USER MANUAL

Vacuum Source Connection

08-25-22
Revision 6.0

Culturing Cells in a Mechanically Active Environment™

Flexcell® International Corporation • 2730 Tucker Street, Suite 200 • Burlington, NC 27215
800-728-3714 • (919) 732-1591 • FAX: (919) 732-5196 • www.flexcellint.com

TABLE OF CONTENTS

INTRODUCTION

VACUUM SOURCE REQUIREMENTS FOR THE FLEXCELL® TENSION SYSTEM

Optimizing performance on the Tension System requires a vacuum source with predetermined minimum specifications. The system can be used with the following configurations:

- **Equibiaxial strain** (with cylindrical Loading Stations™),
- **Unconstrained distension (**without Loading Stations™),
- **Uniaxial strain** (with Arctangle® Loading Stations™).

Each configuration has different vacuum requirements. These requirements do not demand the purchase of two pumps, but determine the minimum pump specifications that the user will need to use the Tension System with their chosen configuration.

EQUIBIAXIAL STRAIN

The equibiaxial strain configuration uses the BioFlex® plate with the cylindrical Loading Stations™ such that the membrane deforms over the top planar surface of the Loading Station™ (loading posts). Distension of the membrane in this way results in equibiaxial strain on the area of the membrane over the Loading Station™. The vacuum requirement to produce a maximum strain of 22% on the BioFlex® membrane in this configuration is -90 kPa. To operate the Tension System in this configuration, a pump is required that will provide the following minimum specifications:

Maximum Vacuum: -100 kPa
Minimum Free Airflow Rate: 5.7 cfm (161 L/min)

Flexcell® recommends the Leybold D8B Oil-Sealed Rotary Vane Vacuum Pump with the ARP 4-8 Oil Return accessory. This pump is used to calibrate the Tension System for both the equibiaxial and unconstrained configurations. It is highly recommended for strong performance and durability. This vacuum pump can be purchased directly from Flexcell®.

UNCONSTRAINED DISTENSION

The unconstrained distension configuration uses the BioFlex® plate without the Loading Stations™ such that the BioFlex® membrane deforms freely downward. Distension of the membrane in this way results in a non-uniform strain profile on the membrane. The vacuum requirement to produce a maximum strain of 30% on the BioFlex® membrane in this configuration is only -30 kPa. To operate the Tension System in this configuration, a vacuum pump is required that will provide the following minimum specifications:

Maximum Vacuum: -50 kPa
Minimum Free Airflow Rate: 1.3 cfm (37 L/min)

UNIAXIAL STRAIN

The uniaxial strain configuration uses the UniFlex® plate, the linear Tissue Train® plate or the trapezoidal Tissue Train® plate with the Arctangle® Loading Stations™ such that the membrane deforms over the top planar surface of the Loading Station™ (loading posts) only at the east and west poles. Distension of the membrane in this way results in uniaxial strain on the area of the membrane over the Loading Station™. The vacuum requirement to produce a maximum strain of 12% on the UniFlex® membrane in

this configuration is -90 kPa. The vacuum requirement to produce a maximum strain of 20% on the either Tissue Train® membrane in this configuration is -90 kPa. To operate the Tension System in this configuration, a pump is required that will provide the following minimum specifications:

Maximum Vacuum: -100 kPa
Minimum Free Airflow Rate: 5.7 cfm (161 L/min)

Again, Flexcell® recommends the Leybold D8B Oil-Sealed Rotary Vane Vacuum Pump with the ARP 4-8 Oil Return accessory. This pump is used to calibrate the Tension System for both uniaxial configuration.

HOUSE VACUUM SYSTEMS

If a house vacuum system is being used in the laboratory, the system capabilities must be known to determine if it is sufficient to operate the Tension system in the desired configuration. Finding the maximum vacuum level of the vacuum system should not be a problem. The free airflow rate of the pump used for house vacuum will likely be greater than that required by the system. However, because house vacuum systems are often shared, neither the airflow rate nor maximum vacuum level available are certain to be stable at all times.

