

FEDI[®] STACK

TECHNICAL MANUAL



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TABLE OF CONTENTS

<i>Chapter</i>		<i>Page</i>
1	General Information	2
2	Introduction - Fractional Electrodeionization - FEDI®	3
3	Dual Voltage – Two Stage Separation Process	4
4	FEDI® Stack Constructional Features	5
5	Important Process Parameters	6
6	FEDI® Stack Handling	8
7	FEDI® Stack Skid Mounting Details	9
8	Bolt Torque Requirement - FEDI® Stack	11
9	FEDI® Stack Port Arrangement	12
10	FEDI® DV Stack's Electrical Cable Details	13
11	FEDI® SV/HF Stack's Electrical Cable Details	15
12	Typical PFD of FEDI® System	17
13	Start Up Procedure	20
14	Shutdown Procedure	23
15	Layup Procedure	23
16	Hot Water Sanitization Conditions of FEDI Rx Models	24
17	DC Power Requirement	25
18	Power Consumption	25
19	Special Precautions and Warnings	26
20	Operational Safety - Safety Standard Compliance	28
21	Operational Parameters Log Sheets	29
22	Stack Cleaning Procedure	31
23	Stack Regeneration Procedure	33
24	Troubleshooting Guide	35
A	APPENDIX A (FEDI-2 Specifications)	38
B	APPENDIX B (FEDI-2 HF -30X Specifications)	40
C	APPENDIX C (FEDI-RX Specifications)	42
D	Global Presence	



1. GENERAL INFORMATION

QUA® is a manufacturer of advanced membrane products for water, wastewater, and water reuse applications. Over a decade of extensive R&D activities have resulted in a range of cutting edge membrane products like FEDI® and Q-SEP®. These products are sold and serviced through a network of qualified original equipment manufacturers (OEM's) around the world.

The Manual

This manual was prepared to provide the operator with information on the installation, operation, maintenance, and troubleshooting of the FEDI® Stacks.

This manual may include drawings, schematics, and technical notes for clarification.

Safety Summary

Words in **ENHANCED CAPITAL** letters are used to identify labels on the device and key safety or qualifying statements. The safety summary does not contain all of the safety statements in the manual. Additional safety statements included within the manual text are enhanced and defined as follows:



NOTE

Note indicates those statements that provide further information and clarification.



CAUTION!

Caution indicates those statements that are used to identify conditions or practices that could result in equipment or other property damage.



WARNING!!

Warning indicates those statements that are used to identify conditions or practices that could result in injury or loss of life.



2. INTRODUCTION

Fractional Electrodeionization – FEDI®

The current range of FEDI® products includes three distinct models:

- (1) FEDI-2 (Single or Dual Voltage Operation)
- (2) FEDI-2HF (Single Voltage Operation)
- (3) FEDI Rx (Single Voltage Operation)

The unique features for each model are explained within the Specifications contained in Appendix A, B, and C

The Dual Voltage FEDI® Process utilizes an advanced Electro deionization concept that removes the strongly and weakly ionized impurities into two separate and independent stages by applying different electrical voltages at each stage. On these dual voltage systems, the first stage is operated at a lower voltage and current and removes the strongly ionized species (i.e. Calcium, Magnesium, Sodium, Sulphates, Nitrates, Chlorides, etc.). The second stage is operated at a higher voltage and current and removes the weakly ionized species like boron and silica. By removing the ions associated with scaling (calcium and magnesium) into a separate, slightly acidic waste stream, the FEDI® process is highly immune to what is the most common scaling problem plaguing the other EDI processes.

For very pure feed water containing low hardness, a single voltage can be applied to both the stages. Examples of such application are FEDI 2HF, FEDI Rx and FEDI-2 SV

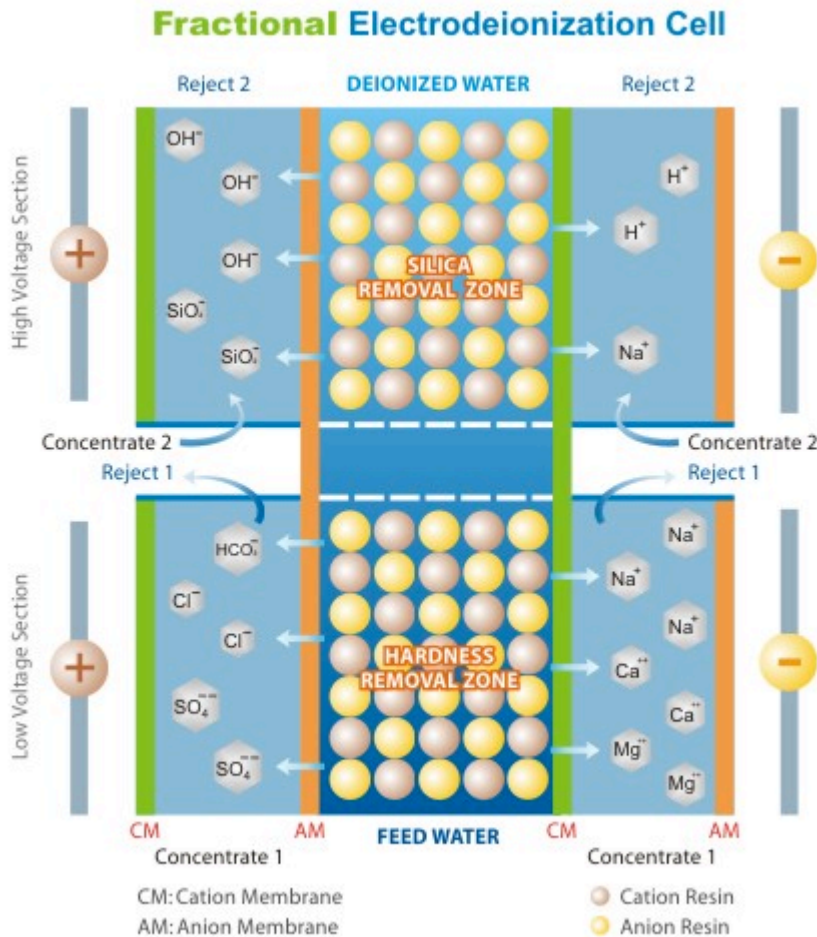
NOTES: “Same” voltage is also in certain places termed as single voltage to differentiate from Dual voltage.



WARNING!!

Water and Electricity DO NOT Mix! Proper training and handling of the FEDI® Stacks is critical to your safety and that of your fellow employees.

3. DUAL VOLTAGE – TWO STAGE SEPARATION PROCESS



Stage-1, The “Hardness Removal Zone” is operated under a lower DC driving force. The feed water enters this zone and strongly ionized impurities (calcium, magnesium, sulphate, nitrates, sodium, chloride, etc.) are removed utilizing the lower DC voltage and current. More than 90% of these conducting ions are removed within this zone consuming approximately one third of total power, as these ions require less power for transfer.

Stage-2, The “Silica Removal or Polishing Zone” removes the weakly ionized impurities (silica and boron) and any remaining strongly ionized impurities under the higher voltage and current driving force. The maximum water splitting occurs in this zone due to the applied high current, which leads to highly regenerated resin providing optimum conditions for the removal of silica and other weakly ionized impurities.



4. FEDI® STACK CONSTRUCTIONAL FEATURES

The FEDI® stack consists of an alternating arrangement of dilute and concentrate compartments, separated by ion exchange membranes. One dilute compartment and one concentrate compartment generated by one anion and one cation exchange membrane is termed as “one cell pair”. The stack is comprised of multiple cell pairs depending upon the product quality and volume required. This multiple cell pair system is bound on each side by electrode chamber. The electrodes on each side of the stack occupy the opposite polarity. The specific voltage is applied and the resulting DC current causes the ion exchange resin within the dilute compartment to regenerate. By continuously applying electricity to the electrodes the resin within the dilute compartment remains regenerated and the deionization process can be sustained.

The DC current provides the driving force for the removal of the undesirable ions. These ions are attracted towards the electrode with the opposite polarity. The ion exchange membranes provide an initial screening of the ions with the anion exchange membrane allowing only anions to transfer across the membrane and the cation exchange membrane only allowing the cations to transfer across the membrane.

The FEDI® stack has inlet and outlet ports defined below:

- (1) Feed
- (2) Product
- (3) Concentrate – 1 (IN)
- (4) Concentrate – 1 (OUT)
- (5) Concentrate – 2 (IN)
- (6) Concentrate – 2 (OUT)
- (7) Electrode Rinse – (IN)
- (8) Electrode Rinse – (OUT)

Please refer to the Specifications in the attached Appendix for the port connection details of each FEDI® model, and the typical Process Flow Diagram (PFD) in Section 11 for typical connections.

NOTES:



5. IMPORTANT PROCESS PARAMETERS

- **Product Pressure:** Always maintain a minimum of 0.7 bar (10 psig) pressure at the product stream
- **Concentrate-1 (OUT) and Concentrate-2 (OUT) Pressure:** Always maintain the Concentrate-1 (OUT) & Concentrate-2 (OUT) pressures as described in below table-

FEDI® Model #	Concentrate -1(OUT) Pressure (Also called C1 Out)	Concentrate -2(OUT) Pressure (Also called C2 Out)
FEDI-2 (DV)*	Please refer Formula -1a or 1b	Concentrate – 2 (OUT) pressure should always be 0.3 to 0.7 bar (5 to10 psi) (minimum) less than the product pressure

FEDI® Model #	Concentrate (Out) Pressure
FEDI-2 (SV)*	Concentrate (OUT) pressure should always be 0.3 to 0.7 bar (5 to10 psi) (minimum) less than the product pressure
FEDI-2 HF	Concentrate–2 (OUT) pressure should be always 0.3 to 0.7 bar (5to10 psi) (minimum) less than the product-2 or product pressure.

