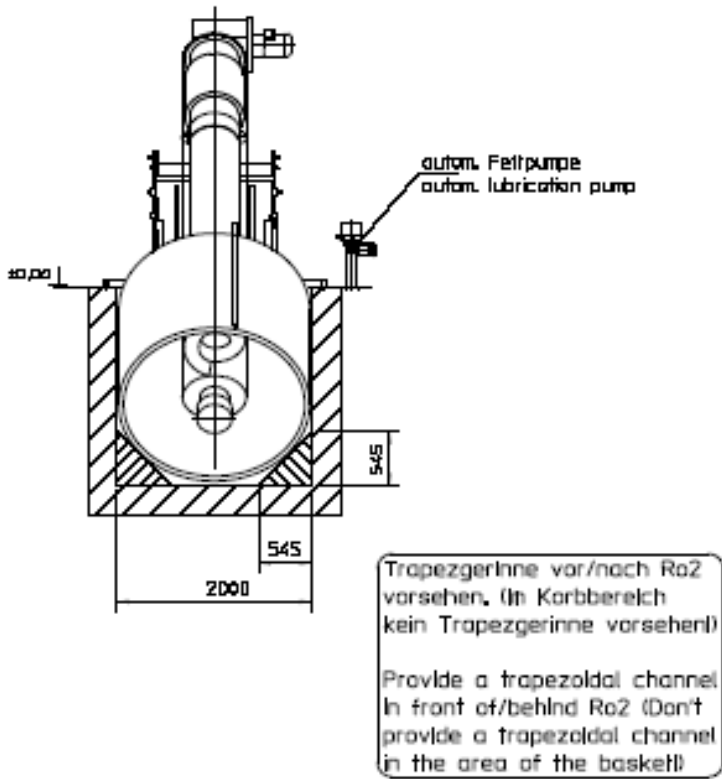
Huber Rotamat Complete Plant – RO5	Dimensions. approx
Overall length	18000 mm
Width	2800 mm
Height	2600 mm

Pretreatment Facility – Screening...

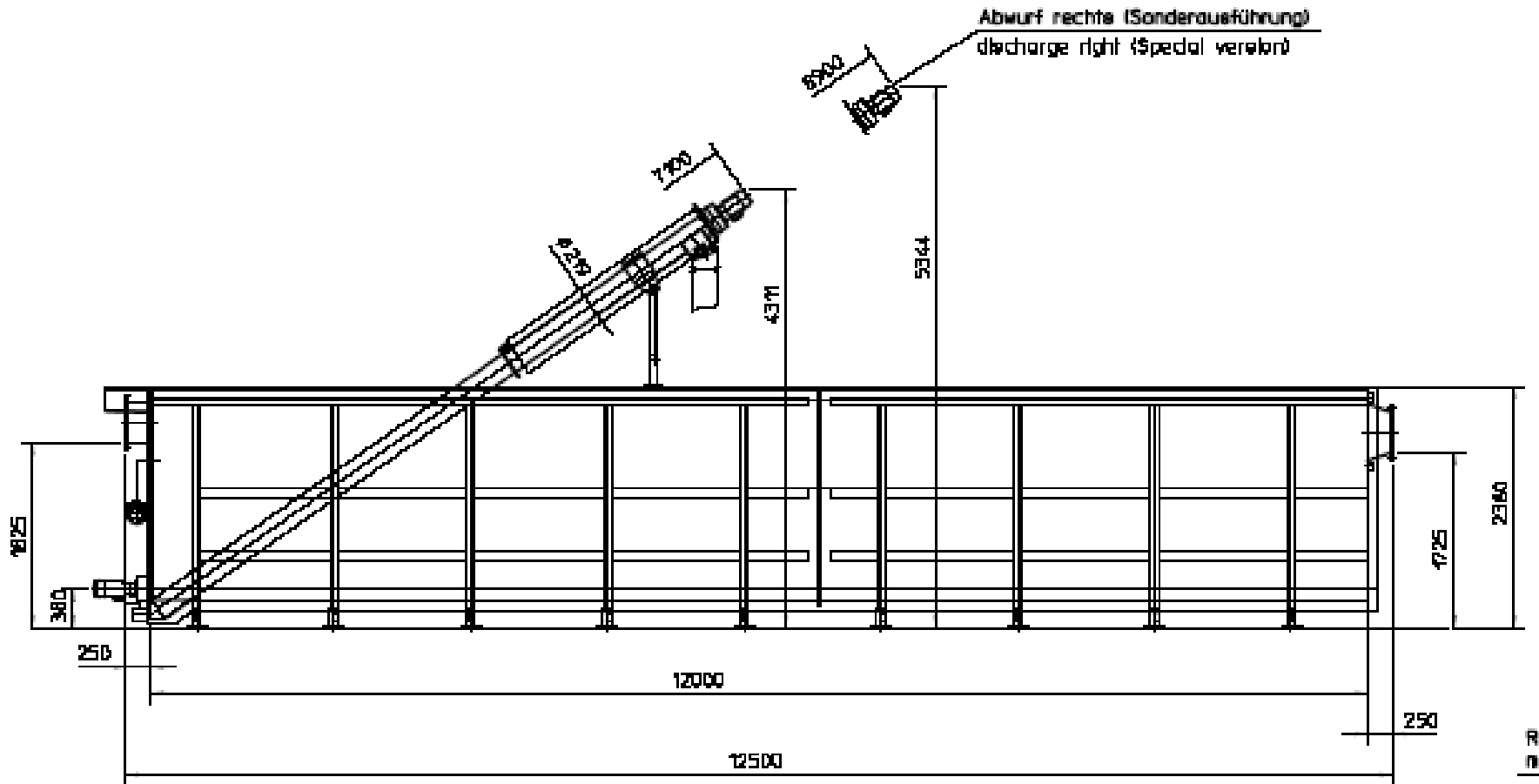


HUBER ROTAMAT – RPPS - 2000	Dimension
Screen Dia	2000 mm
Perforation	3 mm

Screening...



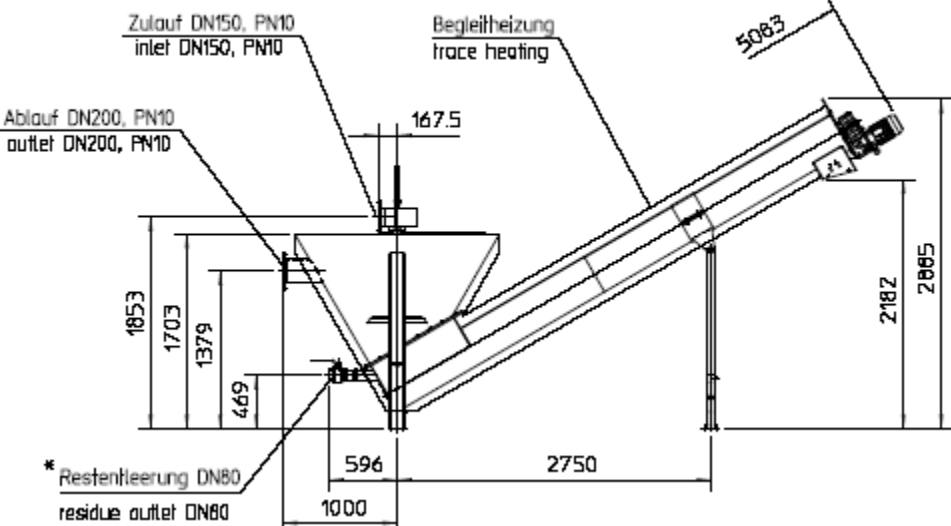
Longitudinal Grit, Oil & Grease TRAP...



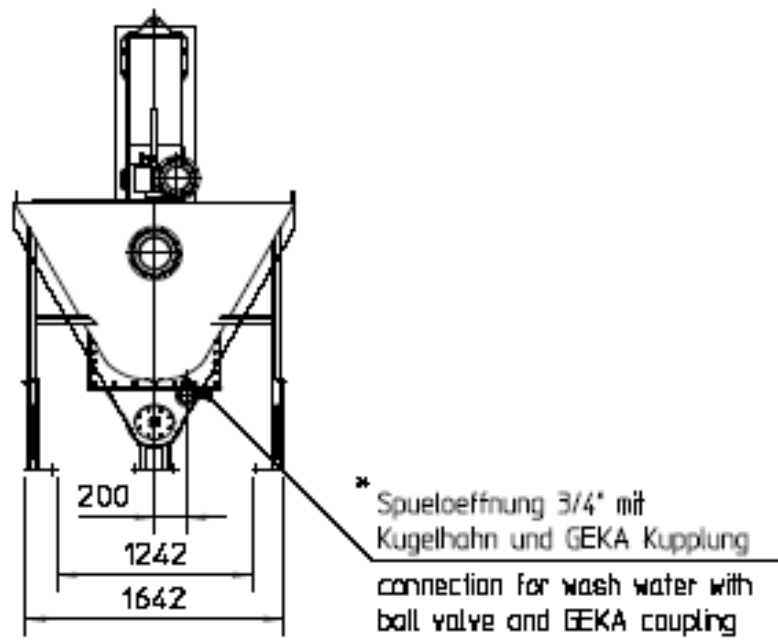
LONGITUDNAL GRIT & OIL & GREASE TRAP WITH AERATION

Separation degree	90 %
with grain diameter	0.2 mm
With a flow velocity of	27.5 cm/s
Grit trap length	12000 mm
Grit trap width	2800 mm