If access of equipment to measure the capabilities of the house vacuum system is limited, the Tension system can be safely tested by connecting it directly to the house vacuum system. The performance of the unit can be noted with respect to the house vacuum system to determine if it will be effective enough for experimental purposes. The house vacuum system can be tested by programming a regimen with the following parameters: **Sine wave, 0-20% elongation, 1.0 Hz, DC% = 50, 1000 cycles.**

This regimen should be run with standard *FLEX IN* and *FLEX OUT* tubing lengths and a BioFlex® baseplate with four culture plates in place and four 25 mm cylindrical Loading Stations™. If the actual output maximum % elongation is 14% or higher, then the house vacuum system is providing enough vacuum to run the unit at its maximum capability. If the output maximum % elongation is lower than 14%, then the house vacuum system is going to be a limitation in the performance of the system. This will only be a problem if the % elongation and frequency combination that are desired for particular experiments is unachievable. Using the Tension system with a vacuum system that does not allow it to run at its maximum capability will not damage the unit. The Tension system will adjust to make the best possible use of the vacuum system that is being used.

If there are questions about the operation of the Tension System with the house vacuum system, call Flexcell® and ask to speak with a technical service representative.

PRESSURE RESERVOIR

The Flexcell® Pressure Reservoir (Fig. 1) enhances the performance of the Tension System. The Pressure Reservoir serves two primary roles: 1) a system-matched volumetric storage device, and 2) a pneumatic pulse dampener or “shock absorber”. Whether this device is used in conjunction with a house vacuum source or with a stand-alone vacuum pump, the system performance is enhanced by the addition of the Pressure Reservoir.

Figure 1. *Pressure Reservoir.*

Pressure Reservoir Features & Benefits

- Suitable with either vacuum or positive pressure sources.
- Isolates or buffers research equipment from transient spikes or surges from vacuum or positive pressure sources.
- Dampens the pressure demand fluctuations seen by the vacuum pump or positive pressure source.
- Provides high volume capacity important for rigorous testing regimens.
- Stabilizes the Flexcell® Tension System performance while operating multiple baseplates.
- Constructed from highest quality components including ASME approved vessel for durable service.
- Includes a large, 3 ½" diameter easy to read compound gauge to monitor the system source pressure as seen by either the vacuum or positive pressure source.
- Quick disconnect fittings included to adapt to your Flexcell® Tension System.
- Interface to pressure or vacuum source is accomplished via a 5 foot length of ½" ID wire reinforced clear tubing.
- Large 7.5 gal (28.4 liter) capacity in compact design.
- Onboard valve to seal reservoir from equipment.
- Equipped with handle and wheels for portability.

CONNECTING VACUUM SYSTEMS TO THE FLEXCELL® TENSION SYSTEM

GENERAL INFORMATION

The Flexcell® Tension System has a single connection for the vacuum source. This connection port is located on the back of the FlexLink® and is labeled ***SYSTEM*** as shown in Figure 2.

All of the following vacuum source configurations will need a single source line coming from the pressure reservoir, or directly from the vacuum source, to the ***SYSTEM*** port on the back of the FlexLink®. The ***SYSTEM*** port requires tubing dimensions of $^{3}/_{8}$" (9.5 mm) outer diameter by ¼" (6.4 mm) inner diameter. Flexcell® recommends the green vacuum tubing that is provided with the Tension System. If you do not use the pressure reservoir or pump recommended by Flexcell®, this tubing or other rigid-walled tubing with the same dimensions must be adapted to your vacuum source.

Figure 2A. *Vacuum source tubing connected to an FX-6000™ Tension FlexLink®.*

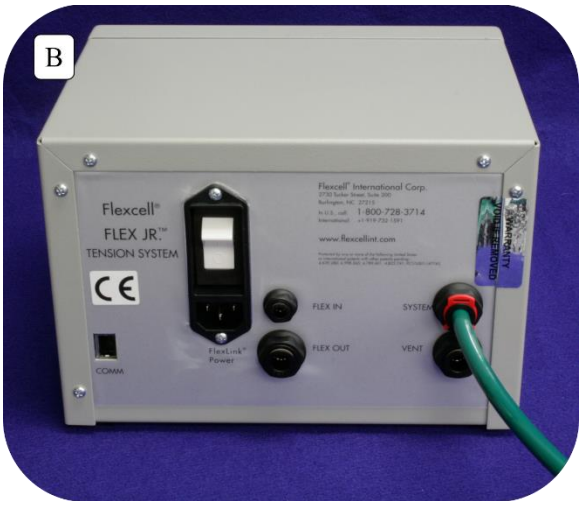

Figure 2B. *Vacuum source tubing connected to a Flex Jr.™ Tension FlexLink®.*

SETTING UP THE LEYBOLD D8B VACUUM PUMP

REMOVE PROTECTIVE SHIPPING COVERS

Remove the Leybold D8B Vacuum Pump from its box and set on a flat surface for assembly. Remove the orange and black protective covers from the vacuum pump inlet and exhaust ports as shown in Figure 3. To remove the orange cover, unscrew the wingnut clamping ring until the ring can be opened. Leave the rubber centering ring with mesh in place.