FEDI® Model #	Concentrate -1(OUT) Pressure (Also called C1 Out)	Concentrate -2(OUT) Pressure (Also called C2 Out)
FEDI Rx (When hardness is >0.2 ppm & < 1.0 ppm)	Please refer Formula -1a or 1b	Concentrate – 2 (OUT) pressure should always be 0.3 to 0.7 bar (5 to10 psi) (minimum) less than the product pressure
FEDI Rx (When hardness is <0.2 ppm)	Concentrate – 2 (OUT) pressure should always be 0.3 to 0.7 bar (5 to10 psi) (minimum) less than the product pressure	



***The FEDI-2 (SV) & FEDI Rx stacks should be fitted with a special interconnection arrangement of Concentrate-1 (OUT) to Concentrate-2 (IN), so only common Concentrate – 2 (OUT) pressure is required to be maintained as in the above table.**

NOTE

*SV = Single Voltage

DV = Dual Voltage

NOTES:

Formula 1a: (English Unit)

- **Concentrate-1(OUT) Pressure**
= $[0.5 \times (2 \times \text{Feed Pressure} - [\text{Feed Pressure} - \text{Product Pressure}]) - 10]$

For example: Feed pressure = 35 psi
& Product pressure = 15 psi

$$\text{Max. Concentrate-1(OUT) pressure} = (0.5 \times (2 \times 35 - (35 - 15))) - 10 \\ = 15 \text{ psi}$$

Formula 1b: (Metric Unit)

- **Concentrate - 1 (OUT) Pressure**
= $[0.5 \times (2 \times \text{Feed Pressure} - [\text{Feed Pressure} - \text{Product Pressure}]) - 0.7]$

For example: Feed pressure = 2.5 bar
& Product pressure = 1.0 bar

$$\text{Max. Concentrate-1(OUT) pressure} = (0.5 \times (2 \times 2.5 - (2.5 - 1.0))) - 0.7 \\ = 1.05 \text{ bar}$$

- **E.Rinse (IN) Pressure:** Should be less than 4.8 bar (70 psig)
- **E.Rinse (OUT) Pressure:** Should be less than 4.0 bar (58 psig)



NOTE

Under certain conditions, when the feed water hardness to the FEDI[®] stack is low, the stack can be operated in a Single Voltage mode. In that case, the voltage and current applied to Stage-1 and Stage-2 will be the same. Refer to the specifications in the attached Appendix for the detailed design conditions, operating parameters, and specifications on each FEDI[®] model.

NOTES:

6. FEDI® STACK HANDLING

The FEDI® stack can be lifted using typical mechanical devices. Refer to the specifications in the attached Appendix for dimensions and weights of each FEDI® model. Two lifting lugs with 25mm (1 inch) holes have been provided on the aluminium end plates to assist in lifting.



While lifting the stack, be careful to ensure the stack is properly seated /secured to avoid risk of topping over.

WARNING!!



Fig.1: FEDI® stack

FEDI® STACK STORAGE:

Do not store the FEDI® stacks outside unprotected or in direct sunlight. The stacks should be stored indoors at a temperature between 4°C (39°F) and 45°C (113°F). After installation, if the stacks will not be operated for more than seven (7) days, refer to the Layup Procedures (Section 14 of this manual) should be followed.



WARNING: Avoid Freezing Temperatures as this can permanently/severely damage the stack(s).

FEDI® STACK INSTALLATION:

Install the FEDI® stacks inside a dry, temperature-controlled building or minimally under a sun cover.

7. FEDI® STACK SKID MOUNTING DETAILS

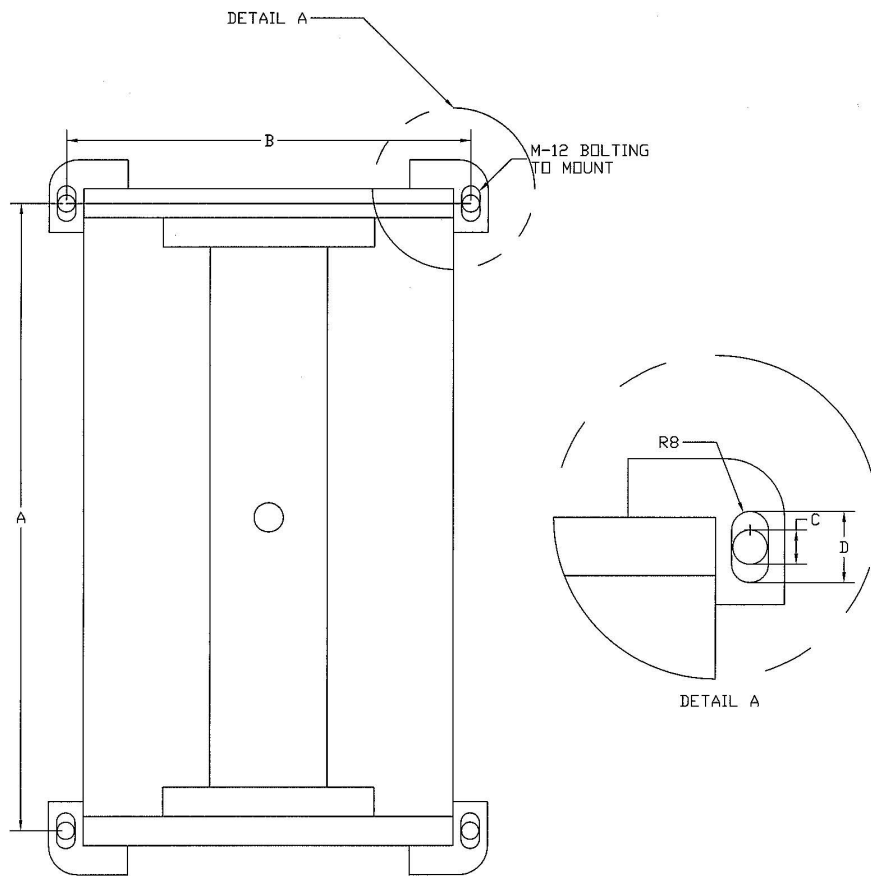


Fig.

2:

Bottom of the stack

Four mounting holes have been provided, with the correct bolthole pattern based upon the model, and referencing Figure 2. The stack should be properly mounted and fastened with bolts and nuts onto the structural skid.

NOTES:



MODEL #	(A) (DIMENSION IN MM)	(B) (DIMENSION IN MM)	(C) (DIMENSION IN MM)	(D) (DIMENSION IN MM)
10X	256 \pm 5	350	15	31
20X	401 \pm 5	350	15	31
30X	546 \pm 5	350	15	31
45X	755 \pm 5	350	15	31
F-2-HF-30X	588 \pm 5	350	15	31
F-2 R _x 5X	187 \pm 5	350	15	31
F-2 R _x 10X	270 \pm 5	350	15	31
F-2 R _x 20X	433 \pm 5	350	15	31
F-2 R _x 30X	596 \pm 5	350	15	31

MODEL #	(A) (DIMENSION IN INCH)	(B) (DIMENSION IN INCH)	(C) (DIMENSION IN INCH)	(D) (DIMENSION IN INCH)
10X	10.08 \pm 0.20	13.78	0.59	1.22
20X	15.78 \pm 0.20	13.78	0.59	1.22
30X	21.50 \pm 0.20	13.78	0.59	1.22
		13.78	0.59	1.22
F-2-HF-30X	23.20 \pm 0.20	13.78	0.59	1.22
F-R _x -5X	7.4 \pm 0.20	13.78	0.59	1.22
F-R _x -10X	10.63 \pm 0.20	13.78	0.59	1.22
F-R _x -20X	17.04 \pm 0.20	13.78	0.59	1.22
F-R _x -30X	23.50 \pm 0.20	13.78	0.59	1.22

8. BOLT TORQUE REQUIREMENT – FEDI® STACK

The bolt torque for the FEDI® stack is set at the factory prior to shipping. Re-torquing of the FEDI® stack is generally not required, but in the event one or more of the bolts loosen, then re-torquing of all of the bolts should be performed in the sequence listed below. Apply 40 Nm (30 ft. lbs.) Torque at sequence numbers 1 to 12 and 13 to 16; and only 35 Nm (26 ft. lbs.) torque at sequence numbers 17 to 20.

Stack Torque Process: In case re-torquing is required, remove the front and back covers on the stack, and hold the stack’s front side M12 nut with the appropriate wrench. Place the appropriately adjusted torque wrench on the stack’s backside M12 nut and tighten as per the sequence shown below:

Stack Torque Sequence:

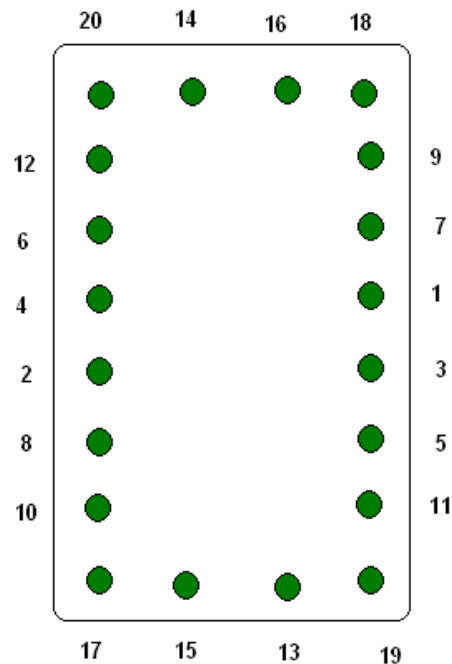


FIG.3: BACK (PORT) SIDE OF THE STACK

Conversion: 40 Nm (Newton Meters) = Approximately 30 Foot Pounds (ft. lbs.)

