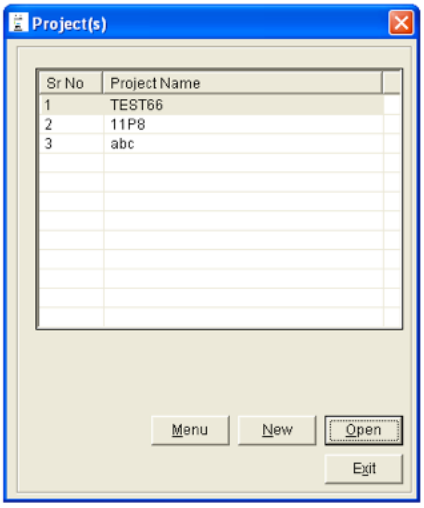
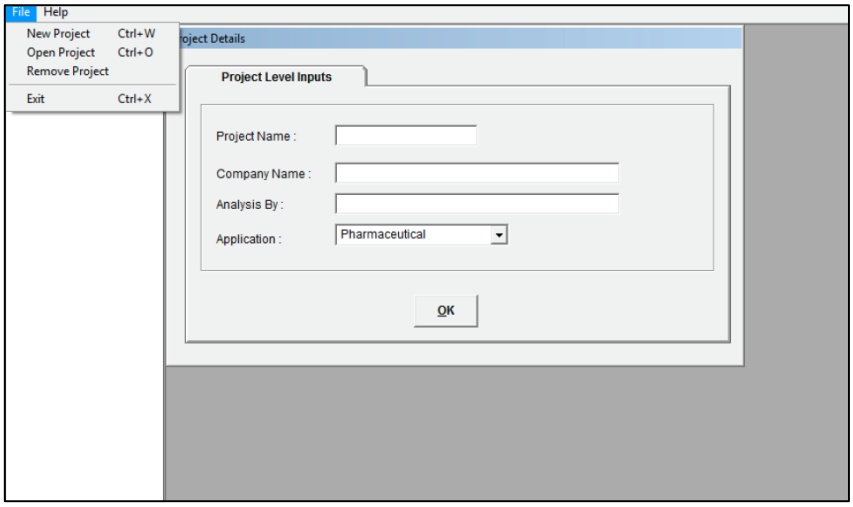
QUA FEDI Software User Manual

The QUA FEDI software is a user-friendly software tool which provides basic information to help the user design the FEDI Fractional Electrodeionization system and predict its performance based on feed water conditions and design requirements. This first section of the user manual (Section A) will provide information on how to operate the software tool. Section B will provide useful guidelines for the user to consider while designing a FEDI system using the software.

A. FEDI Software Instructions

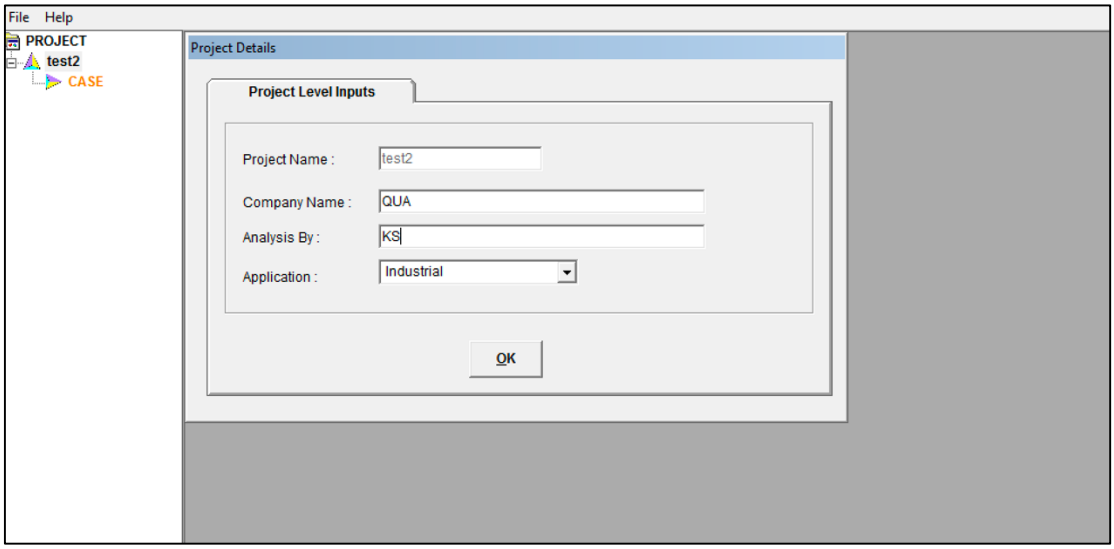
1. After the software is installed, a FEDI program icon is created on the user's desktop. To start the software, double click this icon or do the right click and select the "open" option. A "Project(s)" window appears on the screen. To run a new FEDI projection, select the "new" option. You can also start the program and click the "File" dropdown and select "New Project."