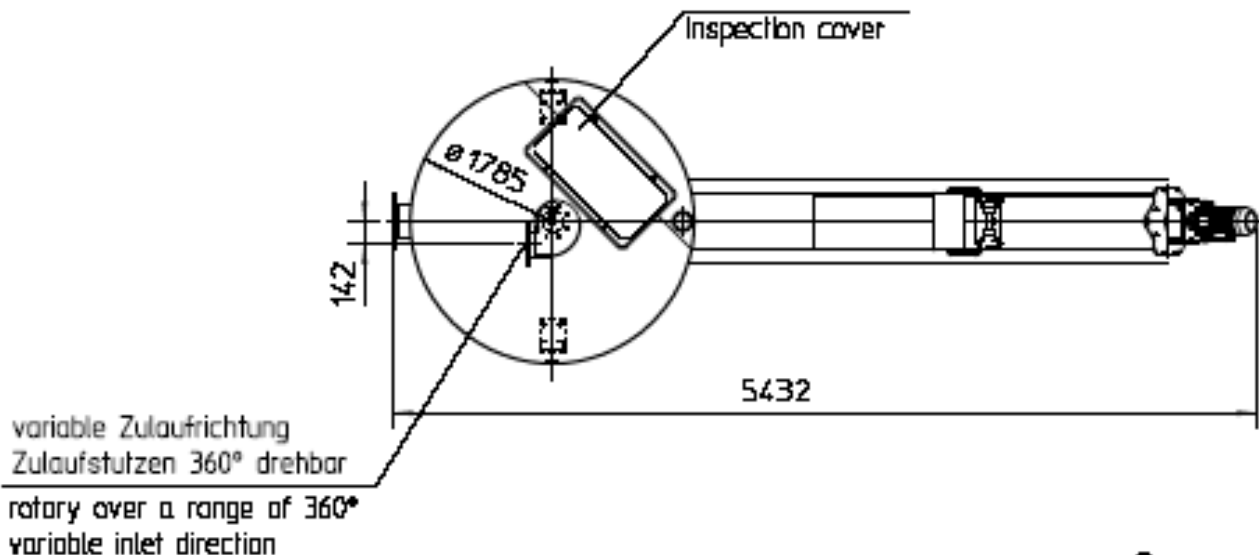
Grit Classifier...



Elevation



Side View



Plan

Process optimization – Procedure of Huber Technology



Various factors involved for optimization design conditions

Optimum Operational Cost – Cost estimation of Sludge Treatment & Aeration and determination of MLSS & corresponding HRT.

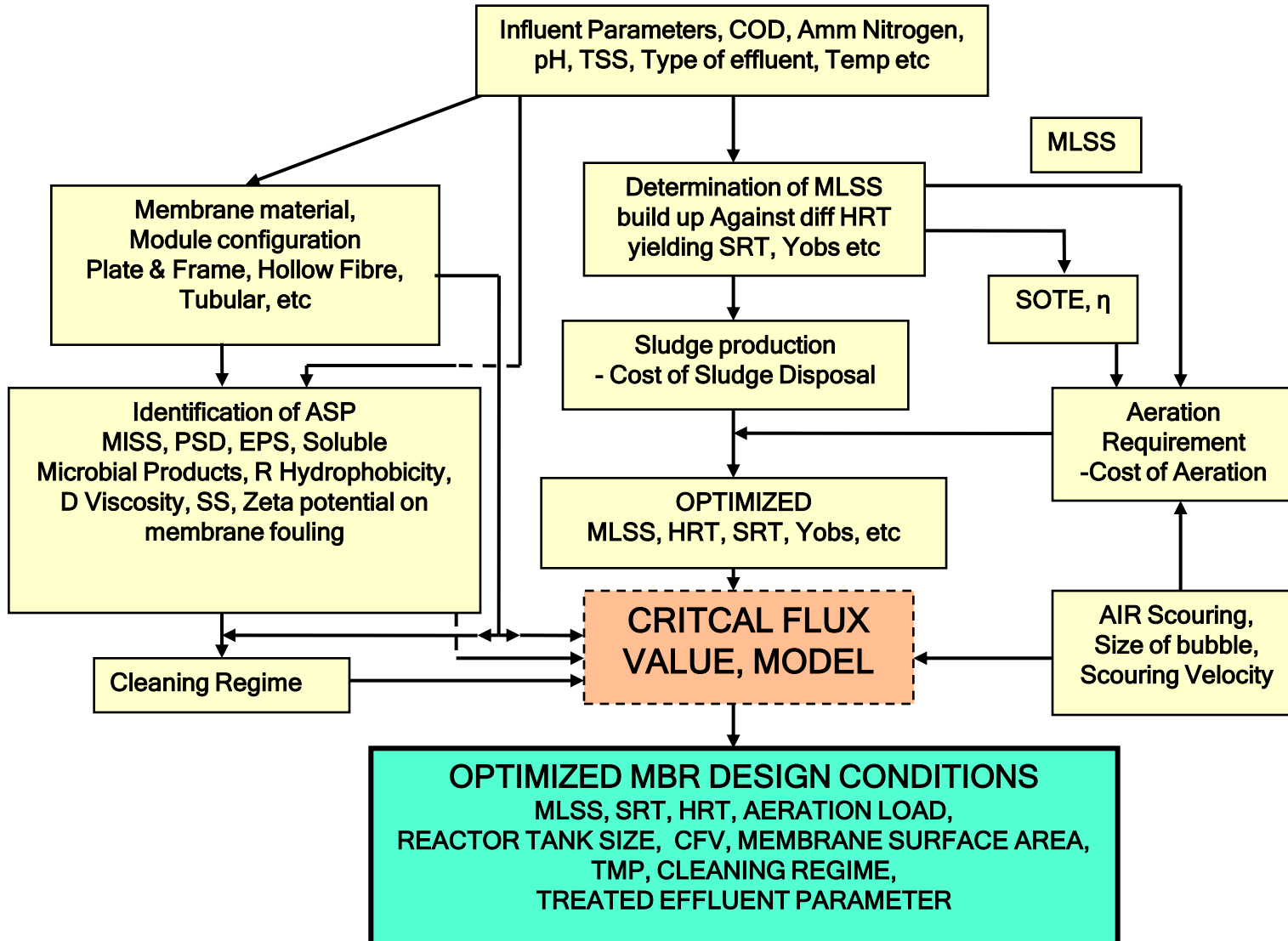
Prediction of CRITICAL FLUX VALUE – using CFV model.

FACTORS AFFECTING CFV -

- **MLSS determined from optimized sludge treatment vs. aeration.**
- **Activated Sludge Properties.**
- **Air Sparging – Size of bubble and its cross flow velocity.**
- **Membrane Material and Module configuration.**
- **Cleaning Regime.**



Algorithm for optimization of design conditions for MBR



Process Design - Parameters

PARAMETERS	UNIT	VALUE
VOLUME		
AT Tank Volume	m3	3180
Nitri-Volume -	m3	1700
Deni-Volume	m3	1500
LOADS		
BOD Load	Kg/d	1425
Dry Solids	Kg/d	2850
Ammonical Nitrogen	Kg/d	332.5
Organic Nitrogen	Kg/d	95
Phosphorus P total	Kg/d	38
SLUDGE AMOUNT		
Surplus Sludge	Kg DS/d	1767
Sludge Age	d	18
Sludge conc. AT MLSS	Kg DS/m3	10,000
OXYGEN DEMAND		
O2 Demand OD	KgO2/d	2795
Max O2 Demand	kgO2/kg BOD	2968



Critical Flux Model

In fixed biological conditions (defined sludge age and hydraulic retention time), C_{solutes} may be considered constant and this equation easily integrated as