35 Nm = Approximately 26 ft. lbs.

NOTES:



9. FEDI[®] STACK PORT ARRANGEMENT

Refer to the appendix in this manual for details on port arrangement in the FEDI[®] stack.

The Port nozzle caps can be removed but should be kept in storage - You will need the nozzle caps later for any long-term storage (LAYUP) as noted in **Chapter 14 - LAYUP PROCEDURE**. Connect the hose/pipes to the nozzles according to connection details given in the table below:

The size of FEDI[®] ports are as follows:

Port Description	Size	Connection	Material
Feed / Product	1 inch	FNPT (Female Thread)	PP
Conc. – 1 (IN) / Conc. – 1 (OUT)	½ inch	FNPT (Female Thread)	PP
Conc. – 2 (IN) / Conc. – 2 (OUT)			
E. Rinse (IN) / E. Rinse (OUT)	10 mm	Push-Fit connection for 10 mm OD Flexible Hose	PA / PP

For the FEDI Rx pharma stacks all the port sizes remain the same as above however the connection type is tri-clover make.

NOTES:

10. FEDI® DV STACK'S ELECTRICAL CABLE DETAILS

The color code for the electrical cable (5-conductor x 1.5 mm²) required for the FEDI® DV stacks is defined below in the first chart.

One end of the cable is connected with a DC male connector, Model Number: **JI 3106F-18-11S**, which attaches to the FEDI® stack. The other end is open, complete with wire ferrules, identified as per the first chart below.

WIRE COLOR	FERUL NO.	DC CURRENT	VOLT SECTION	Coding On DC Connector
Brown	1	+ VE	Stage – 2	A
GREY	2	- VE	Stage – 2	B
BLACK	4	- VE	Stage – 1	C
BLUE	5	+ VE	Stage – 1	D
GREEN/YELLOW	E	Earth / Ground		E

Each FEDI® DV Stack also has additional wiring inside. It is not recommended to disturb the inside wiring of the stack unless absolutely necessary. We are including this chart below simply for future reference/identification purposes.

WIRE COLOR	FERUL NO	DC CURRENT	VOLT SECTION
RED	1	+ VE	Stage – 2
BLACK	2	- VE	Stage – 2
BLACK	4	- VE	Stage – 1
RED	5	+ VE	Stage – 1
GREEN/YELLOW	E	Earth / Ground	



Care should be taken by the OEM and/or the end-user to ensure that the cable supplying the DC power to the FEDI® stack is not damaged during assembly and operation. After assembly of the FEDI® system is completed, the OEM needs to verify the continuity of each wire.

NOTES:

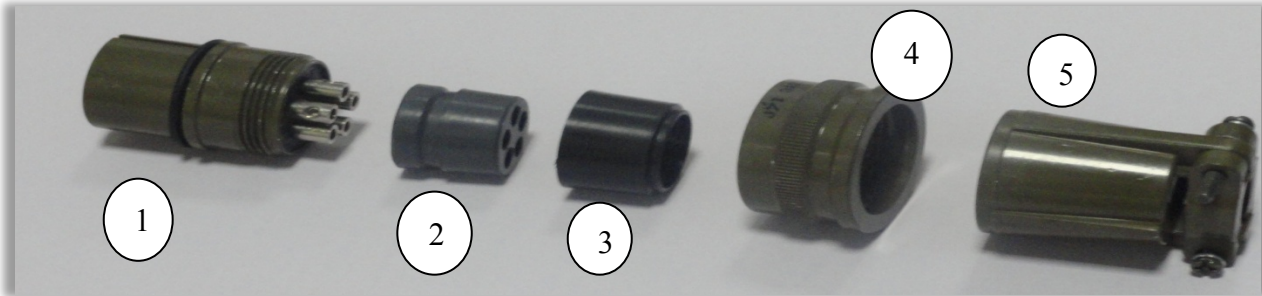
Item Code: 1301002105
Item Description: Electrical Connector Set

Item in the adjoining picture:
 Electrical Connector (Female).

The cable required for connection should be 5 core, 1.5mm² with the outer diameter of 10mm.

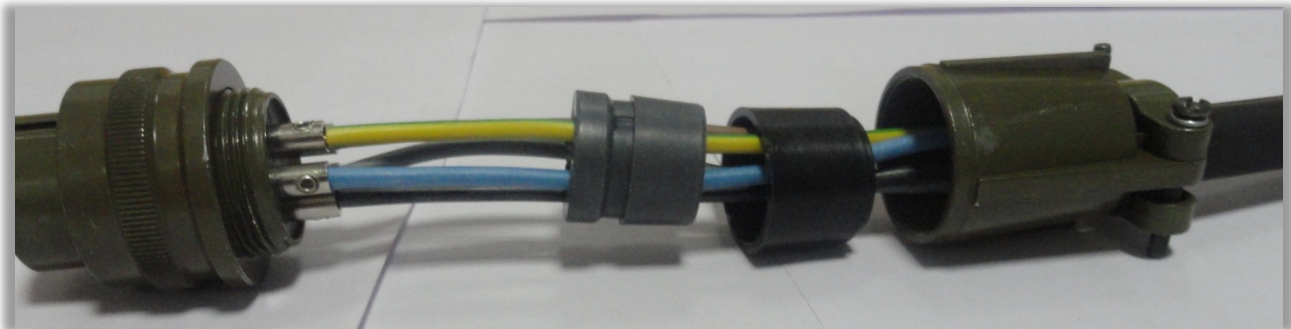


Part Description:

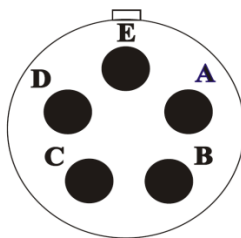


- 1: Cable termination socket
- 2: Grommet
- 3: Grommet Sleeve
- 4: Coupling connector
- 5: Back shell and Cable clamp

Sequence of Connection:



1. Pass the cable through backshell, coupling connector, grommet sleeve, grommet then terminate the cables in the socket.



2. Cable Terminations

- A: Red
- B: GREY
- C: Black
- D: BLUE
- E: GREEN+YELLOW



3. The rubber grommet will cover the cable termination sockets and the grommet sleeve will cover the grommet.

11. FEDI[®] SV/HF/RX STACKS' ELECTRICAL CABLE DETAILS

The color code for electrical cable (3-Conductor X 1.5 mm²) required for the FEDI stack is defined below in the first chart.

One end of the cable is connector with a DC male connector, Model number: JI 3106F-16-10S, which attaches to the FEDI stack. The other end is open Connection is identified as per the chart below.

DC CURRENT	VOLT SECTION	Coding On DC Connector
+ VE	Stage – 1 / 2	A
- VE	Stage – 1 / 2	C
Earth / Ground		B

Each FEDI SV/HF stack also has additional wiring inside. It is not recommended to disturb the inside wiring of stack unless absolutely necessary we are including this chart below simply for future reference/identification purposes.

WIRE COLOR	FERUL NO	Coding On DC Connector	DC CURRENT	VOLT SECTION
RED	1	A	+ VE	Stage – 1 / 2
BLACK	2	C	- VE	Stage – 1 / 2
GREEN/YELLOW	E	B	Earth / Ground	



CAUTION

Care should be taken by the OEM and/or the end-user to ensure that the cable supplying the DC power to the FEDI[®] stack is not damaged during assembly and operation. After assembly of the FEDI[®] system is completed, the OEM needs to verify the continuity of each wire.

NOTES:

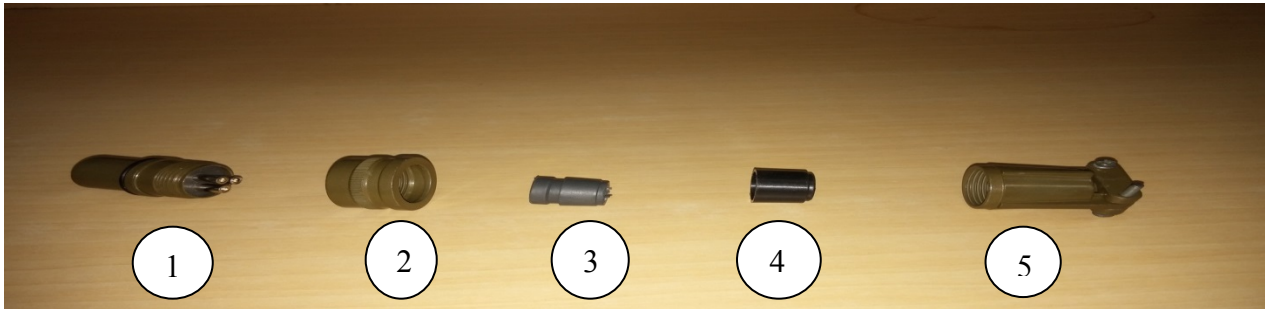
Item Code: 1301002273
Item Description: Electrical Connector Set

Item in the adjoining picture:
 Electrical Connector (Female).

The cable required for connection should be 3 core, 1.5mm²



Part Description:



1: Cable termination socket
 4: Coupling connector

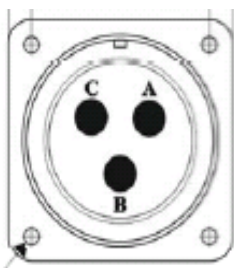
2: Grommet
 5: Back shell and Cable clamp

3: Grommet Sleeve

Sequence of Connection:



1. Pass the cable through backshell, coupling connector, grommet sleeve, grommet then terminate the cables in the socket.