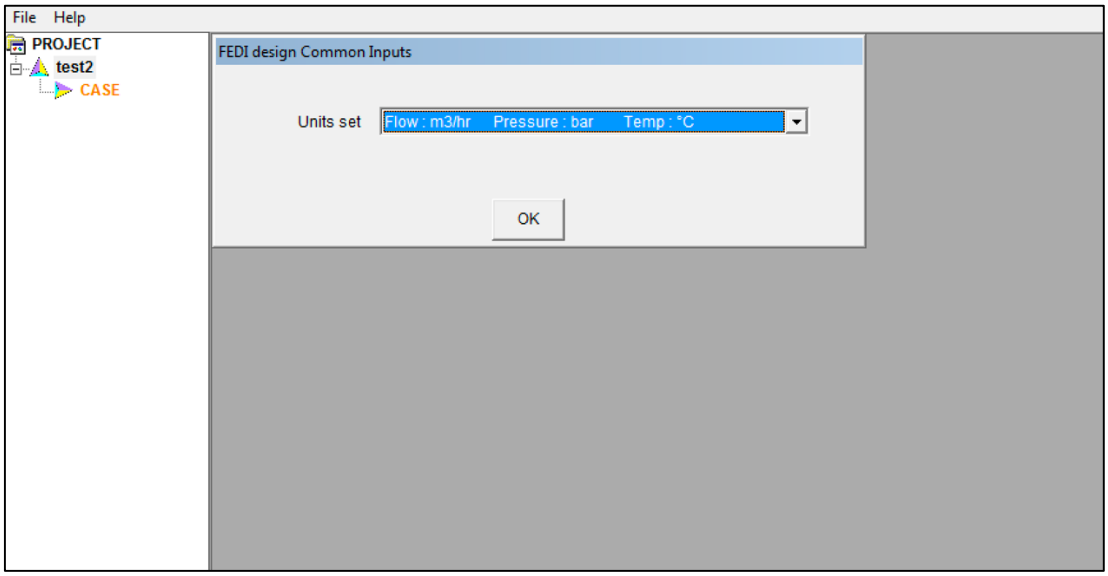


Previously saved FEDI projections are listed in the file menu of this window. These projections can be opened and revised as required.

2. The next screen of the software is the project level input. Here, the user should assign the “project” , “company” and the “analysis by” inputs. All fields are required to be filled to proceed further. After filling the information, click OK. A window appears to confirm that the details have been saved.