$$\Delta P = \Delta P_0 / (1 - ((\alpha \Delta P_0 t^2)/2))$$

$$J_p = J_{p0} / (1 - ((\alpha J_{p0} \mu R_p t^2)/2))$$

Initial J_{p0} value defined such as

$$J_{p0} = Q/A$$

Where α is

$$\alpha = (k_1 k_2 S_p C_{\text{solutes}} / \mu R_p) (\text{LM}^{-1})$$

μ is permeate viscosity

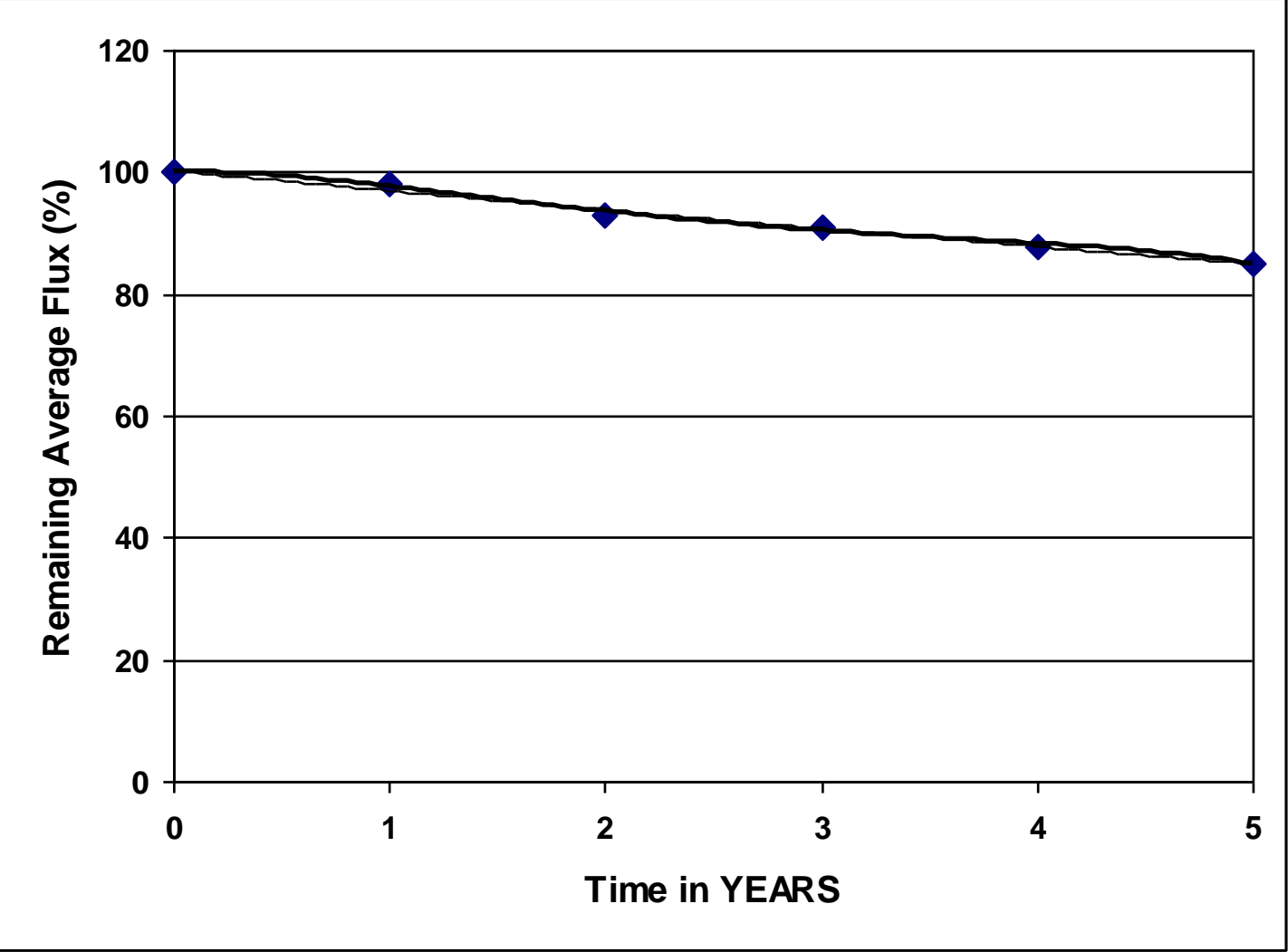
R_p open pore hydraulic resistance



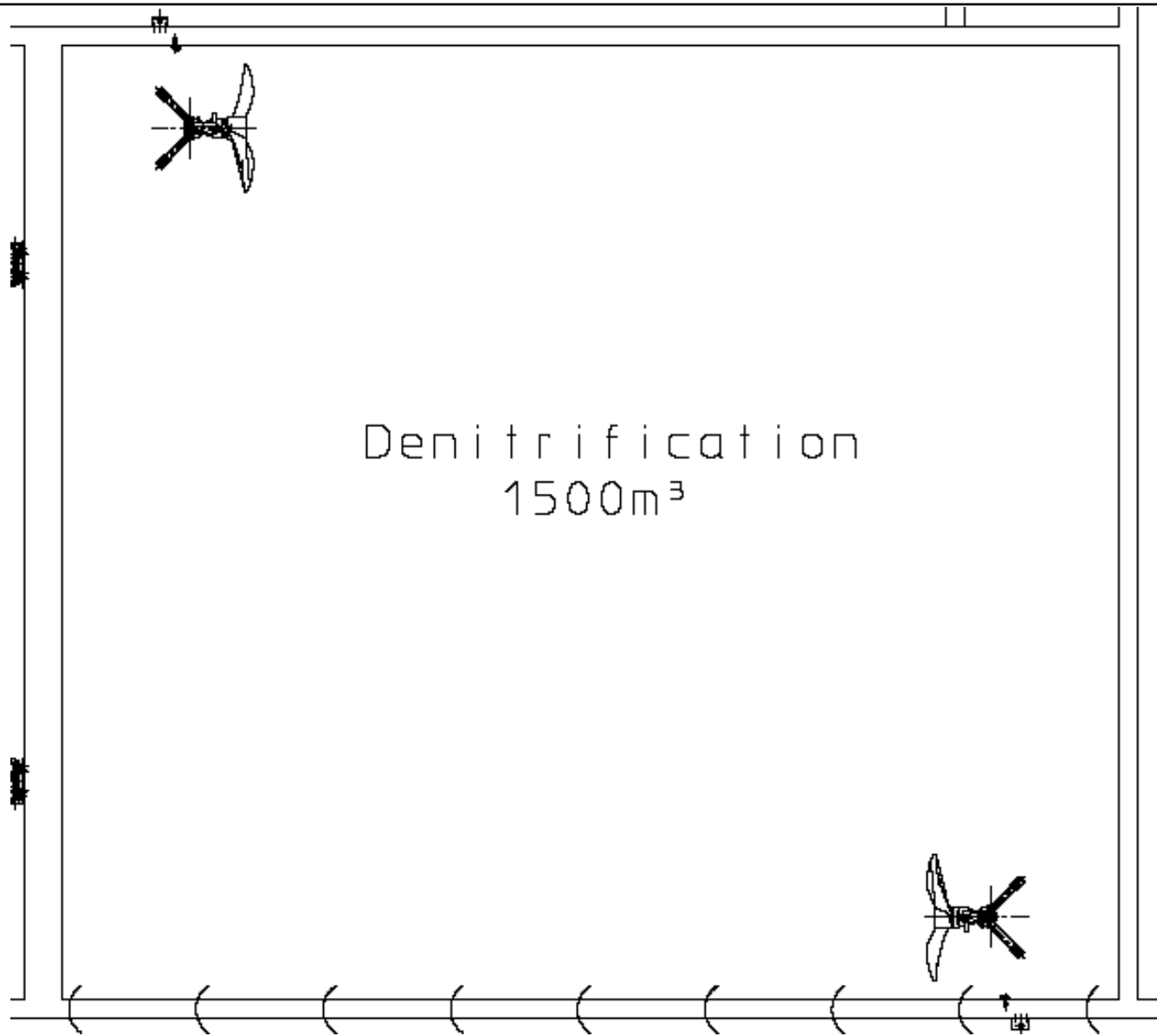
Prediction of REMINING FLUX for 5 years



Using Huber Critical Flux Model



De Nitrification...



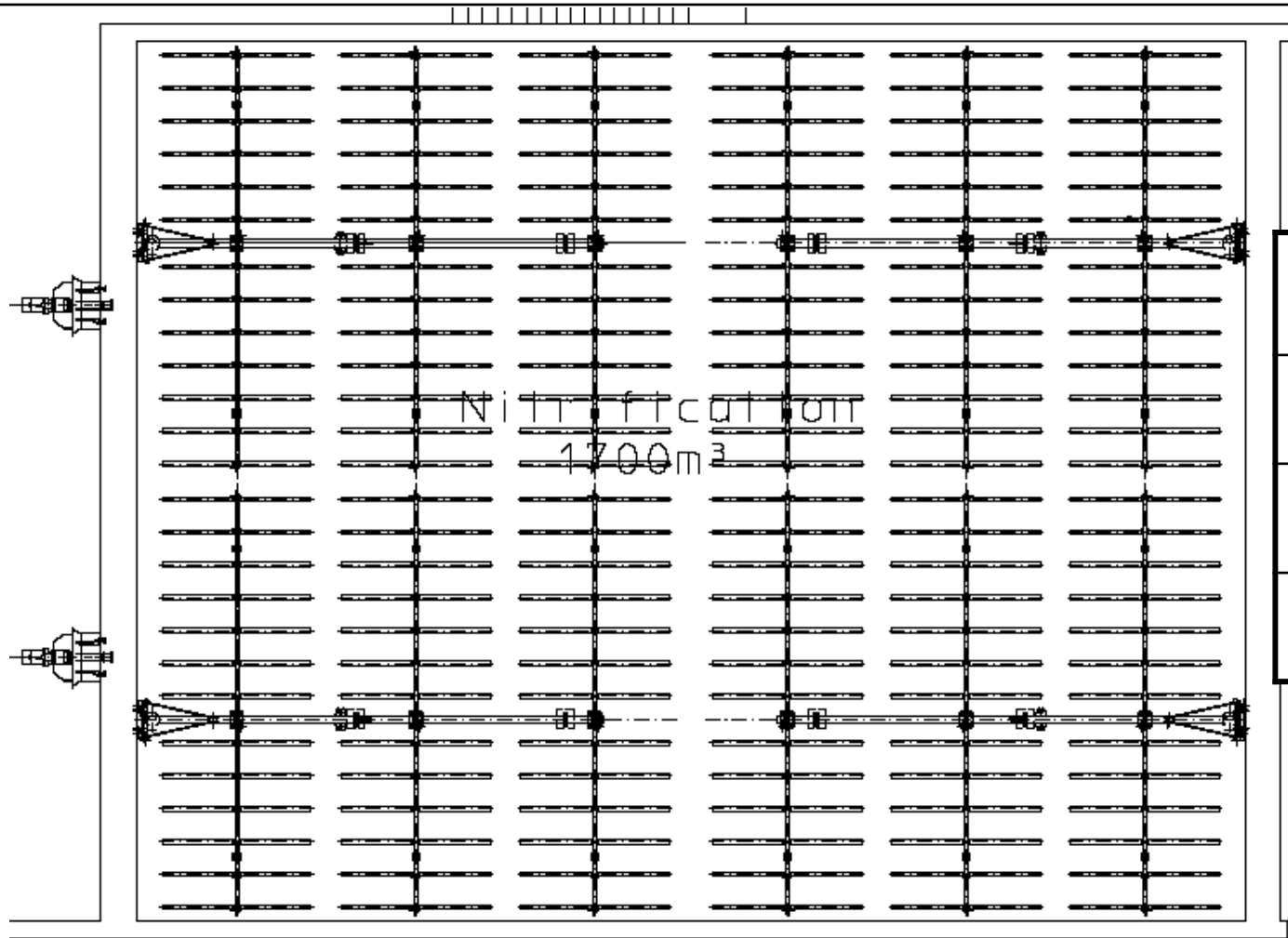
Dim of De nitrification Tank	
Length	1730
Width	1730
Depth	5500

De nitrification Volume – 1500 m³



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Nitrification...