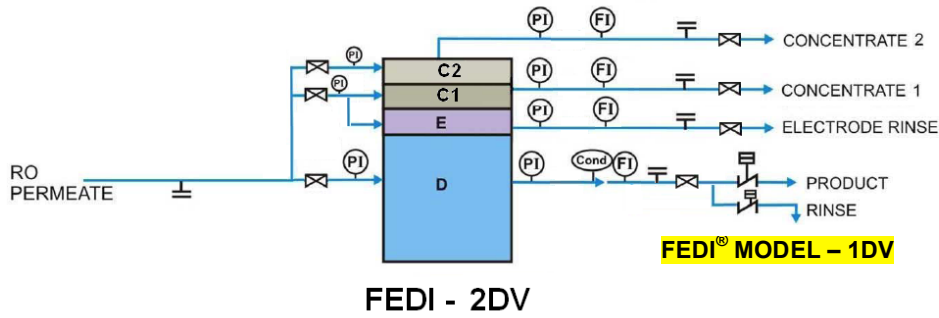
2. Cable Terminations

A: Red (Positive)
 B: Green + Yellow
 C: Black

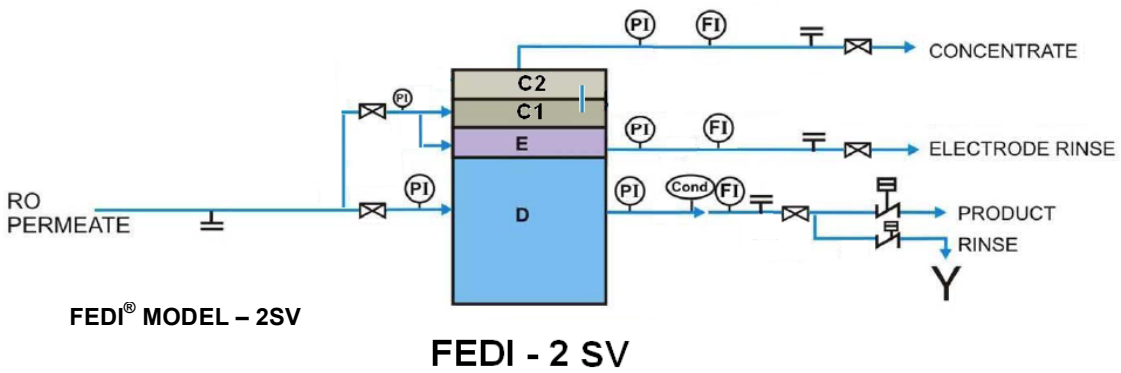


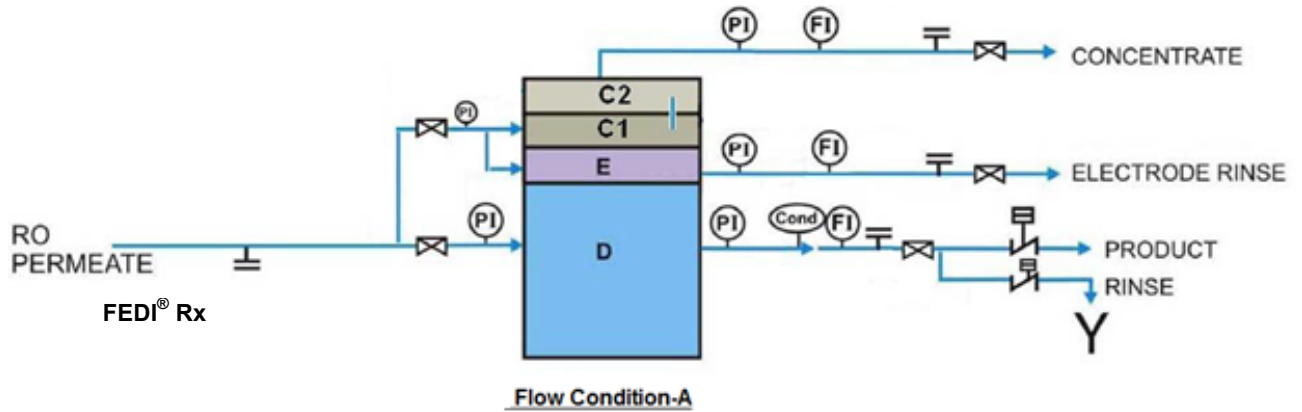
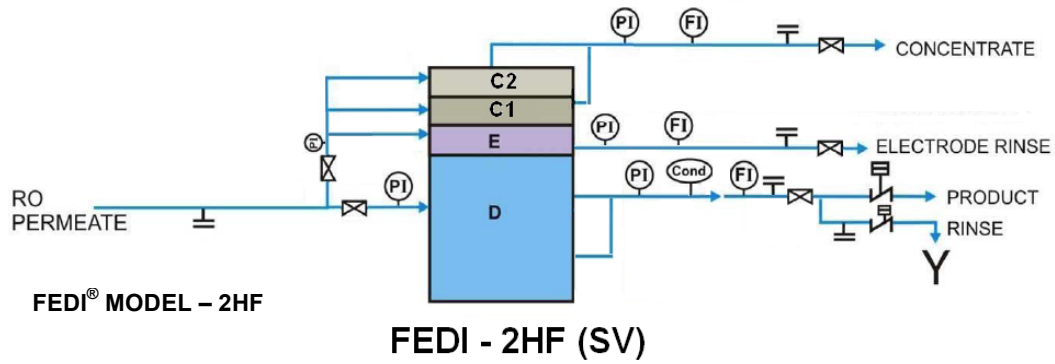
3. The rubber grommet will cover the cable termination sockets and the grommet sleeve will cover the grommet.

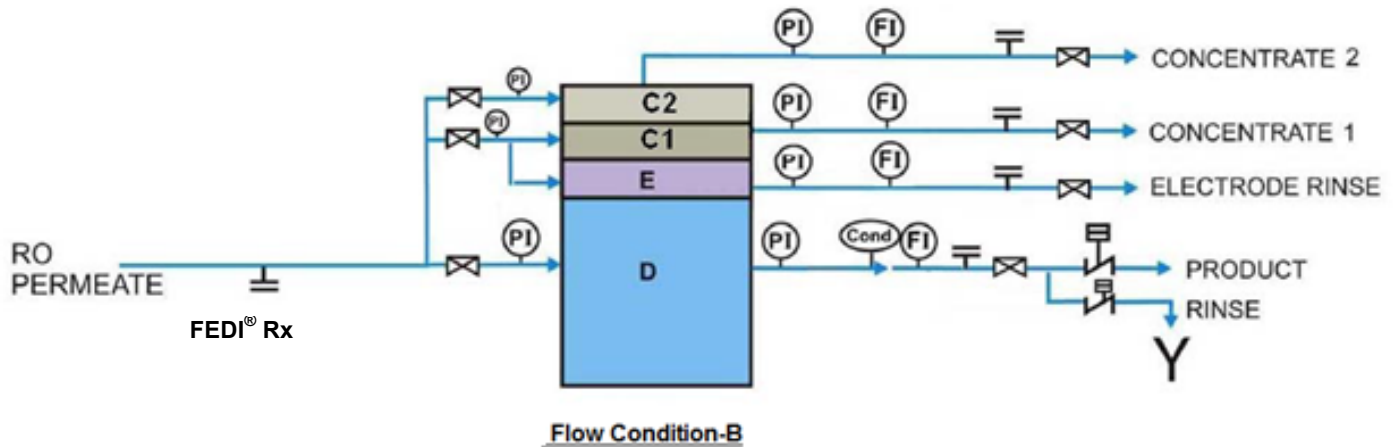
12. TYPICAL PFD OF FEDI® SYSTEM



FEDI® MODEL - 2DV







Please refer to the typical P&ID for each stack model to get details on recommended piping arrangement and instrumentation requirements.

MINIMUM PROCESS INSTRUMENTATION REQUIREMENT:

1. **FLOW:** FEDI Product, Concentrate-1 (OUT), Concentrate-2 (OUT), Electrode Rinse (OUT)
2. **PRESSURE:** FEDI Feed, Product, Concentrate-1 (IN), Concentrate-1 (OUT), Concentrate-2 (IN), Concentrate-2 (OUT), Electrode Rinse (IN) and Electrode Rinse (OUT).
3. **CONDUCTIVITY:** Product.



NOTE

In the event the process parameters deviate from the specified criteria, and to prevent stack failure, it is important that the instrumentation requirements shown above and the necessary automation with interlocks be provided to stop the system operation and alarm the operator.

NOTES: Instrumentation necessary to log & trend feed water data to FEDI should also be made available. These are normally conductivity, PH and temperature.

13. START UP PROCEDURE

- 1) The feed water has to be tested to verify that the required parameters are within the limits of the required feed specifications shown on the specification sheet in the attached Appendix.
- 2) Verify the system piping is properly flushed to remove any foreign material prior to connecting the stacks.
- 3) In case of RO permeate break tank, provision of cartridge filter with 1 micron rating at inlet to FEDI is MANDATORY.
- 4) Verify that all of the inlet and outlet valves to the FEDI[®] stack are open. If not, open all of these valves.
- 5) Make sure that water is actually going to the FEDI[®] stack(s). If a feed tank is supplied, make sure the minimum required water level in the feed tank is attained. Make sure that the pump suction valve is open. The feed pump should be started, keeping the bypass line (if available) open so that any initial water hammer is sent back to the tank. If a bypass line is not available, then care should be taken to gradually open the feed pump discharge valve to avoid any initial water hammer.
- 6) Adjust the feed inlet and product outlet valves of the stack until the specified product flow rate and outlet pressure are achieved. Verify that the inlet pressure to the stack does not exceed the design pressure of 6.9 bar (100 psi). Maintain the product water pressure in the range of 0.7-1.7 bar (10-25 psig)
- 7) If you are installing FEDI-2 (DV) and /or FEDI Rx for flow option-B (>0.2 ppm hardness), make sure to adjust the Concentrate-1(OUT) flow as per the specifications. Adjust the Concentrate-1 (IN and OUT) valves while maintaining the pressure of Concentrate-1(OUT) as calculated from equation shown in Chapter 5 of this manual.