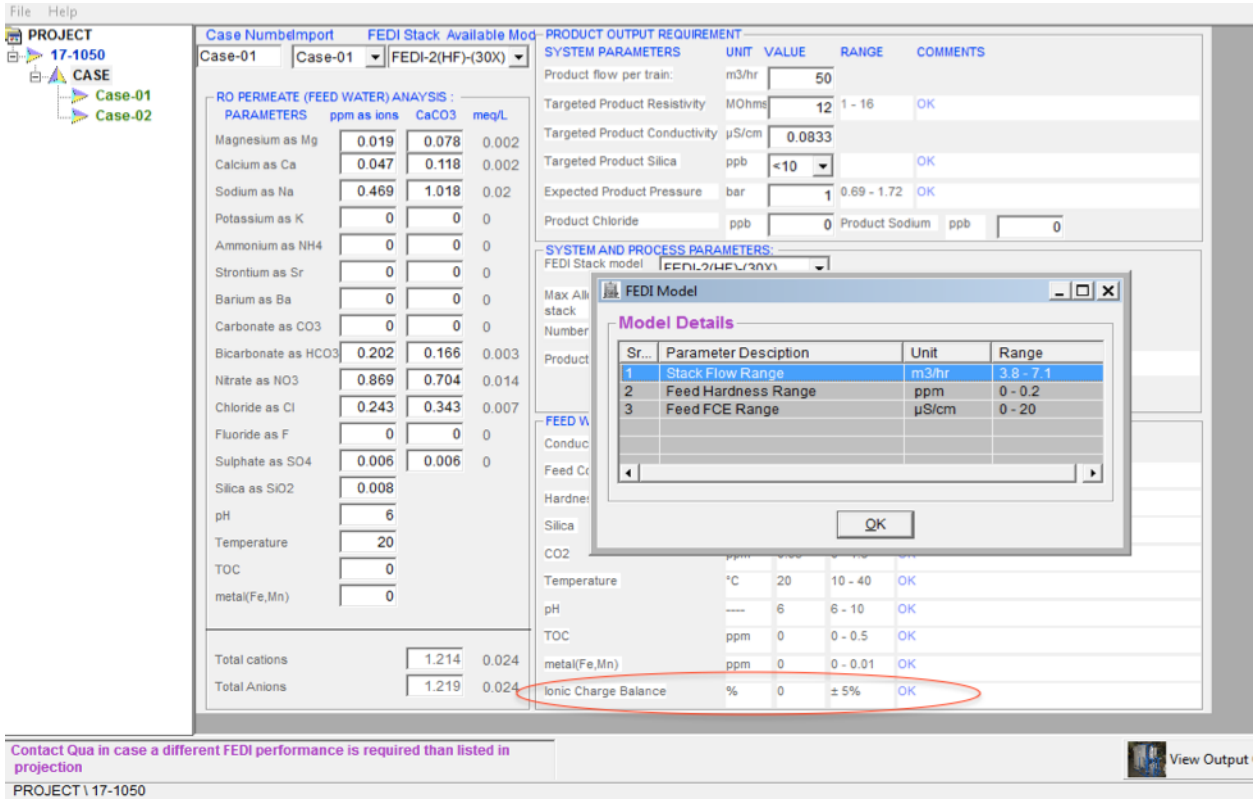


3. The next window “FEDI Design Common Inputs” to advise the user to select Metric or U.S. units for the FEDI projections.



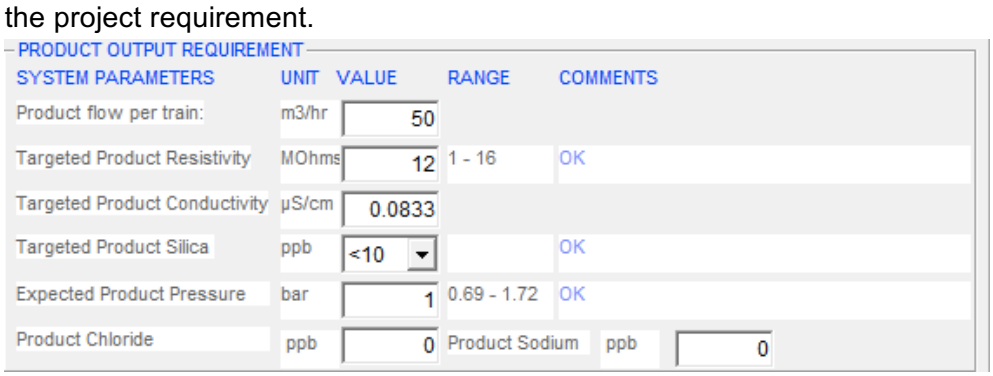
Select the unit and press “OK”. A window appears to confirm that the details have been saved.

4. The main input window appears. The user can fill in the case number/name for this specific projection if they would like, for example: SPRO@25deg (Single Pass RO Permeate at 25°C).



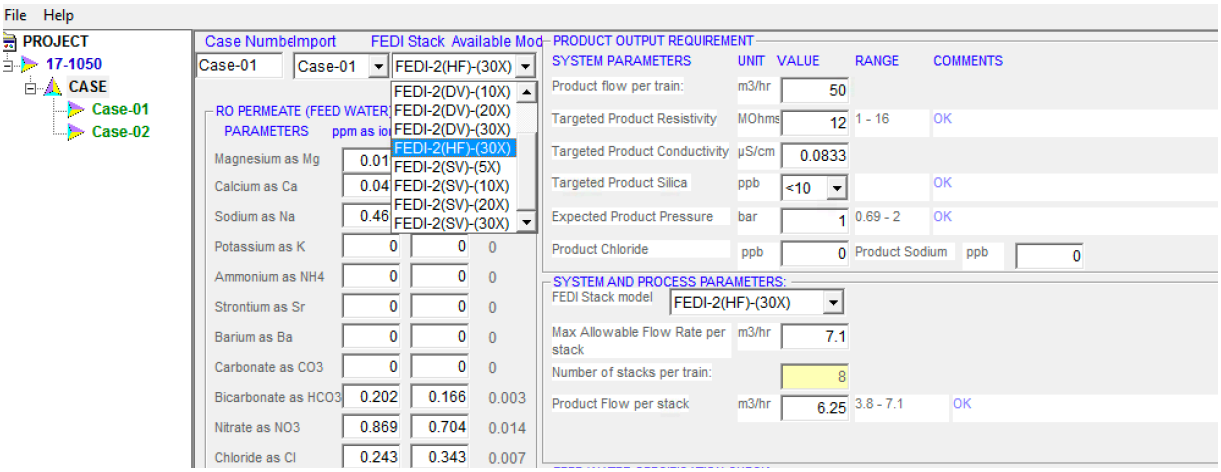
- **Step 1:** Fill in the cation and anion values in the "RO Permeate (feed) water analysis" section. These values can either be entered as ions or as an equivalent to Calcium Carbonate. After filling these values in, please refer to the ionic charge balance in the right bottom section. The ionic charge balance needs to be within ± 5% range; if it is not, please adjust the cations or anions accordingly.

- **Step 2:** In the "Product Output Requirement" section in the top right section, please fill in the system parameters for product flow rate, target conductivity/ resistivity, target product silica, expected product pressure, product sodium and chloride as per the project requirement.