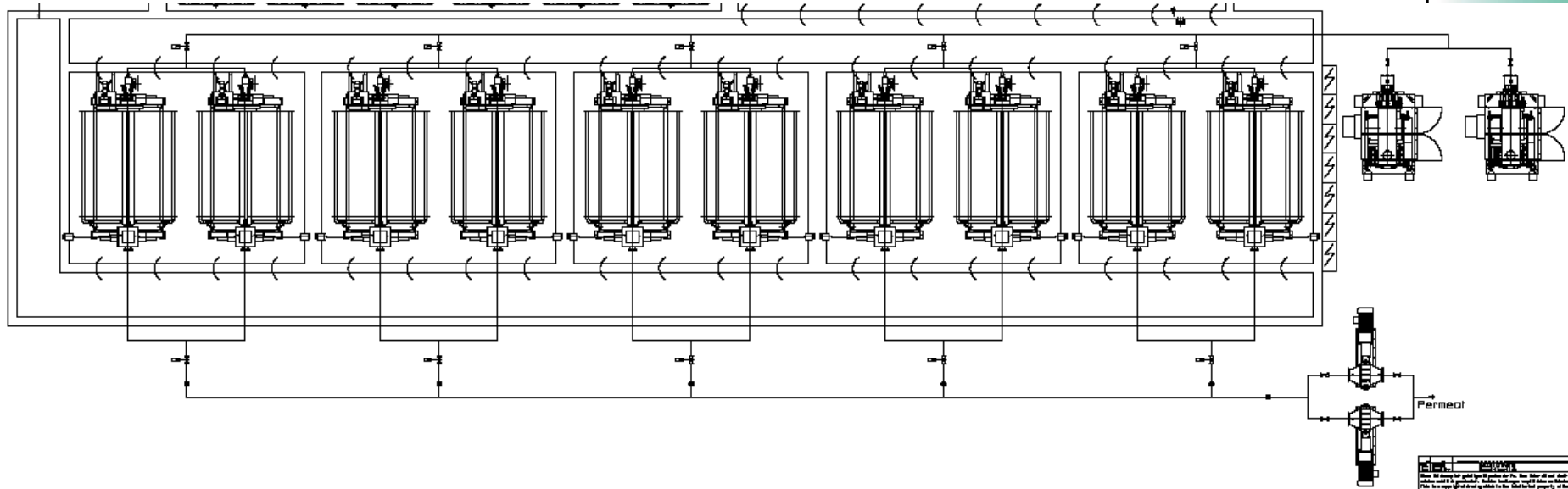
Dim of nitrification Tank	
Length	2000
Width	1730
Depth	5500

Nitrification – Volume – 1700 m³



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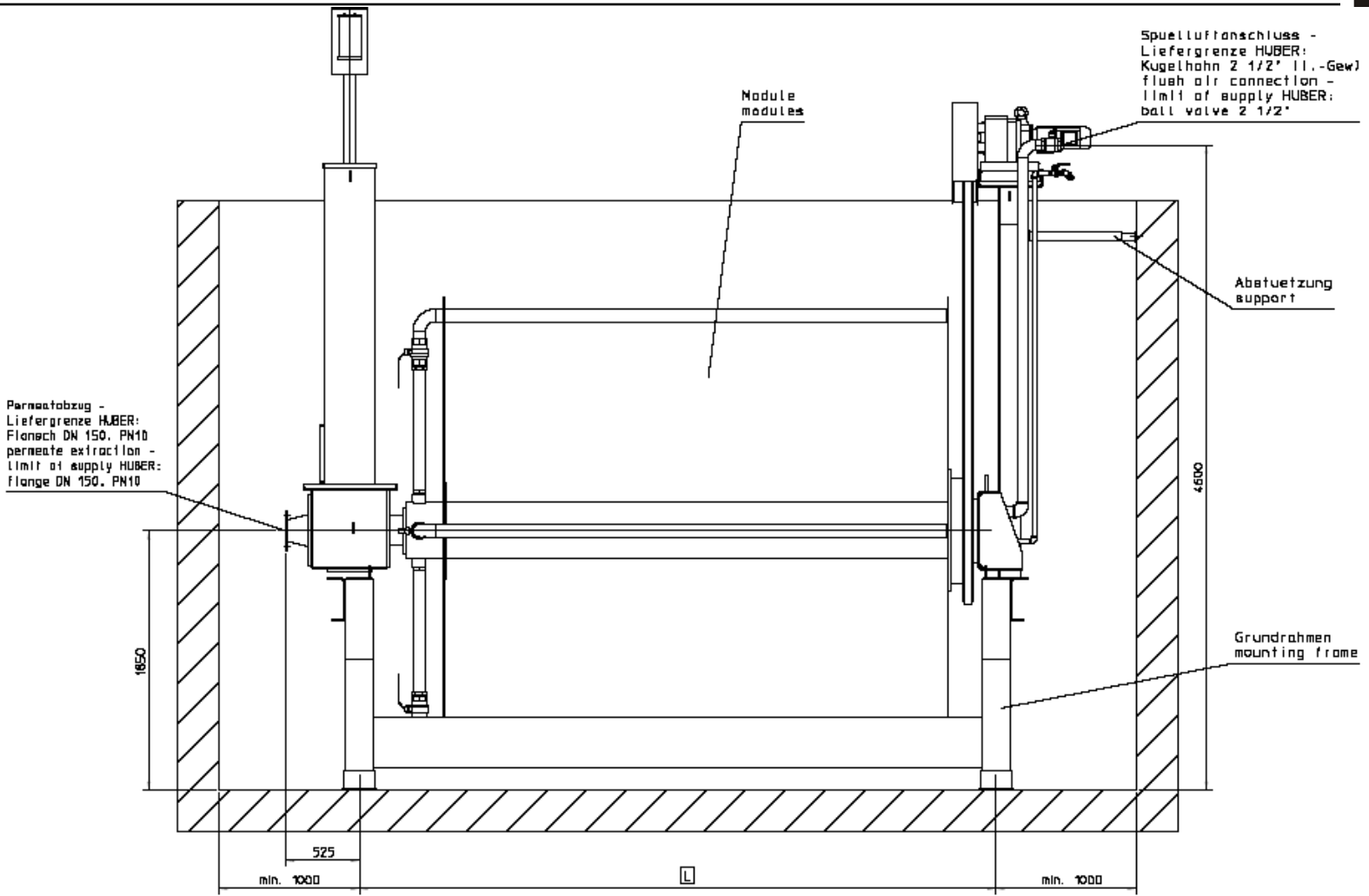
Arrangement of HUBER – VRM 30/480



**Arrangement of Membrane Modules – 5 chambers with
Two VRM 30/480 in each chamber**



HUBER – VRM 30/480

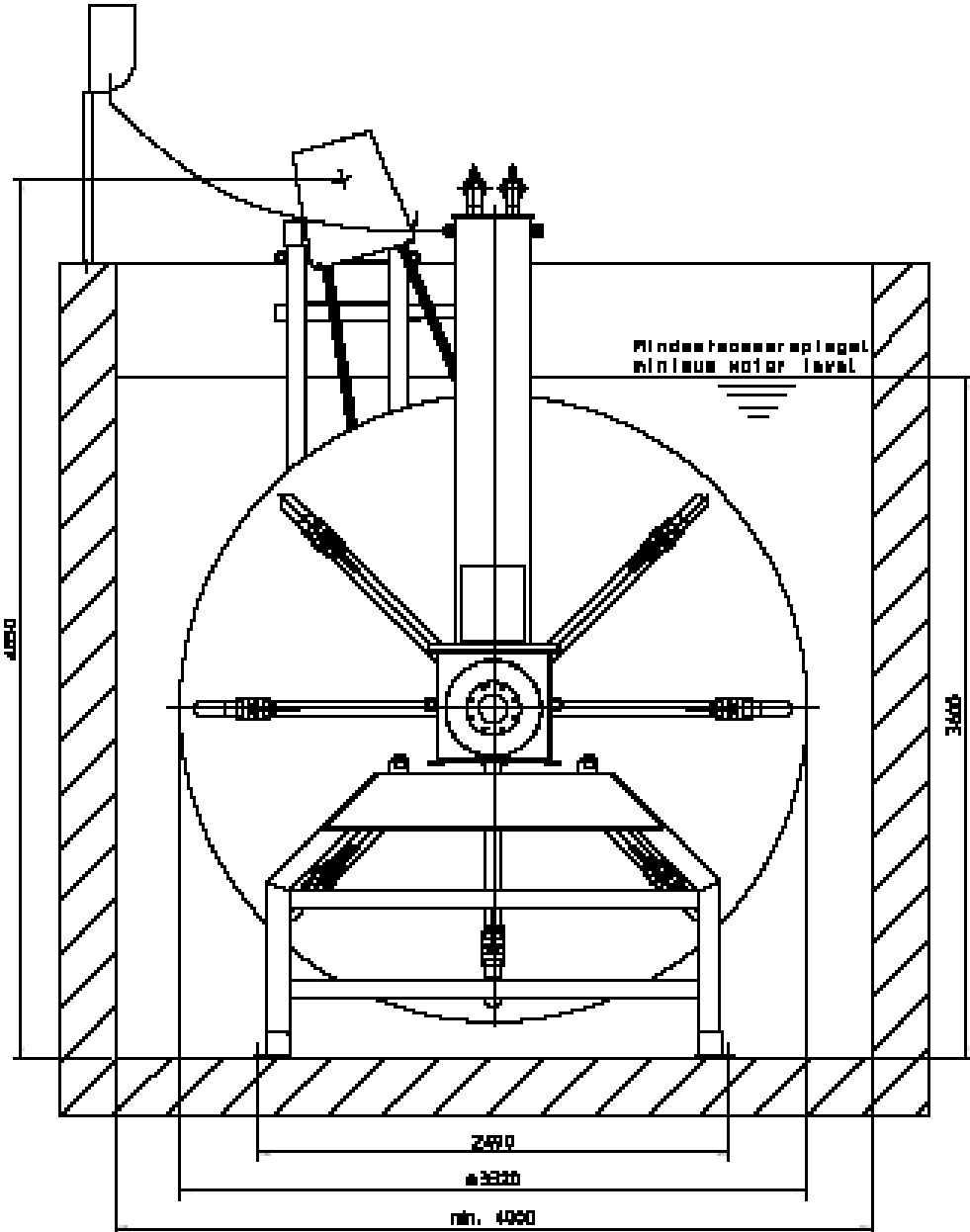


MEMBRANE MODULE	VRM - 30/480
Membrane area, m²	2880
Mass, Without Water, Kg	10400
Length, L, mm	4538