NOTE

The Concentrate-1 (IN) pressure must always be less than the Feed pressure by 0.3 - 0.7 bar (5 - 10 psig)

- 8) If you are installing FEDI-2 (DV), FEDI Rx (< 0.2PPM hardness) make sure to adjust the Concentrate-2 (IN and OUT) flow as per the specifications by adjusting the Concentrate-2 Inlet and Outlet valves such that the Concentrate-2 (OUT) pressure is lower than the Product Pressure by 0.3 to 0.7 bar (5 to 10 psi).

- 9) If you are installing FEDI-2 (SV), make sure to adjust the Concentrate-IN and OUT flow as per specifications by adjusting the Concentrate Inlet and Outlet valves such that the Concentrate-OUT pressure should be lower than the product pressure by 0.3 to 0.7 bar (5 to 10 psi).



The FEDI-2 (SV) & FEDI Rx (<0.2PPM hardness) stacks are fitted with a special interconnection arrangement of Concentrate-1 (OUT) to Concentrate-2 (IN) so only Concentrate- (OUT), also called Concentrate-2 (OUT), pressure is required to be maintained as mentioned in Chapter 5 of this manual.

NOTE

- 10) If you are installing FEDI-2 (HF), make sure to adjust the Concentrate-1 (IN and OUT) and Concentrate-2 (IN and OUT) flow rate as per specifications by adjusting the Concentrate-1 and 2 Inlet and Outlet valves such that the Concentrate-1 (OUT) and Concentrate-2 (OUT) pressure is lower than the Product Pressure by 0.3 to 0.7 bar (5 to 10 psi).
- 11) Adjust the Electrode Rinse (IN and OUT) flow as per specifications by adjusting the Electrode Rinse (IN and OUT) valves. The electrode rinse flow during the start-up phase should be increased a little more to remove the air trap in the system by keeping the electrode chamber flooded.



Make certain that the Electrode Rinse (IN) pressure does not exceed 4.8 bar (70 psig) & the Electrode Rinse (OUT) pressure exceed 4.0 bar (58 psig) under any condition.

NOTE

- 12) Make sure that the minimum flows for the product; Concentrate-1 (OUT), Concentrate-2 (OUT) and Electrode Rinse Stream are maintained as per the specifications attached in the Appendix.



WARNING!!

Water and Electricity DO NOT Mix!
Proper training and handling of the FEDI® stacks is critical to your safety and that of your fellow employees.



WARNING!!

**UNDER NO CIRCUMSTANCE SHOULD A FEDI® STACK BE ENERGIZED WITH DC CURRENT WITHOUT SUITABLE WATER FLOW TO & FROM THE STACK(S)!!
Irreparable damage will occur.**

- 13) Once the flow is adjusted for all inlet and outlet streams, the system is ready for the power supply. Make sure that the DC power connectors are properly connected to the stacks. Keep the DC panel voltage set to 100% and set the current at 0% (with FEDI-2 (DV) set both stages at these values). Switch ON the DC panel and adjust the current. Use the FEDI Engineering Tool to determine the approximate start-up current to be applied. Adjust the current and maintain the voltage at 100%.
- 14) Allow the system to stabilize and record all process parameters identified on the Operational Parameter Log Sheet, Section 19 of this manual.
- 15) All stacks are regenerated and tested prior to shipping. However, because of storage, the stacks may require up to 8 hours of on-line regeneration during the initial start-up in order to achieve the specified product quality.
- 16) ***All operating parameters must be recorded at least 3 times daily. This information is to be entered into a spreadsheet and made available to QUA® in order to assist the site(s) with any technical issues that may arise. In addition, this information is required in order to properly document that the system has been operated properly in the event of a warranty claim.***



14. SHUTDOWN PROCEDURE

Whenever the plant requires a short-term shutdown, the following steps must be followed:

- 1) Isolate the product by opening the dump valve.
- 2) Turn OFF the DC supply.
- 3) Allow the water to flow for 1 – 2 minutes through the stack. This flushes the Concentrate and Electrode rinse chambers and replaces their contact with feed grade water.
- 4) Switch OFF the feed pump.
- 5) Close all the inlet and outlet valves to ensure that the stack remains full of water.

15. LAYUP PROCEDURE

For extended periods of idle time (more than seven (7) days) the stacks should be shut down and stored as follows:

- 1) Follow steps 1 to 3 above.
- 2) After shutdown (power OFF), flush all chambers of the stacks with RO permeate at the service flow rate for 5 – 10 minutes.
- 3) Drain all water from the stacks.
- 4) Disconnect all piping and hoses connected to the stacks. Plug all outlet connections on the stack.
- 5) Prior to restarting the unit, flush all skid piping if possible, and then re-connect the piping to the stacks.
- 6) Check product quality and other parameters. If the water quality is within spec then continue operation; otherwise cleaning or regeneration might be required. Clean and regenerate the stacks as per the FEDI[®] regeneration procedure.



WARNING!!

UNDER NO CIRCUMSTANCE SHOULD A FEDI[®] STACK BE ENERGIZED WITH DC CURRENT WITHOUT SUITABLE WATER FLOW TO & FROM THE STACK(S)!! IRREPARABLE DAMAGE WILL OCCUR.

NOTES:



16. HOT WATER SANITIZATION CONDITIONS OF FEDI R_x MODELS

FEDI Rx stacks hot water sanitization conditions:

Parameters	Conditions
Hot water quality	FEDI product water
Hot water temperature	80-85 °C
Feed Pressure during sanitization	< 30psi/2bar
Sanitization duration	1-2hrs

FEDI Rx Stack Flow during hot water sanitization:

Parameter	5 RX	10 RX	20 RX	30 RX
Product Flow (Lph/gph)	167/44	334 / 88	667 / 176	1000 / 264
Concentrate-1 Flow (Lph/gph)	17/5	33 / 9	67 / 18	100 / 26
Concentrate- 2 Flow (Lph/gph)	17/5	33 / 9	67 / 18	100 / 26
Electrode Rinse Flow (Lph/gph)	30/8	60 / 16	60 / 16	60 / 16

Note:

- Ensure DC power should be in OFF condition during hot water sanitization.
- Ensure minimum feed pressure during sanitization.
- During hot water sanitization, maintain hot water temperature in specified range and re-circulate water with specified flows through hot water system.
- After hot water sanitization, connect the stack in service mode and adjust required flows & pressures and then only ON DC power supply.

17. DC POWER REQUIREMENT

The DC voltage applied to the FEDI[®] stack creates the driving force for water deionization. Monitoring the DC voltage and the current is the key for the long-term efficient performance of the system. The required current depends on many process factors such as:

1. Feed/Concentrate/Electrode Rinse flow rate
2. Conductivity of Feed/Concentrate streams
3. Voltage applied
4. Feed water temperature

The objective is to apply the minimum current necessary for the FEDI[®] stack to continuously achieve the product quality.

Stage-1 typically requires a current between 0.5 and 2.5 DC amps.
Stage-2 typically requires a current between 1.5 and 3.5 DC amps.

The startup engineer should use the FEDI[®] Engineering Tool to determine the exact start-up current to be applied.



NOTE

Single Voltage FEDI[®] stacks will typically require a current between 1.0 to 6.0 DC amps per stack.

18. POWER CONSUMPTION

FEDI-2 DV stacks are designed for dual voltage operation, which allows the system to work with a higher hardness limit without any scale formation. The Dual-Voltage operation also allows for utilizing the power efficiently.

Typical power consumption of the FEDI[®] stack is 0.20 - 0.80 kWh/m³ (depending upon feed quality).

NOTES:

19. SPECIAL PRECAUTIONS AND WARNINGS



CAUTION

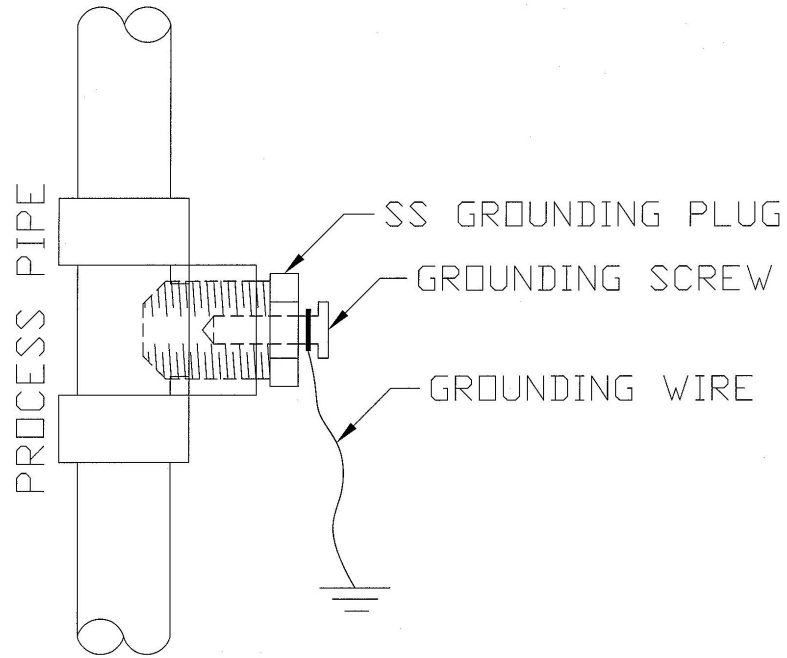
- User must ensure that the Negative/Cathode of the DC supply connected to FEDI[®] stack is properly grounded at the panel side as per the local regulation norms as defined by the local codes where the unit is located.
- The Power supply feeding the FEDI[®] stacks should be adequately protected against any ground faults. The Power Supply should be cut off in case of any ground faults to avoid any hazards to the user. IEC/Local standards should be followed to meet this requirement.
- The stack body and all conducting components mounted on the system (i.e., metal pressure gauges, etc.) should be properly grounded as per local electrical codes/standards. One of the ways this can be accomplished is by inserting a grounded metal device (such as stainless steel threaded plug) in each of the inlet and outlet streams.
- Disconnect the Power Supply before any work is done on the stack.
- Refer to the suggested illustration on the Page 22 for a typical grounding plug(s) installation.