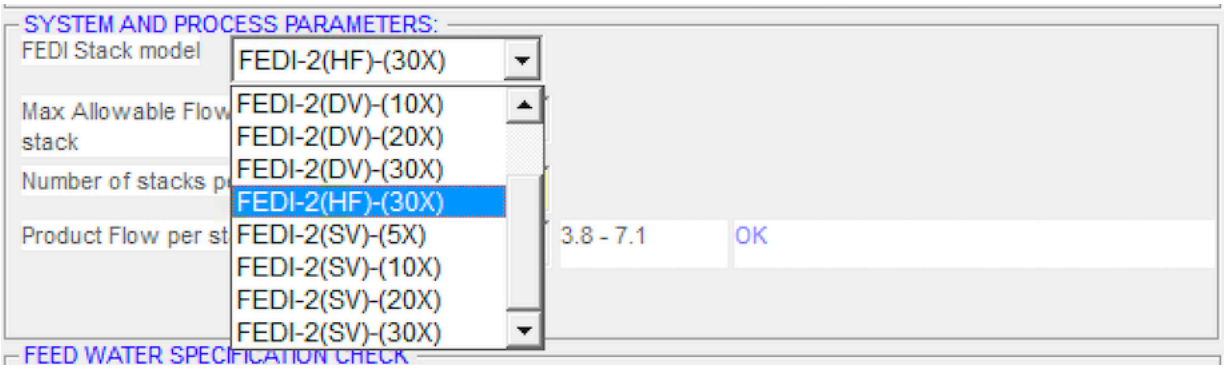


- **Step 3:** The next step is to select the FEDI stack model number in “System and Process Parameters.” FEDI stack has four basic models namely, FEDI – 1, FEDI – 2 DV, FEDI – 2 SV, and FEDI – 2 HF.
  The operating parameter limits of these models can be seen by selecting the FEDI model in the “FEDI Stack Available Model” drop down menu on the top left section of the window or by referring to the FEDI datasheets that can be found on the QUA website.

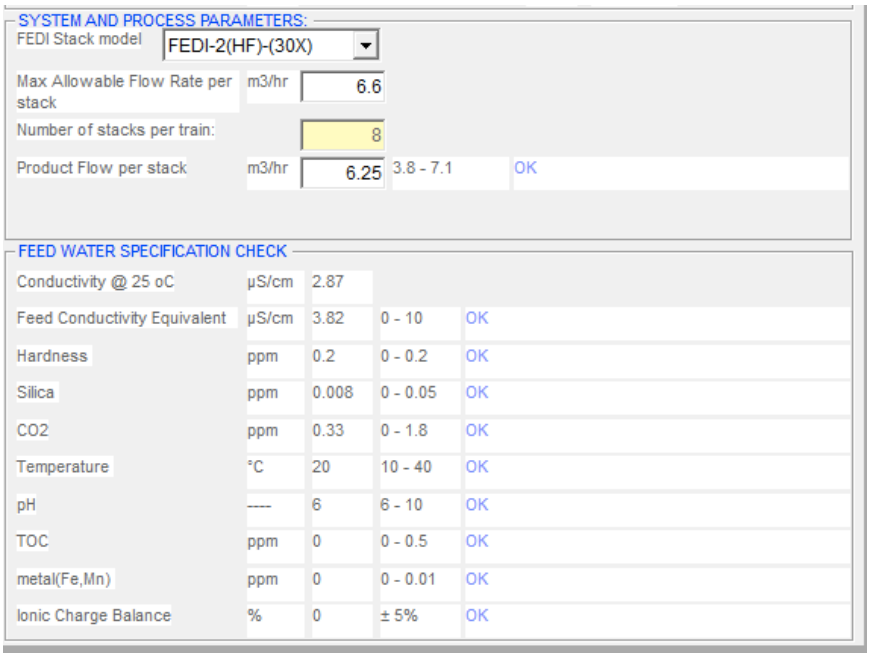
  The software automatically shows the available FEDI models based on the Feed Hardness, Feed Conductivity Equivalent (FCE), and Feed and Product Silica values.



- **Step 4:** Select the FEDI model from the “FEDI Stack Model” dropdown list. The software shows the maximum allowable flow rate for the selected FEDI model and recommends the number of stacks accordingly. The user can change the product flow rate per stack and arrive at the required number of FEDI stacks considering a safety margin.



- **Step 5:** The feed water specification check on the bottom right side section of the window provides the operating range for the various feed parameters. A red warning will appear if any of the parameters are outside the given range. The user needs to adjust the input values accordingly to remove all warnings.