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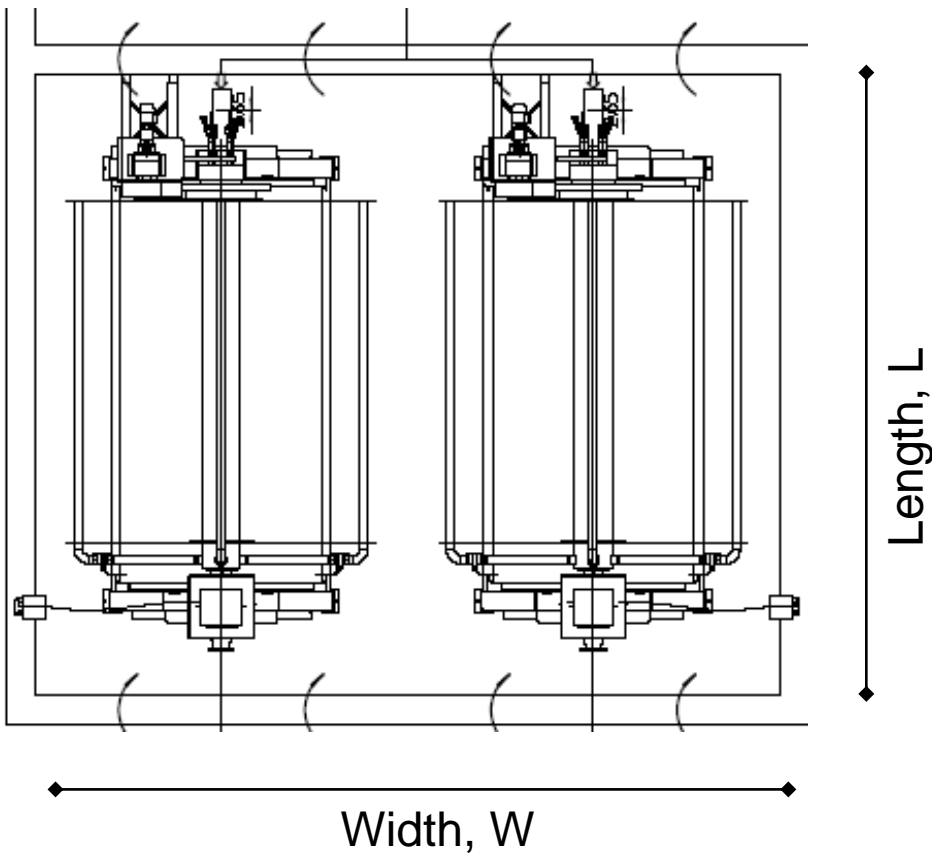
HUBER – VRM 30/480



VRM 30/480	
Height of Equipment	4650 mm
Min water level	3600 mm
Width of equipment	3320 mm
Min chamber width required for each module	4000 mm

