

## Research & Modeling Scale (RAMs) Crossflow Filtration System

### Description

Pall's Research & Modeling scale (RAMs) crossflow filtration system is designed to process fluid streams with suspended solids or biomass. The RAMs system's primary use is to demonstrate achievable effluent quality and collect necessary data for economic and process scale-up modeling.

The system is designed for biofuels research and small-scale production, such as algae-based slurry dewatering evaluations. The RAMs system can also be used in a variety of applications for bioreactor and fermentation processes where membrane-based separation, concentration, and purification are desired.<sup>1</sup>

A low hold-up volume of <2 liters (0.5 gallons) and a 20 liter (5 gallon) tank (included) provides 10x+ concentration studies. The RAMs system design is flexible and allows fluid to be pulled from a larger customer-provided tank (if desired), with final concentration taking place on the skid. This enables concentration of very dilute streams and processing volumes >20 liters (5 gallons) with the RAMs system.

### Applications

- Algal biomass concentration
- Cell separation & concentration
- Suspended solids separation & concentration
- Crossflow product clarification
- Low molecular weight transmission
- High molecular weight concentration
- Diafiltration & perfusion

### Benefits

- Versatile application development tool
- Small footprint
- Low hold-up volume
- Critical data acquisition
- Pilot designs evolve from data
- Commercial scale economic modeling before investing in a costly pilot system
- Automated instrumentation & operation

<sup>1</sup> The materials of construction (including elastomers) should be confirmed for application compatibility before ordering the system. Contact your Pall representative for more information.



Pall's Research & Modeling scale (RAMs) crossflow filtration system.

### Specifications

#### Design pressure

2.8 bar (40 psi) max. working pressure

#### Design temperature

0-40°C (32-104°F)

#### Max. operating temperature

60°C (140°F) during cleaning

#### Crossflow rate

0.5-10 m/s (1.64-32.8 ft/s)

#### Materials of construction

|  |   |
|--|---|
| Modules:                               | Clear polysulfone   |
| Housing:                               | 316L stainless steel  |
| Skid piping:                           | 304 stainless steel   |
| Feed tank:                             | 304 stainless steel<br>20 liters (5 gallons)                      |
| Heat exchanger<br>(shell & tube type): | Stainless steel   |
| Valves:                                | 316 or 316L stainless steel body<br>RTFE or fluoroelastomer seals |
| Pumps:                                 | 316 stainless steel casing and rotor<br>EPDM stator               |
| Control panel:                         | Painted carbon steel  |
| Skid frame:                            | Stainless steel   |

## Dimensions – system skid (nominal)

|                 |                                |
|-----------------|--------------------------------|
| Length:         | 101.6 cm (40 in)               |
| Width:          | 53.3 cm (21 in)                |
| Height          |                                |
| Single T1-70:   | 120.9 cm (47.6 in)             |
| 1-meter module: | 191.8 cm (75.5 in)             |
| Weight:         | 147 kg (325 lb)                |
| Hold-up volume: | approx. 2 liters (0.5 gallons) |

## Standards/codes

|              |                         |
|--------------|-------------------------|
| Skid piping: | ASME B16.5              |
| Electrical:  | NEMA-12 (non-hazardous) |

## Data acquisition

Critical parameters are selected by the operator. Data is logged in csv format to a micro SD card. A USB micro SD card reader should be used to transfer the csv file to a pc.

## Media options

The system is capable of evaluating three different filter media types and their respective effluents. The overall flexibility of the system makes it ideal for evaluating and comparing the effectiveness of different membranes used in specific applications. The RAMs system is very versatile and has five different interchangeable configuration options shown in Table 1. Changing between these options is easy with the available kits listed in the table.

The media options include:

- AccuSep® inorganic membranes
- Membralox® and Schumasiv™ ceramic membranes
- Microza<sup>2</sup> hollow fiber modules

## Product use

It is recommended that the equipment be used indoors in an environmentally-controlled space. Inspect all equipment to ensure that the plugs and connections remain intact after shipment. Follow the procedures outlined in the installation and operation manual. For application specific protocols, contact Pall for development services.

## Building a system

System scope starts by selecting one of two base models with the addition of the proper kits required to hook up the desired membrane format. Then add the proper number of T1-70 housings, membranes or modules necessary for the application.