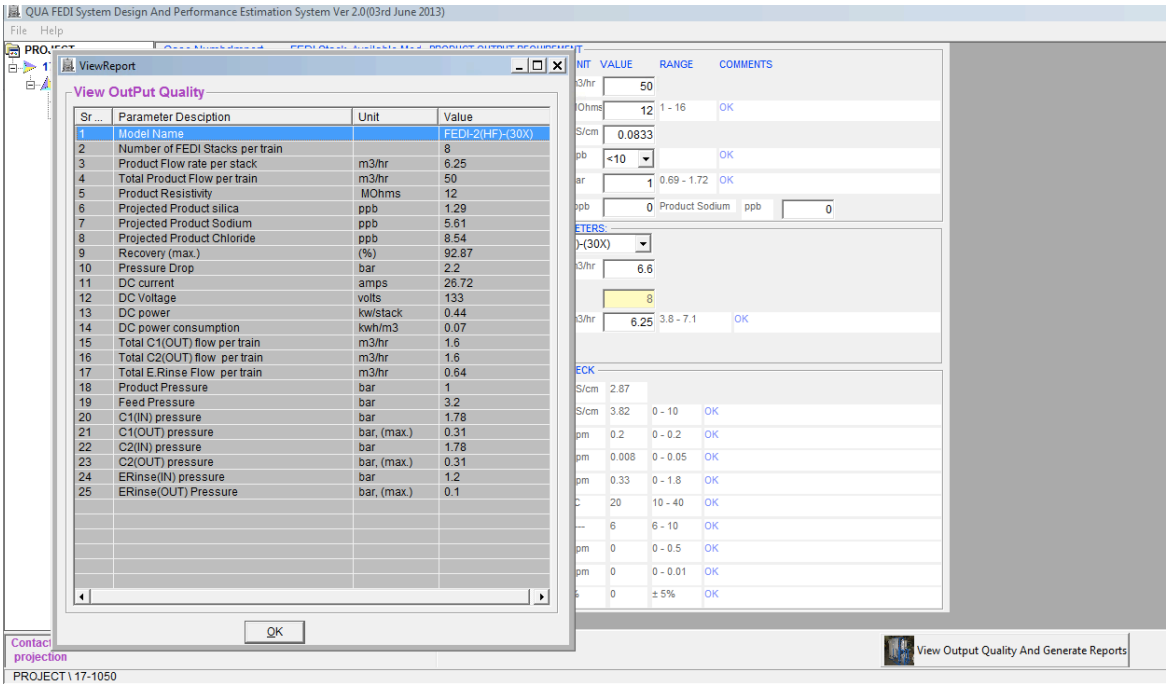
SYSTEM AND PROCESS PARAMETERS:

FEDI Stack model	FEDI-2(HF)-(30X)			
Max Allowable Flow Rate per stack	m3/hr	6.6		
Number of stacks per train:		8		
Product Flow per stack	m3/hr	6.25	3.8 - 7.1	OK

FEED WATER SPECIFICATION CHECK

Conductivity @ 25 oC	µS/cm	2.87		
Feed Conductivity Equivalent	µS/cm	3.82	0 - 10	OK
Hardness	ppm	0.2	0 - 0.2	OK
Silica	ppm	0.008	0 - 0.05	OK
CO2	ppm	0.33	0 - 1.8	OK
Temperature	°C	20	10 - 40	OK
pH	----	6	6 - 10	OK
TOC	ppm	0	0 - 0.5	OK
metal(Fe,Mn)	ppm	0	0 - 0.01	OK
Ionic Charge Balance	%	0	± 5%	OK

- **Step 6:** When all warnings are addressed by adjusting the feed parameters and all specifications are checked as “OK”, the software is ready to provide the output results. Click on “Output Quality and Generate Reports” at the bottom of the screen. The summary of the projection allows the user to decide if the design meets requirements. Click “OK” to proceed further.



QUA FEDI System Design And Performance Estimation System Ver 2.0(03rd June 2013)

File Help

ViewReport

View OutPut Quality

Sr ...	Parameter Desciption	Unit	Value
1	Model Name		FEDI-2(HF)-(30X)
2	Number of FEDI Stacks per train		8
3	Product Flow rate per stack	m3/hr	6.25
4	Total Product Flow per train	m3/hr	50
5	Product Resistivity	MOhms	12
6	Projected Product silica	ppb	1.29
7	Projected Product Sodium	ppb	5.61
8	Projected Product Chloride	ppb	8.54
9	Recovery (max.)	(%)	92.87
10	Pressure Drop	bar	2.2
11	DC current	amps	26.72
12	DC Voltage	volts	133
13	DC power	kw/stack	0.44
14	DC power consumption	kwh/m3	0.07
15	Total C1(OUT) flow per train	m3/hr	1.6
16	Total C2(OUT) flow per train	m3/hr	1.6
17	Total E.Rinse Flow per train	m3/hr	0.64
18	Product Pressure	bar	1
19	Feed Pressure	bar	3.2
20	C1(IN) pressure	bar	1.78
21	C1(OUT) pressure	bar, (max.)	0.31
22	C2(IN) pressure	bar	1.78
23	C2(OUT) pressure	bar, (max.)	0.31
24	ERinse(IN) pressure	bar	1.2
25	ERinse(OUT) Pressure	bar, (max.)	0.1

OK

View Output Quality And Generate Reports

PROJECT \ 17-1050

5. The final FEDI design is generated, along with a schematic drawing. The user can print the report or save as a PDF as well for a digital file.