Side View



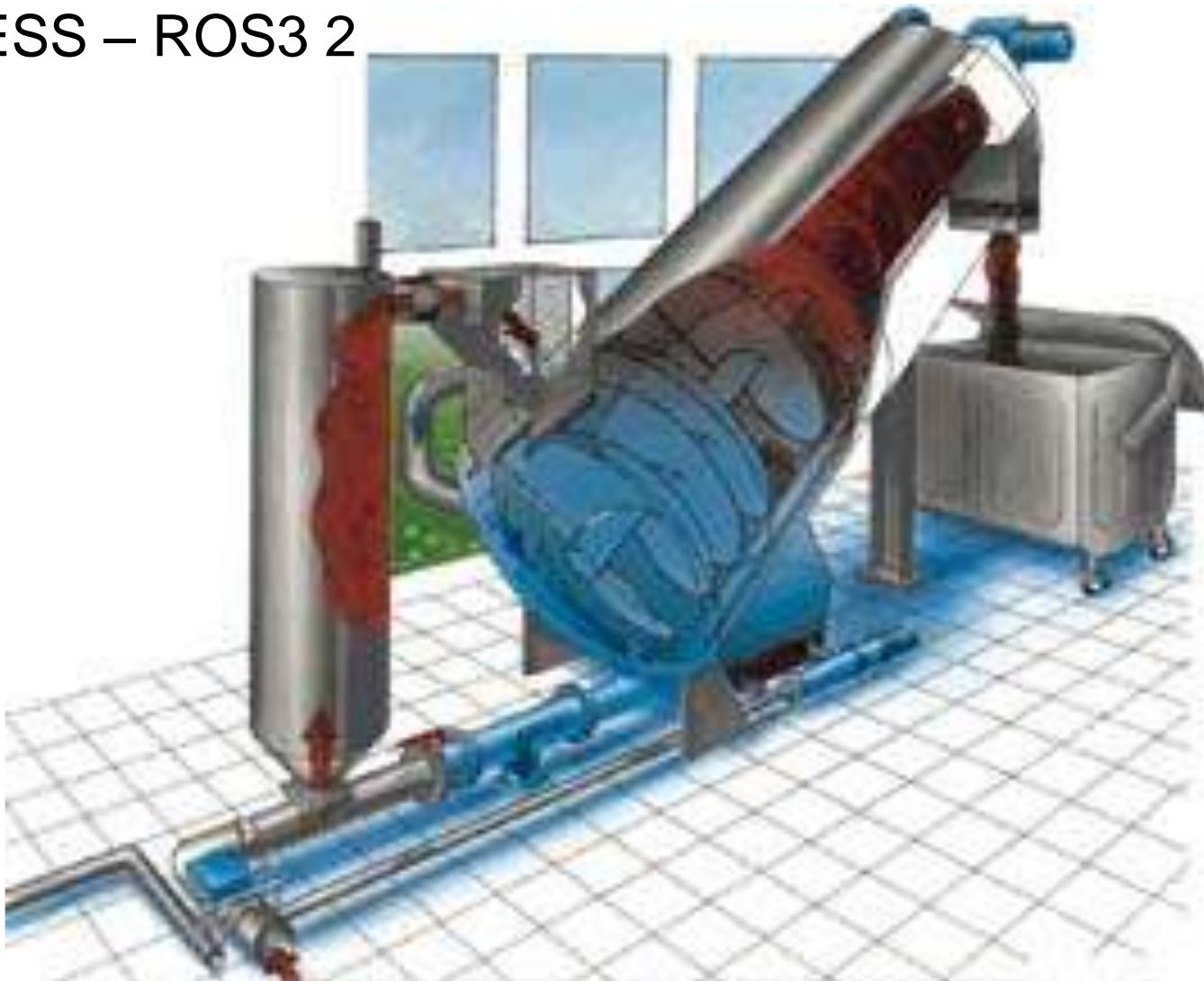


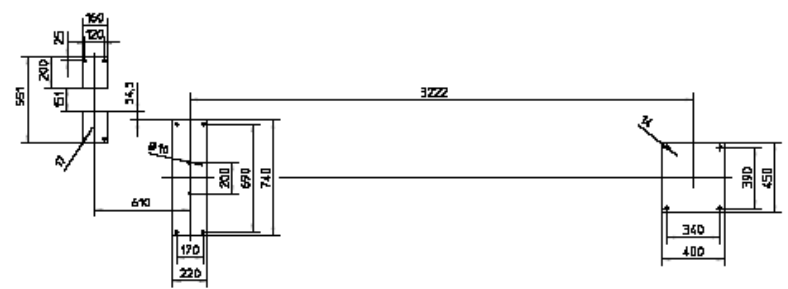
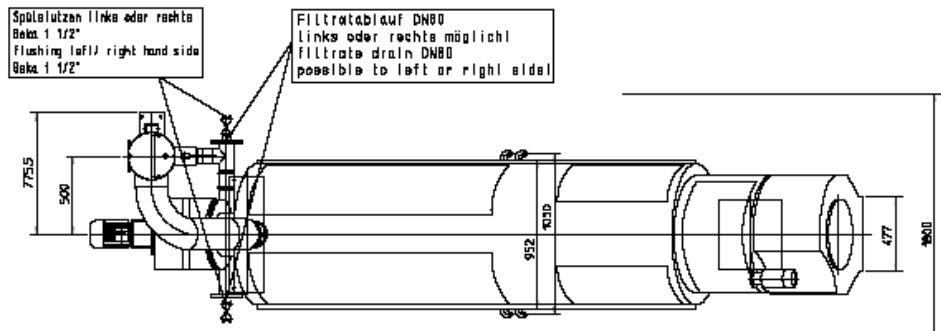
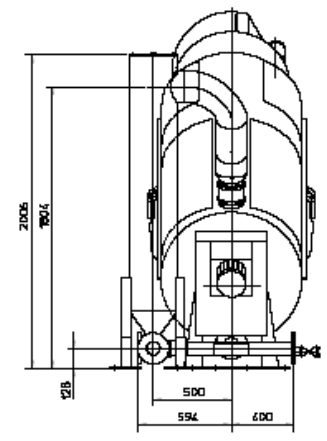
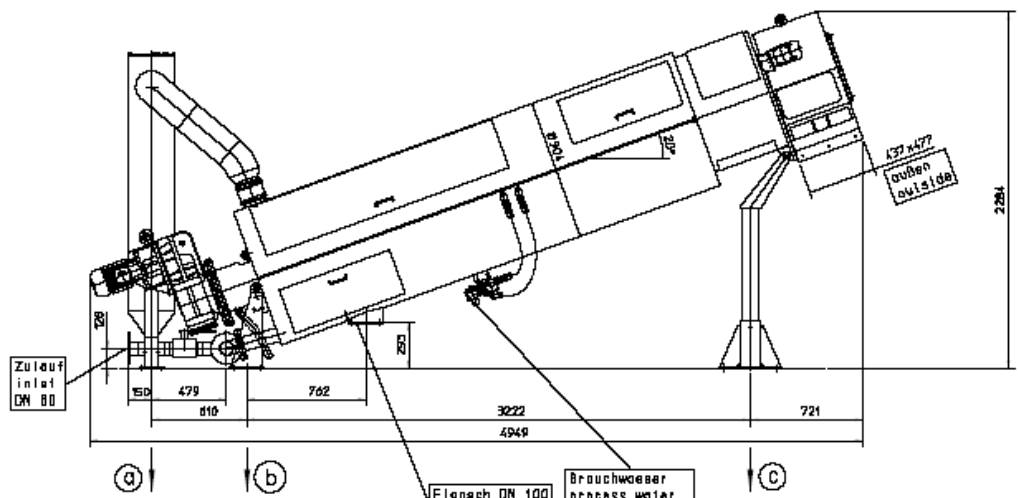
Dimension of each Compartment, with 2 no VRM 30/480 module	
Length	6540
Width	8000
Depth	4100

Total no of VRM Module Compartments – 5



HUBER ROTAMAT – SCREW PRESS – ROS3 2





	unbefüllt empty weight	befüllt full weight
①	0.5 kN	4 kN
②	11 kN	21 kN
③	7 kN	15 kN

Plan Name		Bezeichnung Specification		Vertrieb/Hersteller Distribution		Skizzen/Zeichnungen	
RoS		RoS-3/2		Huber		Huber	
Diese Zeichnung ist geistige Eigenleistung der Fa. Huber & Co. AG und stellt ein urheberrechtlich geschütztes Dokument dar. Die in dieser Zeichnung enthaltenen Informationen sind die geistige Eigentumsrechte der Fa. Huber & Co. AG. Any unauthorized use of this drawing will be held liable for payment of damages.							
Technische Änderungen vorbehalten / Subject to modification				RoS 2008-04		D-92334 Berching / Tel. 09462/201-0	
Rev. No.		Date		Project Name		Project Code	
0	RoS-3/2	04.04.2008	RoS-3/2	Maßblatt RoS-3/2 (Kommune)		Art.-Code Blatt Item Code Sheet	
Stand.-Art.-Code		Position		Project		Art.-Code Blatt Item Code Sheet	
-		2#		-		010_000059 -/1	

HUBER ROTAMAT – SCREW PRESS – ROS3 2



ROTAMAT® Sludge Dewatering Plant RoS 3-2	
Length	4949 mm
Width required	1800 mm
Overall height	2284 mm
POLY DOSING STN	
Two-chamber coagulant agent conditioning plant	2 x 2000l max. stock solution of 4000 l/h / 0.5% (maximum viscosity: 2,000 cp)
L x W x H	2980x 1485 x 1480 (mm)

HUBER ROTAMAT – SCREW PRESS – ROS3 2



ROTAMAT® Sludge Dewatering Plant RoS 3-2	
Sludge volume	10 m ³ /h
Initial solids content	3 - 5 %
Solid throughput	max. 400 kg DS/h
Final solids content required	≥ 16.0 % DR
Operation hours	8 h/day



EQUIPMENT WARRANTIES

EQUIPMENT	MECHANICAL WARRANTY (Pump casing, sealing, bearing, impellers etc..)	ELECTRICAL WARRANTY (Electrical motor, VFD, electrical panel, etc..)
HUBER COMPLETE PLANT – ROTAMAT – RO5		
RPPS, FINE SCREEN – 3 mm	2	1
GRIT CLASSIFIER	2	1
GREASE REMOVAL	2	1
AERATION TANK		
BLOWER	2	1
DIFFUSERS	1	
PIPING, VALVES & ACCESSORIES	2	
VACUUM ROTARY MEMBRANE - VRM – 30/480		
Membrane Module	5	
Blower for air scouring	2	1
Permeate pump	2	1
Sludge Recycling pump	2	1
Motor and Gear Box for driving module	2	1



UTILITIES CONSUMPTIONS – Power, Chemicals...



TOTAL POWER CONSUMPTION

TOTAL PLANT INSTALLED	225 KW
TOTAL PLANT PEAK LOAD	600 KW
TOTAL PLANT WORKING LOAD	460 KW



Description			C O N T I N U O U S	S T D b y	N O U N I T S	Kw		COS PHI	kva	kvar	kva	kvar
1	I-SCREEN 1 MOTOR -RPPS 2000	MCC1	X		1	2.0	2.0	0.85	2.35	1.24		
2	I-SAND TRAP SCREW MOTOR	MCC1	X		1	0.6	0.6	0.85	0.65	0.34		
3	I-GRIT CLASSIFIER MOTOR - ROSF3	MCC1	X		1	1.5	1.5	0.85	1.76	0.93		
4	1- COMPRESSOR MOTOR	MCC1	X		1	0.8	0.8	0.85	0.88	0.46		
5	I-FAT SCRAPER MOTOR	MCC1	X		1	1.1	1.1	0.85	1.29	0.68		
6	I-FAT PUMP MOTOR	MCC1	X		1	1.5	1.5	0.85	1.76	0.93		
8	MBR - VRM 30/ 480 1	MCC1	X		10	1.5	15.0	0.85	1.76	0.93		
9	MBR 1 VRM 1 PERMEATE PUMP MOTOR	MCC1	X	1	2	55.0	110.0	0.85	64.71	34.09		
17	MBR 1 RETURN SLUDGE PUMP 1 MOTOR	MCC1	X		2	18.0	36.0	0.85	21.18	11.16		
21	II- SCREEN 1 MOTOR	MCC1	X		1	1.5	1.5	0.85	1.76	0.93		
23	II- GRIT REMOVAL MOTOR	MCC1	X		1	1.1	1.1	0.85	1.29	0.68		
24	II-COMPRESSOR MOTOR	MCC1	X		1	0.8	0.8	0.85	0.88	0.46		
25	II- FAT SCRAPER MOTOR	MCC1	X		1	1.1	1.1	0.85	1.29	0.68		
26	II-FAT PUMP MOTOR	MCC1	X		1	1.5	1.5	0.85	1.76	0.93		
44	AIR BLOWER 1 MOTOR	MCC1	X		1	132.0	132.0	0.82	160.98	92.14		
45	AIR BLOWER 2 MOTOR	MCC1			1	132.0	132.0	0.82	160.98	92.14	160.98	92.14
46	AIR BLOWER 3 MOTOR	MCC1	X	X	1	132.0	132.0	0.82				
59	MISC	MCC1	X		1	10.0	10.0	0.85	11.76	6.20		
61	CHEMICAL CLEANING PUMP	MCC1	X		2	2.2	4.4	0.85			2.59	1.36
62	SPARE	MCC1	X			10.0	0.0	0.85	11.76	6.20		
							596.8		455.89	254.83		



HUBER MEMBRANE MODULES – Specific Details, Energy consumption, etc...



Specific energy consumption of VRM Plants*

Manufacturer		Hans Huber AG	Hans Huber AG
Plant type		VRM 20	VRM 30
Membrane process		UF	UF
Pore width	µm	0,007 - 0,038	0,007 - 0,038
Pore symmetry		asymmetric/composite	asymmetric/composite
Membrane type		flat membrane	flat membrane
Membrane material		PES	PES
pH resistance		0 - 14	0 - 14
Installation form		rotationally symmetric	rotationally symmetric
Resistance to drying up		no	no
Membrane diameter	mm	6 (plate spacing)	6 (plate spacing)
System design			
Membrane element	m ²	0,75	1,5
Module	m ²	3	6
Biggest filter unit	m ²	900	2880
Biggest filter unit dimensions	l*b*h	dimension sheet	dimension sheet
Space demand	m ² /m ³	dimension sheet	dimension sheet
Floor space required	m ² /m ²	dimension sheet	dimension sheet
Pre-treatment	mm	<3,0 (perfor.) <1,0 (wedge wire)	<3,0 (perfor.) <1,0 (wedge wire)
Sensitivity to entanglement of material		no	no
Max. transmembrane pressure	mbar	300	300
Transmembrane pressure (operation)	mbar	20 - 150	20 - 150
Flux gross	l/m ² *h	10 - 35	10 - 35
Max. flux net	l/m ² *h	30	30
Design continuous flux	l/m ² *h	15 - 17	15 - 17
Continuous throughput of the biggest unit	m ³ /h	13	41
Max. throughput of the biggest unit (temporary)	m ³ /h	24	78
Typical filtration time	min.	9	9
Typical regeneration time	sek.	1 (pause)	1 (pause)
Backwashing		no	no
Scouring air demand	m ³ /m ² *h	0,35	0,25
Scouring air		sequentially coarse bubbles	sequentially coarse bubbles
Pressure height - scouring air	mWs	1,6	2,1
Blower for the biggest unit	W	7500	15000
Energy - scouring air per m ² membrane	W/m ²	8,3	5,2
Driving power	W	1100	1100
Specific driving power	W/m ²	1,2	0,4
Permeate pump for the biggest unit	W	3300	5500
Permeate pump	W/m ²	3,7	1,9
Sum - energy per m ² membrane	W/m ²	13,2	7,5
Total power - biggest unit	kW	11,9	21,6
Total energy per m ³ permeate*	kWh/m ³	0,49	0,28