WARNING!!

UNDER NO CIRCUMSTANCE SHOULD A FEDI[®] STACK BE ENERGIZED WITH DC CURRENT WITHOUT SUITABLE WATER FLOW TO & FROM THE STACK(S)!! IRREPARABLE DAMAGE WILL OCCUR.

NOTES:



GROUNDING PLUG DETAIL

20. OPERATIONAL SAFETY

SAFETY STANDARD COMPLIANCE:

The FEDI-2; FEDI-2HF and FEDI Rx Models are CE certified and comply with requirements specified in Annexure IV of Council Directive 2006/95/EC on Electrical Safety



CAUTION

While lifting the stack, be careful to make sure that the stack is properly seated/secured on the lifting equipment. This will help avoid the risk of a stack topping over and causing injury or damage to the equipment.

The internal conducting components of the FEDI® stacks are grounded to the Green wire connection. It is the responsibility of the OEM to ensure a proper earthing arrangement for each FEDI® stack, as well as the DC power system.

All of the Inlet and Outlet Water Connections TO and FROM the FEDI® stacks must be suitably grounded as illustrated in Chapter 17, the Special Precautions and Warnings Section.

If one or more of the FEDI® stacks are removed from the system, and/or in the event that the system is required to operate without these stack(s), please ensure that the power supply to the stack(s) that is to be removed is turned off from the DC panel by removing the cable(s) from the DC panel terminal, and/or by removing the fuses of the associated stack(s) from the DC panel.



WARNING

Do not touch either the stack(s), DC connector, or cable/wire without disconnecting the power!! If an arc is observed at the DC connection point, immediately shut down the system and fix the problem!

NOTES:



DC POWER CONSUMPTION LOG SHEET:

(Recommended Log Interval): Every Shift

Date/ Time	Stage -1	Stage - 2	Stage -1	Stage - 2
	VDC	VDC	ADC	ADC

OTHER TESTS (Required At Least Once Per Week)

SN	Test Parameters	Feed	Product
1	Silica as SiO ₂		
2	Total CO ₂		N/A
3	Hardness as CaCO ₃		
4	Current (amps)	At each FEDI [®] Stack	



22. STACK CLEANING PROCEDURE

Over a period of time, cleaning of the stack may be required due to:

- ✓ Hardness scaling
- ✓ Fouling with inorganic and organic / biological material
- ✓ Combination of the above

If the FEDI® stack voltage increases more than 30% beyond the set start-up stable voltage, the stack might require cleaning. Before cleaning consult a QUA® representative for proper guidance.

A FEDI® stack is first cleaned using Hydrochloric Acid (HCl) solution, followed then with a Sodium Chloride solution (NaCl).

Cleaning Solution Steps:

- 1) Hydrochloric Acid solution (1.0% to 2%)
- 2) Sodium Chloride solution (0.5 %)
- 3) DI water – RO permeate / FEDI product water.

Flow Rate per stack during cleaning: (With a re-circulation loop to the cleaning tank)

Parameter	FEDI® 2-5 X	FEDI® 2-10 X	FEDI® 2-20 X	FEDI® 2-30 X	FEDI® 2-45X	FEDI® 2-HF-30X
Product Flow (lph/gph)	133-167 / 36-44	267 – 334 / 71 - 88	533 - 667 / 140 - 176	800 -1000 / 211 – 264	1200-1500	1600 -2000 / 422 – 528
Concentrate-1 Flow (lph/gph)	17/5	33 / 9	67 / 18	100 / 26	150	100 / 26
Concentrate- 2 Flow (lph/gph)	17/5	33 / 9	67 / 18	100 / 26	150	100 / 26
Electrode Rinse Flow (lph/gph)	30/8	60 / 16	60 / 16	60 / 16	60	60 / 16

NOTES:

STACK CLEANING PROCEDURE:

- 1) Before initiating a cleaning procedure, record all operating parameters.
- 2) Switch OFF the DC power supply to stack.
- 3) Connect the stack to the cleaning skid.
- 4) Prepare the hydrochloric acid solution with RO permeate water in cleaning tank.



NOTE

Use high-purity HCl. UNDER NO CIRCUMSTANCE USE COMMERCIAL GRADE ACID!

- 5) Re-circulate the HCl solution through the stack for one hour and then drain all acid to the waste recovery tank.
- 6) Flush the stacks with RO permeate water for 4-5 minutes with the same flow.
- 7) Prepare the high purity grade sodium chloride solution (0.5%) with RO permeate water in cleaning the tank.



NOTE

UNDER NO CIRCUMSTANCE USE COMMERCIAL GRADE SODIUM CHLORIDE!

Refer to Chapter 12 for additional details on the salt specifications.

- 8) Re-circulate the NaCl solution through the stack for at least a half an hour.
- 9) Flush the stacks with RO permeate water until the product water conductivity drops below 50 $\mu\text{S}/\text{cm}$.
- 10) Connect the stack to the main process line and proceed with the regeneration procedure listed in Chapter 21.



WARNING!!

UNDER NO CIRCUMSTANCE SHOULD A FEDI[®] STACK BE ENERGIZED WITH DC CURRENT WITHOUT SUITABLE WATER FLOW TO & FROM THE STACK(S)!!

Irreparable damage will occur.

23. STACK REGENERATION PROCEDURE

After every cleaning or during start up (if required), the stack should be regenerated as per the following procedure:

- 1) Connect the stack(s) to the main process line while setting the flow rate per stack for regeneration as follows:

Parameter	FEDI® 2-5 X	FEDI® 2-10 X	FEDI® 2-20X	FEDI® 2-30 X	FEDI® 2-45X	FEDI® 2-HF-30X
Product Flow (lph/gph)	167 / 44	334 / 88	667 / 176	1000 / 264	1500	2000 / 528
Concentrate-1 Flow (lph/gph)	34 / 9	67 / 18	134 / 35	200 / 53	300	200 / 53
Concentrate- 2 Flow (lph/gph)	34 / 9	67 / 18	134 / 35	200 / 53	300	200 / 53
Electrode Rinse Flow (lph/gph)	50 / 13	100 / 26	100 / 26	100 / 26	100	100 / 26

- 2) When the flows of the various feed and product streams are set, switch ON the DC power supply to the stack.



UNDER NO CIRCUMSTANCE SHOULD A FEDI® STACK BE ENERGIZED WITH DC CURRENT WITHOUT SUITABLE WATER FLOW TO & FROM THE STACK(S)!! Irreparable damage will occur.

- 3) Set the current level as follows during regeneration:

- a. Stage-1: current 2.0 – 2.5 amps (Maximum)
- b. Stage-2: current 3.0 – 3.5 amps (Maximum)



NOTE

**In case of single voltage DC rectifier, set the current as follows:
Current = 5.0 - 6.0 amps.**

Do not exceed the maximum voltage as given in the specifications for the respective FEDI® model.



- 4) The stack may take from 5-8 hours for proper regeneration to produce water with the desired product conductivity.
- 5) Increase all the flows to the required value, set the operating voltage and current, and check the product water quality (Service Mode).
- 6) When the product water quality exceeds 10 MOhms.cm ($< 0.1\mu\text{S/cm}$) level, continue the stack operation in service mode.
- 7) If the product water quality does not exceed the 10 Mega Ohms .cm ($< 0.1\mu\text{S/cm}$) level, regenerate the stack(s) for an additional 5-8 hours at the regeneration flow rate and current (as mentioned in Steps 1 and 3). Also check the feed water quality and ensure that it meets feed water specifications.

NOTES:

24. TROUBLESHOOTING GUIDE

Problem Area	Causes	Corrective Action
<p>Low Product Quality</p>	<p>Feed water quality – not according to specification</p>	<p>★ Check feed water quality especially CO₂ Load, conductivity, silica, hardness and other contaminants.</p>
	<p>Water flow below minimum Water flow above maximum</p>	<p>★ Check and re-adjust feed and concentrate valves</p>
	<p>Power</p> <ul style="list-style-type: none"> ○ Current too low ○ Current too high ○ No power at electrodes ○ Polarity of electrodes reverse 	<p>★ Check and re-adjust voltage at electrodes. Ensure proper polarity and continuity.</p>
	<p>The pressure difference between dilute and concentrate stream incorrectly set</p>	<p>★ Check and re-adjust the pressure difference between the dilute and concentrate streams. Ensure that the pressure of the Feed/Product side is always higher than the corresponding pressure on the concentrate side.</p>
	<p>Stack Scaled or fouled</p>	<p>★ Clean stack according to the cleaning procedure.</p>
<p>The feed water temperature is below or above the range</p>	<p>★ Check and maintain the feed water temperature as per design and within limits.</p>	

Problem Area	Causes	Corrective Action
Low Product Flow	<p>Feed pressure is too low</p> <p>Dilute stream fouled or scaled</p> <p>Temperature too low (< 10 °C or <50 °F)</p>	<ul style="list-style-type: none"> ★ Increase feed water flow rate by adjusting the valves. ★ Check feed water quality especially hardness, total CO₂ and TOC load. Clean the stack according to cleaning procedure. ★ Maintain the temperature of the feed water as per design and within the limits.
Low Concentrate Flow	<p>Inlet pressure is too low</p> <p>Inlet and outlet valves are incorrectly set</p> <p>Scaling or fouling of concentrate chambers</p> <p>Valve incorrectly set.</p> <p>Scaling or fouling on the Electrode Rinse chambers</p>	<ul style="list-style-type: none"> ★ Increase the flow rate by increasing the pressure. ★ Adjust the valve and set the flow accordingly. ★ Check the feed water for hardness, CO₂ and silica load. Clean concentrate Chamber according to cleaning procedure. ★ Adjust the valve and set the flow accordingly. ★ Check feed water for hardness, CO₂ and silica load. Clean the Electrode Rinse chamber according to the cleaning procedure.
Stack Current Draw Too Low	<p>Electrode Rinse flow too low - minimum Electrode Rinse flow 60 lph (16 gph)</p> <p>Concentrate conductivity too low (FEDI-1 only).</p> <p>Stacks exhausted</p> <p>Scaling or fouling</p>	<ul style="list-style-type: none"> ★ Check and Increase Electrode Rinse flow. ★ Increase salt dosing ★ Regenerate the stack ★ Clean the stack



Problem Area	Corrective Action	Causes
Stack current draw too high	Electrode Rinse flow too high (max. flow 115 lph (30gph)). Concentrate flow too low. (Minimum concentrate flow 150 lph (40 gph)) No or low water flow through stack.	★ Decrease the Electrode Rinse flow and maintain it as per design. ★ Check and increase concentrate Flow. ★ Ensure flow of water in all stream are per the specifications, otherwise this no or low flow condition will damage the stack.