FEDI DESIGN-PERFORMANCE PROJECTION REPORT

Zoom 100%

FEDI DESIGN-PERFORMANCE PROJECTION

Date:	6-14-2017
Project Name :	17-1050
Case Number :	Case-01
User:	KMS , QUA

DESIGN FEEDWATER ANALYSIS

Ion	ppm as ion	ppm as CaCO3
Mg2+	0.019	0.078
Ca2+	0.047	0.118
Na+	0.469	1.018
K+	0	0
NH4+	0	0
Sr2+	0	0
Ba2+	0	0
CO32-	0	0
HCO3-	0.202	0.166
NO3-	0.869	0.704
Cl-	0.243	0.343
F-	0	0
SO42-	0.006	0.006
Total cations		1.214
Total Anions		1.219

Parameters	Unit	Value
Conductivity	µS/cm	2.87
FCE	µS/cm	3.82
Feed Hardness	ppm	0.2
Feed Silica	ppm	0.008
CO2	ppm	0.33
pH	---	6
Temperature	°C	20
Ionic Balance	%	0

FLOWS AND PRESSURES

Parameters	Flow(m3/hr)	Range(m3/hr)	Pressure(bar)
Product	50	30.4-56.8	1

SYSTEM DESIGN PARAMETERS

Parameters	Unit	Value
Product flow per train:	m3/hr	50
Stack type:	---	FEDI-2(HF)-(30X)
Number of stacks per train:	---	8
Product Flow per stack:	m3/hr	6.25
Recovery:	%	92.87

PRODUCT REQUIREMENTS

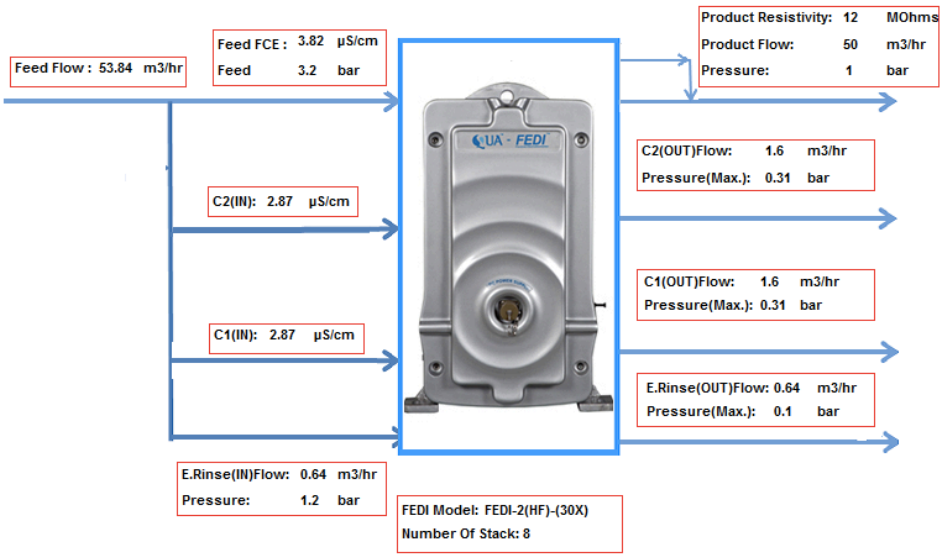
Parameters	Unit	Value	Status
Conductivity:	µS/cm	0.0833	OK
Resistivity:	MOhms.cm	12	OK
SiO2:	ppb	<10	OK
Cl:	ppb	NONE	OK
Na:	ppb	NONE	OK
Product Pressure:	bar	1	

CALCULATED PRODUCT QUALITY AND PROCESS PARAMETERS

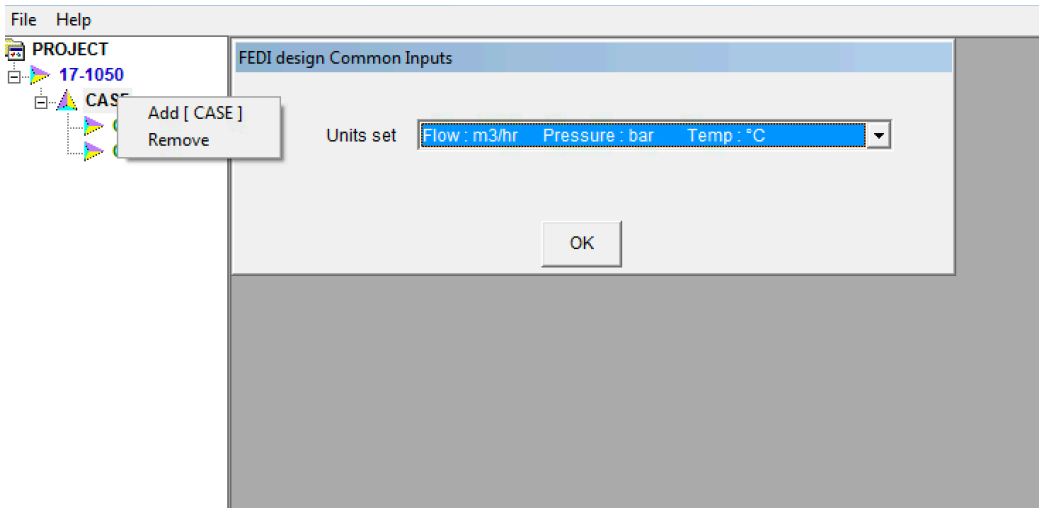
Parameters	Unit	Value
Conductivity:	µS/cm	0.0833
Resistivity:	MOhms.cm	12
SiO2:	ppb	1.29
Cl:	ppb	8.54
Na:	ppb	5.61
DC current:	amps	26.72
DC Voltage:	volts	133
DC power:	kw/stack	0.44
DC power consumption:	kwh/m3	0.07
Recommended Rectifier Max Voltage:	volts	500
Recommended Rectifier Max Current:	amps	48