Manufacturer	Unit	Hans Huber AG
Plant Type		VRM 30/480
Membrane Process		UF
Membrane Type		PES, Plate and Frame Type
Pore Width	µm	0.007 - .038
Pore Symmetry		Asymmetric/Composite
Membrane Material		PES
PH Resistance		0 – 14
Installation form		Rotational
Resistance to Drying		no
Membrane Dia		6 (Plate Spacing)
Membrane Element	m2	1.5 m2
Total Module	m2	6 m2
Filter unit surface are	m2	2880 m2
Max Trans membrane Pressure	mbar	300 m bar
Trans membrane Pressure (Operation)	mbar	20 – 150 m bar
Flux gross	l/m2/h	10 – 35
Max Flux	l/m2/h	30
Design Continuous Flux	l/m2/h	15-17
Typical Filtration Time	min	9
Scouring Air Demand	m3/m2/h	0.25



Manufacturer	Unit	Hans Huber AG
Plant Type		VRM 30/480
Scouring Air		Sequentially Coarse AIR
Scouring Air Pressure Height	mWs	2.1
Energy scouring Air per m2	W/m2	5.2
Driving Power	W	1100
Permeate Pump per m2	W/m2	0.4
Energy per m2/membrane	W/m2	7.5
Total Energy per m3 Permeate	W	0.28



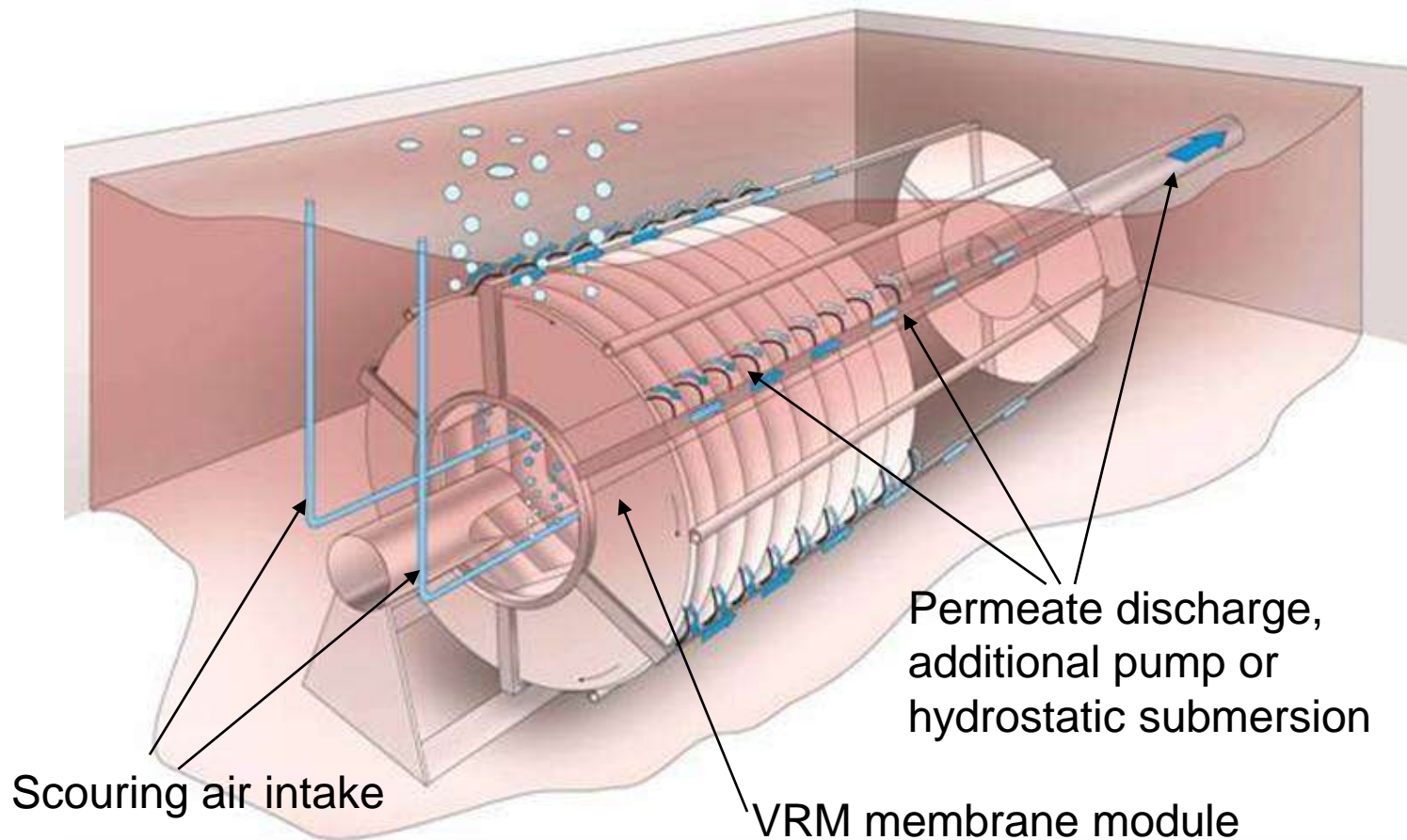
Chemical for CLEANING...

VRM 30/480	Type of Cleaning	Maintenance Cleaning (1000 ppm) Duration – Every Four week or more	Recovery Cleaning (300 ppm) Duration – Semi Yearly or more	Chemical consumption per module Membrane surface area 2880 m2	Chemical consumption per module Membrane surface area 28800 m2
VRM 30	Sodium Hypochlorite Cleaning (12% solution)	0.0083 l per m2 membrane surface area	0.015 – 0.15 l per m2 membrane surface area	45 l	450 l
	Citric Acid (50% - Solution)	.002 l per m2 membrane surface area	0.01 – 0.03 l per m2 membrane surface area	35 l	350 l

HUBER Membrane Technology

HUBER Membrane Technology Products

VacuumRotationMembrane (VRM®)



HUBER Membrane Technology

Advantage of HUBER VRM, Rotary Module.



- Rotation of module reduces the concentration of solute on the membrane surface
- Optimized and equalized scouring effect of the surface of membrane.



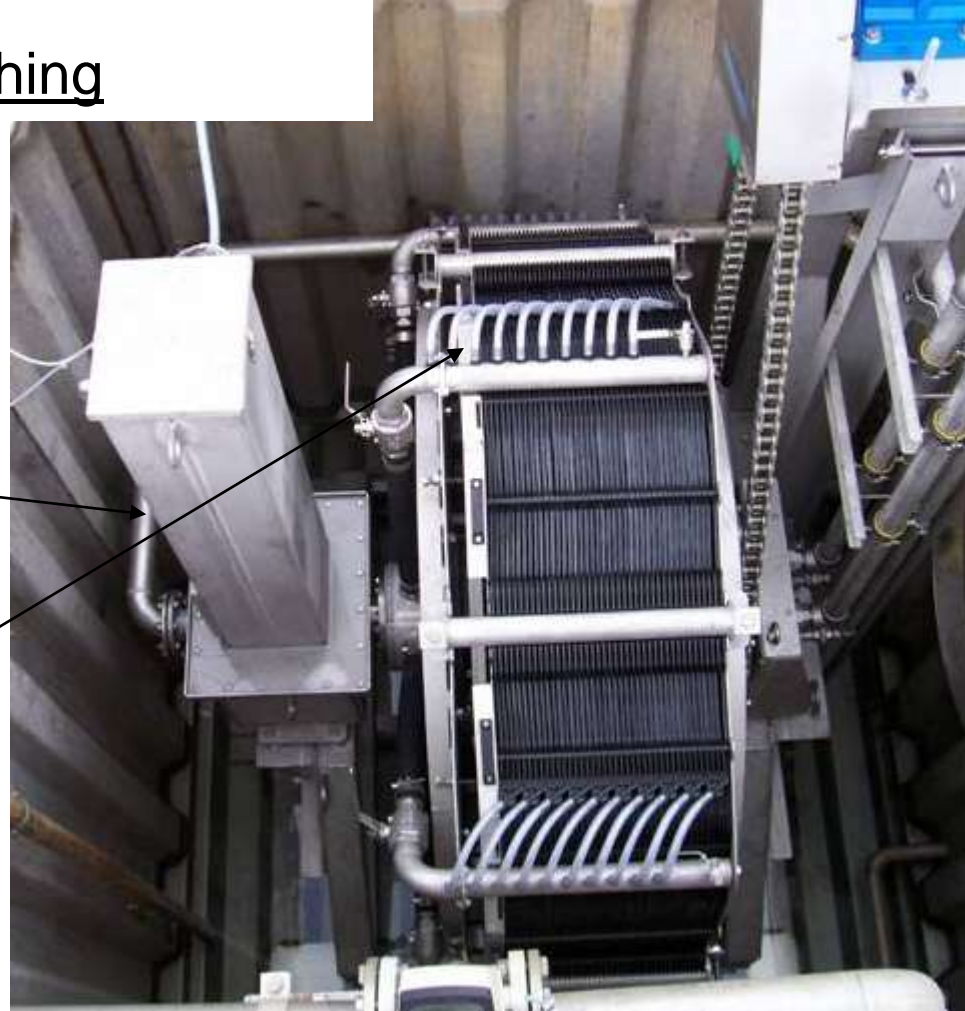
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HUBER Membrane Technology Products