## Ordering information

**RAMS-SYS-RF-120-1:** Base model Research & Modeling scale cross flow system with 120 volt, 1 phase electrical.

**RAMS-SYS-BW-120-1:** Base model with the optional backwash/backpulse included.

**RAMS-KIT-BW:** Service for Pall to add optional backwash/backpulse kit to the base model.

**S700-00139:** T1-70 housing with EPDM O-ring

**S700-00141:** T1-70 housing with fluorocarbon elastomer O-ring

**S700-01137:** T1-70 housing with PTFE O-ring

**Table 1. Example system configuration options**

| Module type   | Media <sup>3</sup> | Permeate flow rate @ 50 l/mh flux <sup>4</sup> (29 gfd) | Interchange kit ordering information   |
|---|--------------------|---|--|
| One T1-70 stainless steel housing                   | Ceramic element    | 0.004 lpm (0.001 gpm)                                   | <b>RAMS-KIT-1-T170</b><br>(order one T1-70 housing from ordering information above)  |
|   | AccuSep element    | 0.0027 lpm (0.010 gpm)                                  |  |
| Two T1-70 stainless steel housings in series        | Ceramic element    | 0.008 lpm (0.002 gpm)                                   | <b>RAMS-KIT-2-T170</b><br>(order two T1-70 housings from ordering information above) |
|   | AccuSep element    | 0.013 lpm (0.0035 gpm)                                  |  |
| One 30 cm (12 in) long Microza hollow fiber module  | USP-143 module     | 0.098 lpm (0.026 gpm)                                   | <b>RAMS-KIT-1-MCRZA</b><br>(order Microza module from Table 5a or 5b)                |
|   | UMP-153 module     | 0.07 lpm (0.018 gpm)                                    |  |
| Two 30 cm (12 in) long Microza hollow fiber modules | USP-143 module     | 0.019 lpm (0.05 gpm)                                    | <b>RAMS-KIT-2-MCRZA</b><br>(order Microza module from Table 5a or 5b)                |
|   | UMP-153 module     | 0.13 lpm (0.035 gpm)                                    |  |
| One 1 m (39 in) long Microza hollow fiber module    | XUSP-143L module   | 0.26 lpm (0.07 gpm)                                     | <b>RAMS-KIT-3-T170</b><br>(order Microza module from Table 5a)                       |

<sup>2</sup> Microza is a trademark of Asahi Kasei Corporation.

<sup>3</sup> Elements ordered separately. See Tables below.

<sup>4</sup> Flux rates will vary depending on fluids and crossflow rate.

**Table 2. AccuSep media specifications**

| Part number      | Media type                      | Pore rating |
|------------------|---------------------------------|-------------|
| 7EC4910-130SC050 | Stainless steel                 | 5.0 micron  |
| 7EC4910-130SC020 | Stainless steel                 | 2.0 micron  |
| 7EC4910-130CC102 | Zirconia-coated stainless steel | 0.1 micron  |

Literature reference:

E78a: [http://www.pall.com/pdf/E78a\\_AccuSep\\_Inorganic.pdf](http://www.pall.com/pdf/E78a_AccuSep_Inorganic.pdf)

GDS110: <http://www.pall.com/pdf/GDS110.pdf>

**Table 3. Membralox ceramic media specifications**

| Part number | Seal   | Pore rating  |
|-------------|--------|--------------|
| S700-01446  | Enamel | 5.0 nm       |
| S700-01447  | Enamel | 10.0 nm      |
| S700-00117  | Enamel | 0.005 micron |
| S700-00114  | Enamel | 0.02 micron  |
| S700-00121  | Enamel | 0.05 micron  |
| S700-00111  | Enamel | 0.1 micron   |
| S700-00108  | Enamel | 0.2 micron   |
| S700-00105  | Enamel | 0.5 micron   |
| S700-00102  | Enamel | 0.8 micron   |
| S700-00099  | Enamel | 1.4 micron   |
| S700-00090  | Enamel | 5.0 micron   |

Literature reference:

PIMEMBRAEN: <http://www.pall.com/pdf/PIMEMBRAEN.pdf>

**Table 4. Schumasiv ceramic media specifications**

| Part number | Seal  | Pore rating  |
|-------------|-------|--------------|
| 88501350    | Epoxy | 0.005 micron |
| 88501220    | Epoxy | 0.01 micron  |
| 88501420    | Epoxy | 0.05 micron  |
| 88501340    | Epoxy | 0.1 micron   |
| 88501230    | Epoxy | 0.2 micron   |
| 88501250    | Epoxy | 0.6 micron   |
| 88501270    | Epoxy | 1.2 micron   |
| 9581132     | Epoxy | 2.0 micron   |
| 89580862    | PTFE  | 0.005 micron |
| 89580863    | PTFE  | 0.01 micron  |
| 89581464    | PTFE  | 0.05 micron  |
| 89580250    | PTFE  | 0.2 micron   |
| 89581463    | PTFE  | 0.6 micron   |
| 89581462    | PTFE  | 1.2 micron   |
| 9580251     | PTFE  | 6.0 micron   |