NOTES:

APPENDIX A

FEDI-2 SPECIFICATIONS

5X, 10X, 20X, 30X AND 45X

The FEDI® stacks are designed to produce high purity water up to 18 MΩ.cm using a patented process with double sets of electrodes per stack. The FEDI® stack design will replace mixed bed technology and produces pure water continuously, without the use of regeneration chemicals. Applications include the semiconductor, power, pharmaceutical, and food and beverage industries.



Features FEDI-2

FEDI-2 is available in two operating modes: Dual Voltage (DV) and Single Voltage (SV). The stacks contain media on the concentrate side, eliminating the need for a salt injection.

DV Mode:

- High hardness tolerance, reduces cleaning frequency, while increasing stack reliability
- Apply after a Single Pass RO, ultimately lowering overall system cost
- Low feed pressure-no counter current operation required
- Improved removal of strongly and weakly ionized impurities
- No concentrate recirculation

SV Mode:

- Reduced hardness tolerance
- Excellent product water quality
- High recovery

Stack Flows:

Parameters	Unit	5X**	10X	20X	30X	45X
Typical Product Flow	m ³ /hr	0.6*	1.2*	2.3*	3.5*	5.2*
	gpm	2.6	5.2	10	15.4	23
Maximum Product Flow	m ³ /hr	0.85	1.7	3.3	5.0	7.5
	gpm	3.7	7.5	14.5	22	33
Minimum Product Flow	m ³ /hr	0.25	0.5	1.0	1.5	2.3
	gpm	1.1	2.2	4.4	6.6	10.1
Max. Concentrate Flow DV mode	m ³ /hr	N/A	0.16	0.33	0.5	0.375
	gpm	N/A	0.7	1.45	2.2	3.3
Max. Concentrate Flow SV Mode	m ³ /hr	0.05	0.09	0.17	0.25	0.38
	gpm	0.2	0.4	0.7	1.1	1.7
Electrode Rinse Flow	m ³ /hr			0.1		
	gpm			0.44		

*Depending upon feed water hardness, to be confirmed by FEDI Engineering Tool

** 5X IS APPLICABLE ONLY FOR SV STACKS

Electrical DV Operation:

Parameters		Unit	10X	20X	30X	45X
Voltage 1 Voltage 2	Typical	VDC	90 140	170 270	250 400	400 500
	Maximum	VDC	200	350	500	600
Current 1/Current 2 Typical		Amp	1.5 / 2.5			
Current 1/Current 2 Maximum		Amp	2.5 / 3.5			

Electrical SV Operation:

Parameters	Unit	5X	10X	20X	30X	45X
Voltage Typical	VDC	60	110	210	300	450
Voltage Maximum	VDC	100	200	350	500	600
Current Typical	Amp		4			
Current Maximum	Amp		6			

Operating Conditions:

Parameters	Unit	5X, 10X, 20X, 30X, 45X
Recovery	%	up to 95
Feed water Temperature	°C	10 – 40
	°F	50 – 100
Pressure Drop (Feed to Product) @ typical flow	Bar	1.7 – 2.4
	psi	25 - 35
Max. Operating Pressure	bar	6.9
	psi	100

Product Water Specifications:

Parameters	Unit	Specifications
Product Resistivity	MΩ.cm	5 - 18
Silica (reactive)	ppb	<5 - 50

Feed Water Specifications:

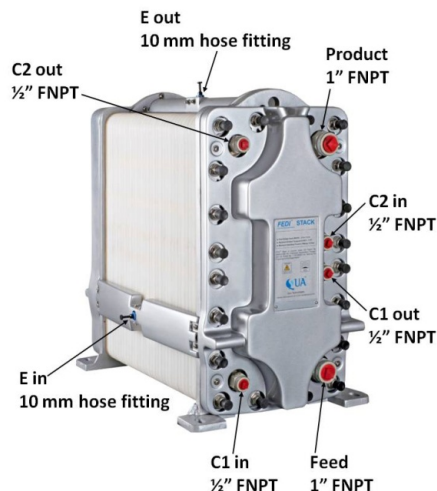
Parameters	Unit	Specifications
Feed Conductivity Equivalent (FCE) (Including CO2) *	µS/cm	< 40
pH		6 – 10
Silica (reactive)	ppm	< 1.0
Total Hardness as CaCO3	ppm	< 2.0 DV** < 1.0 SV
TOC	ppm	< 0.5
Heavy Metals (Fe, Mn etc.)	ppm	< 0.01
Free Chlorine as Cl2	ppm	< 0.05
Feed water SDI		<1.0

Weight and Dimensions:

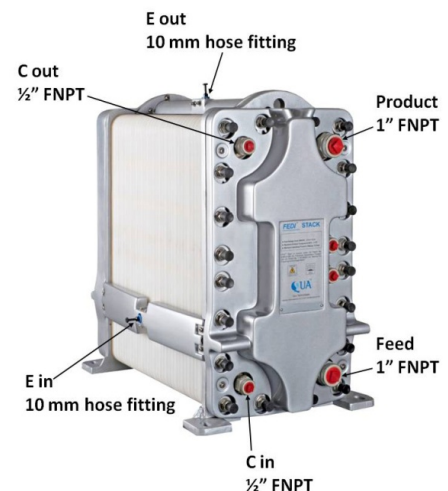
Parameters	Unit	5X	10X	20X	30X	45X
Weight (per Stack)	kg	44	60	80	100	140
	lbs.	97	132	176	220	309
Shipping Weight (per Stack)	kg	54	80	115	130	180
	lbs.	119	176	253	286	397
Length	mm	275	285	430	575	860
	inch	10.8	11.2	16.9	22.6	33.9
Width	mm			400		
	inch			15.8		
Height	mm			619		
	inch			24.4		

* Feed Conductivity Equivalent, FCE, (µS/cm) = Feed water conductivity (µS/cm) + ppm CO2 x 2.83 + ppm SiO2 x 2.08
 ** NOT APPLICABLE FOR FEDI-2-5X DV

FEDI-2 Connections DV Mode:



FEDI-2 Connection SV Mode:



The above information provides the general characteristics and description of a FEDI® stack. We believe that the above information is updated and accurate. However, the content of this datasheet might be subject to changes with further developments of the product and product line. Make sure that the FEDI® stacks are operated according to the latest version of the QUA® Operation and Maintenance/Technical Manual guidelines. Contact us for assistance in the selection of the FEDI® stacks specifically designed for your application.

APPENDIX B

FEDI-2HF-30X SPECIFICATIONS

The FEDI[®] stacks are designed to produce high purity water up to 18 MΩ.m using a patented process with double sets of electrodes per stack. The FEDI[®] design replaces a mixed bed technology and produces pure water continuously, without the use of regeneration chemicals. Applications include the semiconductor, power, pharmaceutical and food and beverage and industries.



Features FEDI-2HF

The stacks are designed for operation after Double Pass Reverse Osmosis (RO). The stacks contain media on the concentrate side, eliminating the need for salt injection.

- High stack flow up to 8.4 m³/hr. (37 gpm)
- No concentrate recirculation
- High recovery
- Meets water specifications for high pressure boilers and gas turbines, as well as a variety of other applications

Stack Flows:

Parameters	Unit	30X
Typical Product Flow	m ³ /hr.	6.8
	gpm	30
Maximum Product Flow	m ³ /hr.	8.4
	gpm	37
Minimum Product Flow	m ³ /hr.	4.5
	gpm	20
Max. Concentrate Flow (Conc. -1 + Conc. -2)	m ³ /hr.	0.5
	gpm	2.2
Electrode Rinse Flow	m ³ /hr.	0.1
	gpm	0.44

Electrical SV Operation:

Parameters		Unit	30X
Voltage	Typical	VDC	175
	Maximum	VDC	500
Current 1/Current 2 Typical		Amp.	4
Current 1/Current 2 Maximum		Amp.	6

Operating Conditions:

Parameters	Unit	30X
Recovery	%	up to 95
Feed water Temperature	°C	10 – 40
	°F	50 – 104
Pressure Drop (Feed to Product) @ Typical Flow	bar	1.4 – 2.1
	psi	20 – 30
Max. Operating Pressure	bar	6.9
	psi	100



Feed water Specifications:

Parameters	Unit	Specifications
Feed Conductivity Equivalent (FCE) (Including CO2) *	μS/cm	≤ 20
pH		6 – 10
Silica (reactive)	ppm	< 0.2
Total Hardness as CaCO3	ppm	< 0.2
TOC	ppm	< 0.5
Heavy Metals (Fe, Mn etc.)	ppm	< 0.01
Free Chlorine as Cl2	ppm	< 0.05
Feed water SDI		<1.0

* Feed Conductivity Equivalent, FCE, (μS/cm) = Feed water conductivity (μS/cm) + ppm CO2 x 2.83 + ppm SiO2 x 2.08.