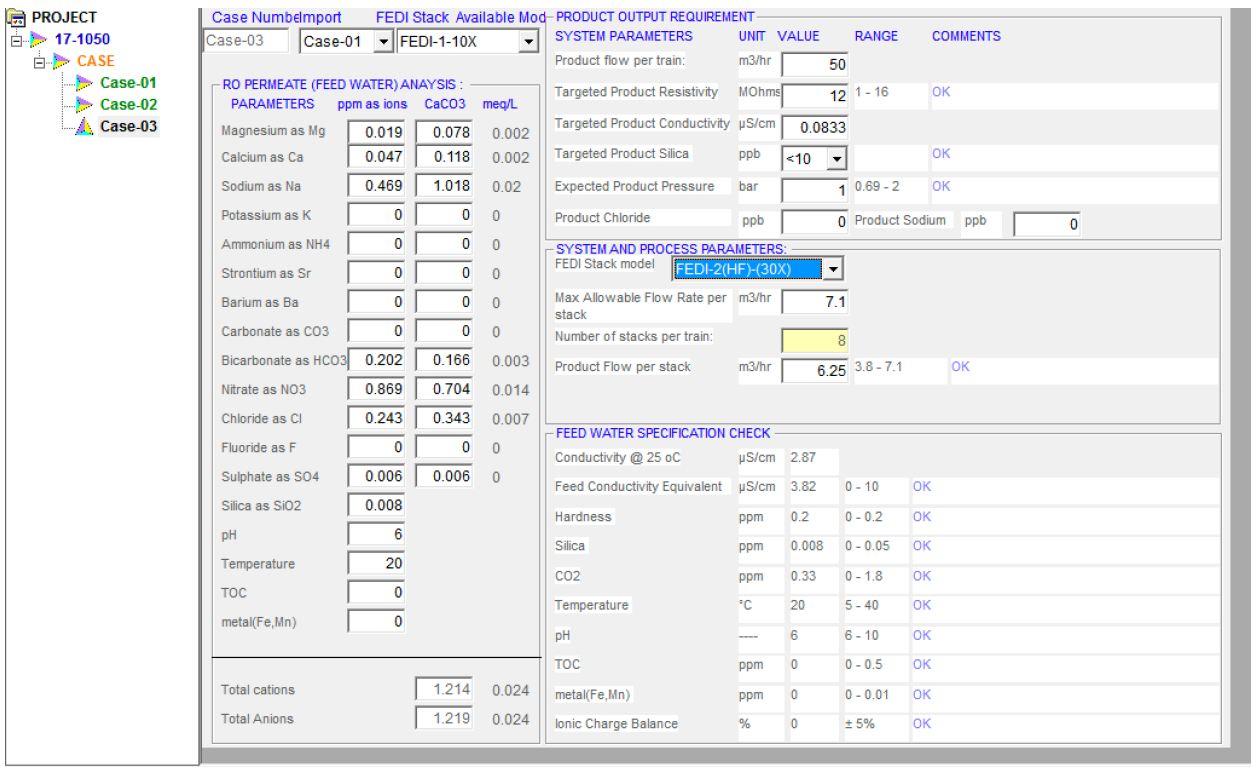
FEDI DESIGN-PERFORMANCE PROJECTION

FEDI STACK SCHEMATIC DIAGRAM



6. If the user wants to add another case to the same project, right click case on the left column under the project name and click “Add [Case]”





The Input screen with the default values of feed water analysis and product output requirement from the previous project would appear. User can change the values and run the projection for the new case. For multiple cases, the user can import the default feed values from the earlier saved cases.

B. FEDI Software Guidelines

The following are some guidelines for the user to consider while running the FEDI program.