VRM on WWTP Berching

Huber patented permeate discharge system

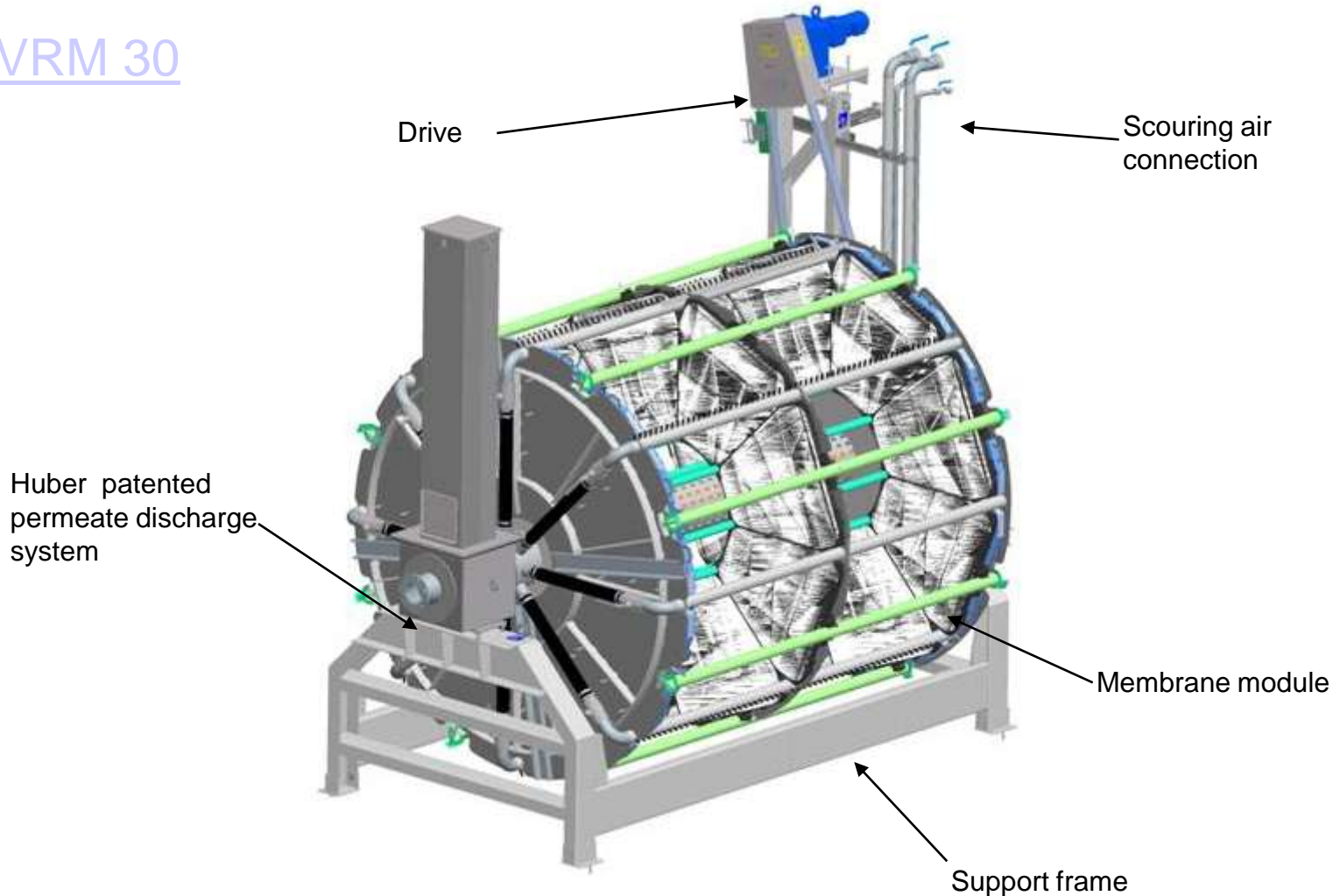
Permeate collector, increased throughput



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VRM 30



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Specific data

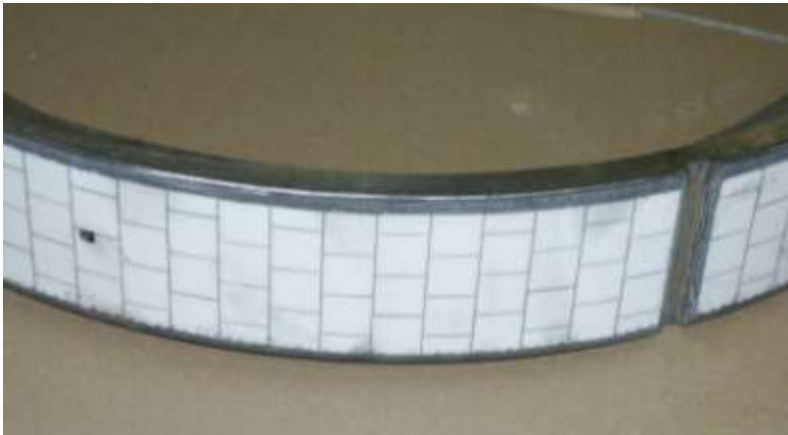
- ⇒ Diameter of filtration units: 3.2 (VRM 30)
- ⇒ Membrane module – Rotatory
- ⇒ Membrane Type – Plate and Frame
- ⇒ Membrane area: up to 2880 m² per unit
- ⇒ Throughput: up to 90 m³/h (peak) per unit
- ⇒ Peak flows of up to 60 l/mh with an optimal biological system
- ⇒ For installation into filtration chambers or directly into aeration tanks
- ⇒ Minimum tank depth. 3.7 m (VRM 30)



HUBER Membrane Technology

HUBER Membrane Technology Products

VRM ceramic journal bearing



ADVANTAGES

- ⇒ High-strength ceramic bearing
- ⇒ Glued on and polished ceramic plates
- ⇒ Very good sliding properties
 - ➔ Minimised power consumption
- ⇒ Reduced wear, long life
- ⇒ Also suitable for very abrasive media



HUBER Membrane Technology

HUBER Membrane Technology Products

VRM permeate collector



ADVANTAGES

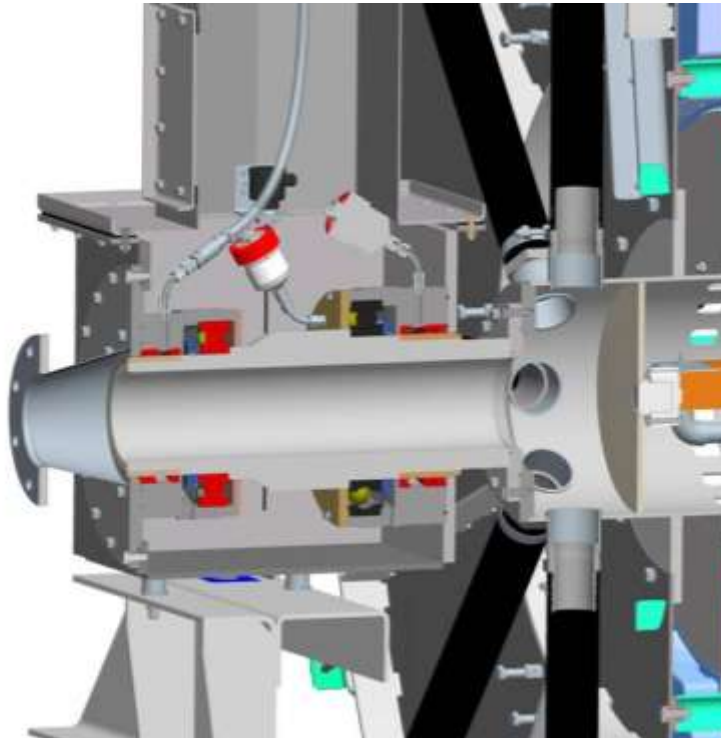
- Reduced pressure losses compared to the FESTO distributor → Higher throughputs (high flux up to 80 l/mh)
- Easier and faster to mount
- Lower price → Reduces the total membrane price
- Use of standard fabric hoses



HUBER Membrane Technology

HUBER Membrane Technology Products

VRM permeate bearing and permeate discharge



ADVANTAGES

- ⦿ No permeate contamination
➔ The shaft can be emptied
- ⦿ Automatic lubrication of the ball bearing
- ⦿ Sealing liquid on the permeate side for detection of leaks
- ⦿ The only wear parts are:
sealings (approx. 2 years life)
bearing (> 5 years life)
➔ low life-time costs

Huber Membrane Module – VRM - Specific Advantages – Summation

- 1. Due to rotation of the module there is cross flow velocity effect resulting in very low fouling of membrane**
- 2. Particles up to 3 mm size does not cause any fouling problem.**
- 3. Huber MBR system can withstand Oil and Grease in emulsified form up to form 80 mm**
- 4. The scouring air demand is minimized due to rotational effect and is equalized through out the system**
- 5. Huber Robust Mechanical design ensures uninterrupted operations up to 5 years.**



DBU's German Environmental Award 2006.



High-value water – Huber enhances
worldwide wastewater recycling

Hans G. Huber receives the German Environmental
Award 2006 for his innovative decentralised wastewater
treatment technology



DBU's German Environmental Award 2006.



Federal President Horst Koehler (3rd.f.r.) presented the German Environmental Award of the Deutsche Bundesstiftung Umwelt to Hans G. Huber (4th.f.r.)



ANY QUERIES, PLEASE?



**THANK YOU,
FOR YOUR ATTENTION!**

SHUKARAN!