Product Water Specifications:

Parameters	Unit	Specifications
Product Resistivity	MΩ.cm	10 to 16
Silica (reactive)	ppb	<10 - <50

Weight and Dimensions:

Parameters	Unit	30X
Weight (per Stack)	kg	115
	lbs.	253
Shipping Weight (per Stack)	kg	152
	lbs.	334
Length	mm	685
	inch	27.0
Width	mm	400
	inch	15.7
Height	mm	619
	inch	24.4

FEDI-2HF Connections:



The above information provides the general characteristics and description of a FEDI® stack. We believe that the above information is updated and accurate. However, the content of this datasheet might be subject to changes with further developments of the product and product line. Make sure that the FEDI® stacks are operated according to the latest version of the QUA® Operation and Maintenance/Technical Manual guidelines. Contact us for assistance in the selection of the FEDI® stacks specifically designed for your application.



APPENDIX C

FRACTIONAL ELECTRODEIONIZATION FEDI R_x SPECIFICATIONS

5RX, 10RX, 20RX AND 30RX

QUA FEDI R_x stacks for Pharmaceutical applications feature hot water sanitization ability at a temperature 80 - 85°C. These stacks have the ability to produce high purity water up to 16 MOhms.cm using a patented process with double sets of electrodes per stack. FEDI R_x stacks are available in 4 sizes (5X, 10X, 20X & 30X) and have application in Pharmaceutical, Biomedical & Laboratories where hot water sanitization is required.



Features

- High product water quality up to 16MOhms.cm
- Quick hot water sanitization at 80-85°C
- Tri – Clover fittings
- Exhaustion and regeneration not required before and after the hot sanitization
- Quick high product water quality after sanitization
- High recovery and Lower power consumption
- No salt dosing in concentrate
- High tolerance to feed water quality fluctuation
- FDA compliant
- CE Certified

Stack Flows:

Flow Condition-A: Feed Hardness ≤ 0.2 ppm (as CaCO₃)

Parameters	Unit	5 RX	10 RX	20 RX	30 RX
Typical Product Flow	m ³ /hr	0.6	1.2	2.3	3.5
	gpm	2.6	5.2	10	15.4
Maximum Product Flow	m ³ /hr	0.85	1.7	3.3	5.0
	gpm	3.7	7.5	14.5	22
Minimum Product Flow	m ³ /hr	0.25	0.5	1.0	1.5
	gpm	1.1	2.2	4.4	6.6
Max. Concentrate Flow SV Mode	m ³ /hr	0.05	0.09	0.17	0.25
	gpm	0.2	0.4	0.7	1.1
Electrode Rinse Flow	m ³ /hr	0.1			
	gpm	0.44			

Flow Condition-B: Feed Hardness ≥ 0.2 ppm and ≤ 1 ppm (as CaCO₃)

Parameters	Unit	5 RX	10 RX	20 RX	30 RX
Typical Product Flow	m ³ /hr	0.6	1.2	2.3	3.5
	gpm	2.6	5.2	10	15.4
Maximum Product Flow	m ³ /hr	0.85	1.7	3.3	5.0
	gpm	3.7	7.5	14.5	22
Minimum Product Flow	m ³ /hr	0.25	0.5	1.0	1.5
	gpm	1.1	2.2	4.4	6.6
Max. Concentrate 1 Flow	m ³ /hr	0.05	0.09	0.17	0.25
	gpm	0.2	0.4	0.7	1.1
Max. Concentrate 2 Flow	m ³ /hr	0.05	0.09	0.17	0.25
	gpm	0.2	0.4	0.7	1.1
Electrode Rinse Flow	m ³ /hr	0.1			
	gpm	0.44			

**Depending upon feedwater hardness, to be confirmed by FEDI Engineering Tool*



Electrical SV Operation:

Parameters	Unit	5X	10X	20X	30X
Voltage Typical	VDC	60	110	210	300
Voltage Maximum	VDC	90	200	350	500
Current Typical	Amp.	4			
Current Maximum	Amp.	6			

Operating Conditions:

Parameters	Unit	5X,10X, 20X, 30X
Recovery	%	up to 95
Feedwater Temperature	°C °F	10 – 50 50 – 122
Pressure Drop (Feed to Product) @ typical flow	Bar psi	1.4 – 2.4 20 - 35
Max. Operating Pressure	bar psi	6.9 100
Recommended Operating Pressure	Bar psi	< 4.8 < 70

Feed water Specifications:

Parameters	Unit	Specifications
Feed Conductivity Equivalent (FCE) (Including CO2) *	µS/cm	< 40
pH		6 - 10
Silica (reactive)	ppm	< 1.0
Total Hardness as CaCO3	ppm	< 1.0 SV
TOC	ppm	< 0.5
Heavy Metals (Fe, Mn etc.)	ppm	< 0.01
Free Chlorine as Cl2	ppm	< 0.05
Feedwater SDI		<1.0

* Feed Conductivity Equivalent, FCE, (µS/cm) = Feedwater conductivity (µS/cm) + ppm CO2 x 2.83 + ppm SiO2 x 2.08.

Conditions during HWS

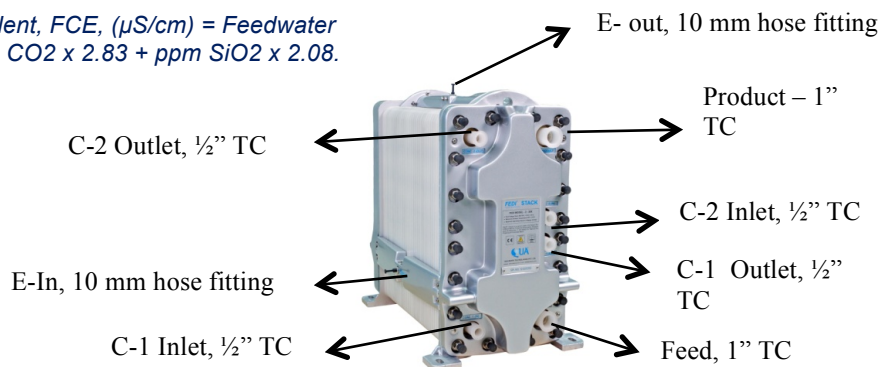
Parameters	Unit
Hot water quality	FEDI product water
Hot water temperature	80-85 °C
Maximum pressure during sanitization	30psi / 2bar
Sanitization duration	1-2hrs
Flows during sanitization	Stack min flows

Product water specifications:

Parameters	Unit	Specifications
Product Resistivity	MΩ.cm	5 - 18
Silica (reactive)	ppb	<5 - 50

Weight & Dimensions:

Parameters	Unit	5X	10X	20X	30X
Weight (per Stack)	kg	44	70	90	115
	lbs	97	154	198	253
Shipping Weight (per Stack)	kg	54	80	115	130
	lbs	119	176	253	286
Length	mm	220	363	530	697
	inch	8.7	14.3	20.9	27.4
Width	mm	400			
	inch	15.7			
Height	mm	619			
	inch	24.4			

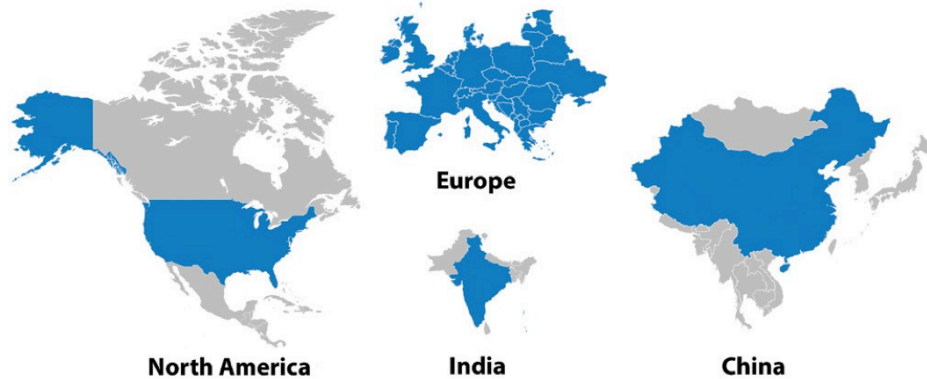


The above information provides the general characteristics and description of FEDI® stack. We believe that the above information is correct as of this printing. However, the content of this datasheet might be subject to changes with further development of the product. Make sure FEDI® stacks are operated according to Operation and Maintenance guidelines. Contact us for assistance in selection of FEDI® stacks for your application.

For additional information and local contacts: sales@quagroup.com or www.quagroup.com



APPENDIX D GLOBAL PRESENCE



QUA Group LLC
One Four Coins Drive Canonsburg, PA 15317
USA
Tel: +1 877 782 7558
sales@quagroup.com

QUA Water Technologies Pvt. Ltd.
Plot No. 35,T-Block, MIDC Bhosari, Pune 411026
India
Mobile: +91 8806661037
Mobile: +91 9823042075
sales@quagroup.com

QUA Group-China
15 Floor, Huilong
54-56 Zhongzhou 2 Road, Guangzhou 510080
China
Mobile: +86 13917516227
lib@quagroup.com

QUA Group - Europe
Via G. Mussi 4, 20154 Milan
Italy
Mobile: +39-347-1025891
muscellag@quagroup.com

www.quagroup.com