1. Conductivity:

Product Conductivity Requirement	Select Targeted Product Conductivity for Projections	Resistivity
If ≤ 0.2 µS/cm	Then 0.1 µS/cm or < 0.1 µS/cm	10 MOhms+
If ≤ 0.1 µS/cm	Then 0.0833 or 0.062 µS/cm	12 – 16 MOhms

Always leave some margin in the program for target product conductivity – ensures desired product quality in case of feed quality variation in actual field conditions.

2. Feed Hardness Level

The FEDI program automatically filters models based on hardness – but here are some helpful guidelines to consider:

Feed Hardness Level	Option Available	Best Option for Selection
< 2 ppm but ≥ 1 ppm	FEDI-2 DV	FEDI-2 DV
≤ 1 ppm but ≥ 0.5 ppm	FEDI-2 DV & SV	FEDI-2 DV
≤ 0.5 but ≥ 0.2 ppm	FEDI-2 DV & SV	FEDI-2 SV
≤ 0.2 ppm	FEDI-2 DV, SV & FEDI-2 HF	FEDI-2 SV or FEDI-2 HF*

*FEDI-2 HF should be installed after 2-pass RO

3. **Product Requirements**

If the design requires a certain quality of product, the FEDI model chosen should be considered. Adjusting the outlet resistivity in the program will increase the current to the stack and help in achieving Na and Cl levels.

Product Requirement	Option Available	Best Option for Selection
SiO_2 < 10 ppb Na < 3 ppb Cl < 3 ppb	All FEDI models	FEDI-2 SV or DV
SiO_2 < 10 ppb or < 20 ppb Na < 10 ppb Cl < 10 ppb	All FEDI models	Select between FEDI-2DV/SV and FEDI-2 HF based on other feed parameters
SiO_2 < 5 ppb	FEDI-2 SV	FEDI-2 SV

4. **Pressure Drop**

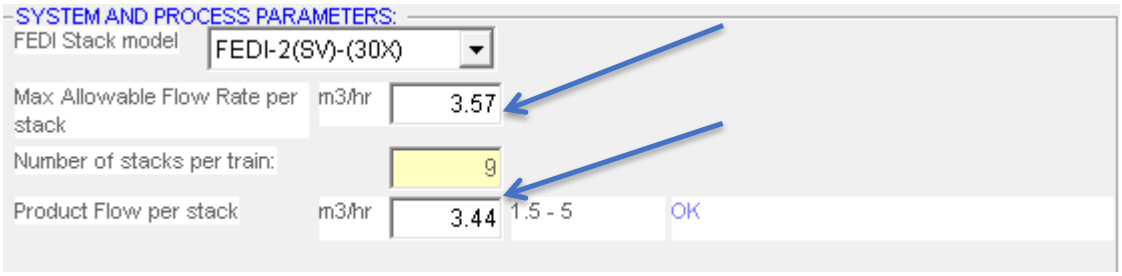
Pressure drop requirements are important to keep in mind. Pressure drop is directly impacted by lower temperature.

The temperature range for FEDI operation is 5 – 40 °C (41 – 100 °F).

FEDI Model	Pressure Drop
FEDI-2 SV	25 to 35 psi (1.7 to 2.4 bar)
FEDI-2 DV	25 to 35 psi (1.7 to 2.4 bar)
FEDI-2 HF	20 to 30 psi (1.4 to 2.4 bar)

Maximum allowable flow rate is calculated by the program. This value should not be exceeded while running the projection. A pressure drop warning will occur if it is exceeded when running the projection. This can be overcome by lowering the product flow per stack.

Careful consideration should be made when increasing the flow per stack as this will increase the pressure drop.



5. Current/Voltage

While creating projections, your start up total current should be below 4 amps per stack.

- Allow some margin on current value in case of any upset or variation in feed.

SYSTEM DESIGN PARAMETERS		
Parameters	**Unit**	**Value**
Product flow per train:	m3/hr	50
Stack type:	---	FEDI-2(HF)-(30X)
Number of stacks per train:	---	8
Product Flow per stack:	m3/hr	6.25
Recovery:	%	92.87

CALCULATED PRODUCT QUALITY AND PROCESS PARAMETERS		
Parameters	**Unit**	**Value**
Conductivity:	µS/cm	0.0833
Resistivity:	MOhms.cm	12
SiO2:	ppb	1.29
Cl:	ppb	8.54
Na:	ppb	5.61
DC current:	amps	26.72
DC Voltage:	volts	133
DC power:	kw/stack	0.44
DC power consumption:	kwh/m3	0.07
Recommended Rectifier Max Voltage:	volts	500
Recommended Rectifier Max Current:	amps	48

26.72 amps/8 stacks = 3.35 amps per stack

6. pH

Feed pH is also important to watch – keep it around 6.5 or higher if possible. This will directly impact feed CO2 value. If the pH is low – we typically recommend inter-pass caustic dosing in the RO upstream or a membrane degasser prior to the FEDI system.

7. Performance Guarantees

When there are strict product guarantees on projects or other warnings you might be getting in the program – please contact QUA to ensure the FEDI selected will work well with the requirement.