Literature reference:

PISCHUMASIVEN: [www.pall.com/pdf/PISCHUMASIVEN.pdf](http://www.pall.com/pdf/PISCHUMASIVEN.pdf)

**Table 5a. Microza (MF) media specifications**

| Part number | Media type  | Pore rating |
|-------------|---|-------------|
| PSP-103     | Microza PE hollow fiber<br>0.17 m <sup>2</sup> , 0.7 mm fiber ID                    | 0.1 micron  |
| PSP-113     | Microza PE hollow fiber<br>0.1 m <sup>2</sup> , 2.0 mm fiber ID                     | 0.1 micron  |
| WSP-143     | Microza PE hollow fiber<br>0.09 m <sup>2</sup> , 1.4 mm fiber ID                    | 0.1 micron  |
| UMP-153     | Microza PVDF hollow fiber<br>0.08 m <sup>2</sup> , 2.6mm fiber ID                   | 0.2 micron  |
| USP-143     | Microza PVDF hollow fiber<br>0.12 m <sup>2</sup> , 1.4 mm fiber ID                  | 0.1 micron  |
| ULP-143     | Microza PVDF hollow fiber<br>0.1 m <sup>2</sup> , 1.1 mm fiber ID                   | 0.45 micron |
| XUSP-143L   | Microza PVDF hollow fiber<br>0.57 m <sup>2</sup> , 1.4 mm fiber ID,<br>1 meter long | 0.1 micron  |
| XUMP-153L   | Microza PVDF hollow fiber<br>0.43 m <sup>2</sup> , 2.6 mm fiber ID,<br>1 meter long | 0.2 micron  |

Literature reference:

[www.pall.com/FoodandBev\\_41053.asp](http://www.pall.com/FoodandBev_41053.asp)

**Table 5b. Microza (UF) media specifications**

| Part number | Media type  | Pore rating       |
|-------------|---|-------------------|
| ACP-1010    | Microza PAN hollow fiber<br>0.19 m <sup>2</sup> , 0.8 mm fiber ID | 13,000 KD<br>MWCO |
| ACP-1050    | Microza PAN hollow fiber<br>0.12 m <sup>2</sup> , 1.4 mm fiber ID | 13,000 KD<br>MWCO |
| AHP-1010    | Microza PAN hollow fiber<br>0.19 m <sup>2</sup> , 0.8 mm fiber ID | 50,000 KD<br>MWCO |
| AIP-1013    | Microza PAN hollow fiber<br>0.19 m <sup>2</sup> , 0.8 mm fiber ID | 6,000 KD<br>MWCO  |
| FLT-1026    | Microza PS hollow fiber<br>0.15 m <sup>2</sup> , 0.6 mm fiber ID  | 10,000 KD<br>MWCO |
| SAP-1013    | Microza PS hollow fiber<br>0.19 m <sup>2</sup> , 0.7mm fiber ID   | 4,000 KD<br>MWCO  |
| SEP-1013    | Microza PS hollow fiber<br>0.19 m <sup>2</sup> , 0.7mm fiber ID   | 3,000 KD<br>MWCO  |
| SIP-1023    | Microza PS hollow fiber<br>0.19 m <sup>2</sup> , 0.8mm fiber ID   | 6,000 KD<br>MWCO  |
| SLP-1053    | Microza PS hollow fiber<br>0.12 m <sup>2</sup> , 1.4mm fiber ID   | 10,000 KD<br>MWCO |

Literature reference:

[www.pall.com/FoodandBev\\_41053.asp](http://www.pall.com/FoodandBev_41053.asp)

## Pall Technical Services

The RAMs crossflow system is intended for use by researchers and process developers. Pall offers a range of Application Development Services that can compliment and enhance the usefulness of the RAMs system. The following Technical Services can be purchased from Pall:

- RAMs system set-up and training
- Basic process protocol development
- On-site process development assistance
- Pall assisted use of the RAMs system
- Economic modeling of RAMs data
- Pilot scale detailed system engineering
- Technical reports in support of process development assistance

Please contact Pall for process specific application development services.



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