CONNECT THE SMOKE ELIMINATOR EXHAUST FILTER

Take out the fittings and parts shown below in Figure 4A to attach the smoke eliminator exhaust filter. Remove the protective shipping covers from the elbow adapter and smoke eliminator exhaust filter. Connect the elbow adapter to the exhaust port using a centering ring and a clamping ring. The centering ring should be inserted to fit between the flanges of the exhaust port and the elbow adapter. The clamping ring is secured around the flanges and centering ring, then tightened with the wingnut. Install the elbow such that the open end is facing upwards. Use the same technique to connect the smoke eliminator exhaust filter to the elbow adapter using a centering ring and a clamping ring. The assembled smoke eliminator exhaust filter should appear as shown in Figure 4B.

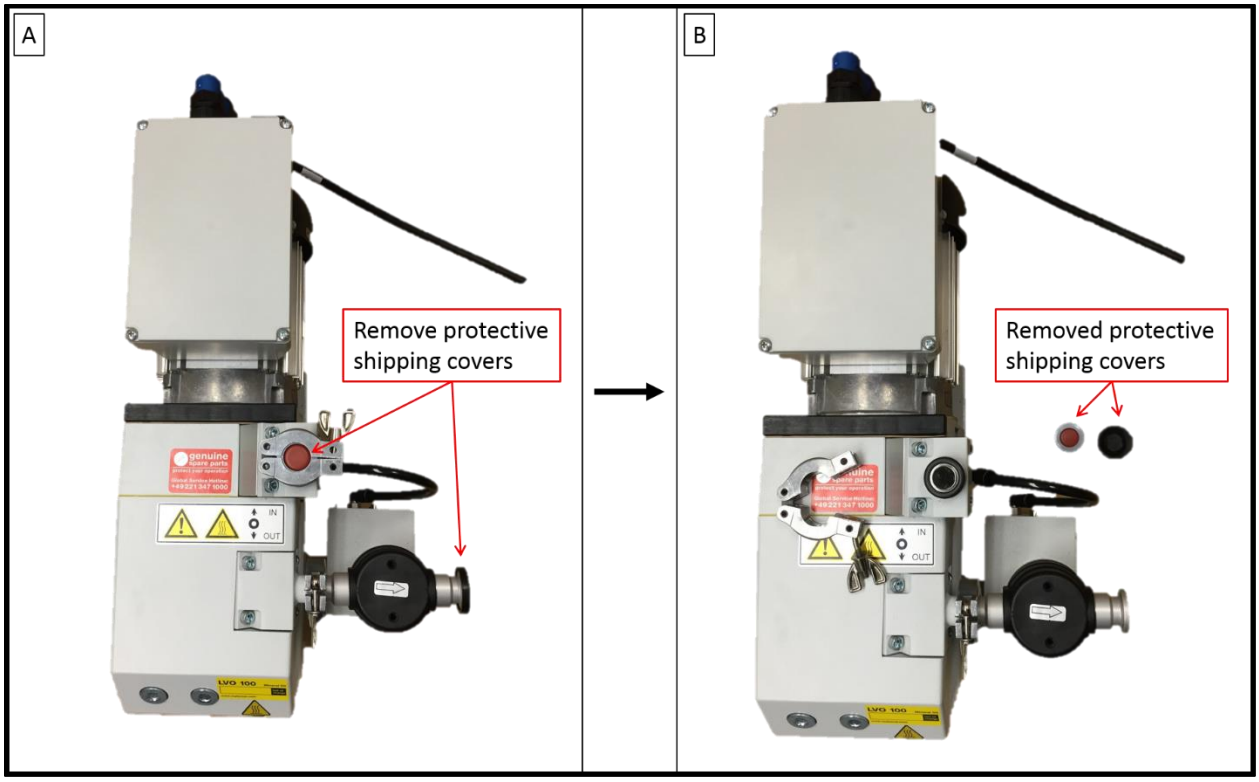

Figure 3. *Removing protective shipping covers*

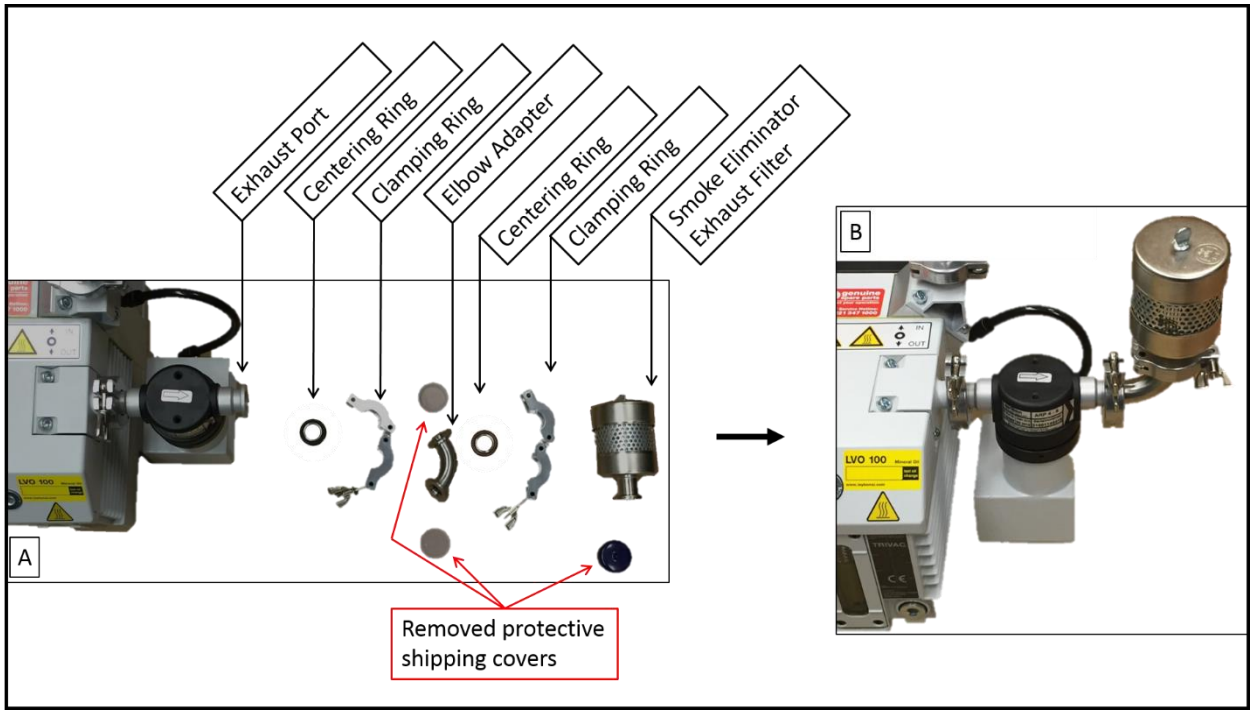

Figure 3. *Connecting the smoke eliminator exhaust filter.*

CONNECTING THE LEYBOLD D8B VACUUM PUMP AND PRESSURE RESERVOIR

CONNECT THE PRESSURE RESERVOIR TO THE VACUUM PUMP

There will be a hose clamp on the open end of the vacuum tubing connecting to the pressure reservoir (Fig. 5A). Loosen the hose clamp with a flathead screwdriver. Firmly insert the barbed, open end of the aluminum adapter into the vacuum tubing (Fig. 5B). Insert the adapter far enough into the tubing such that the full width of the hose clamp is covering the vacuum tubing and the clamp is under the adapter barb. Tighten the hose clamp. Connect the flanged end of the adapter to the rubber centering ring resting in the vacuum pump inlet port and secure with the wingnut clamping ring (Fig. 5C).

CONNECT THE PRESSURE RESERVOIR TO THE FLEXLINK®

There will be a male quick-disconnect fitting connected to a female quick-disconnect fitting on the pressure reservoir valve (Fig. 6A). Press the silver release button to disconnect the male quick-disconnect. Take the $^{3}/_{8}$" OD blue tubing and cut to the length necessary to connect the pressure reservoir valve to the FlexLink® ***SYSTEM*** Port (Fig. 6B).

NOTE: *Keep the length of the blue tubing as short as possible. Flexcell® does not recommend a maximum length, but keep in mind that unnecessarily long tubing can decrease performance of the Flexcell® system by lowering the vacuum supply flow rate.*

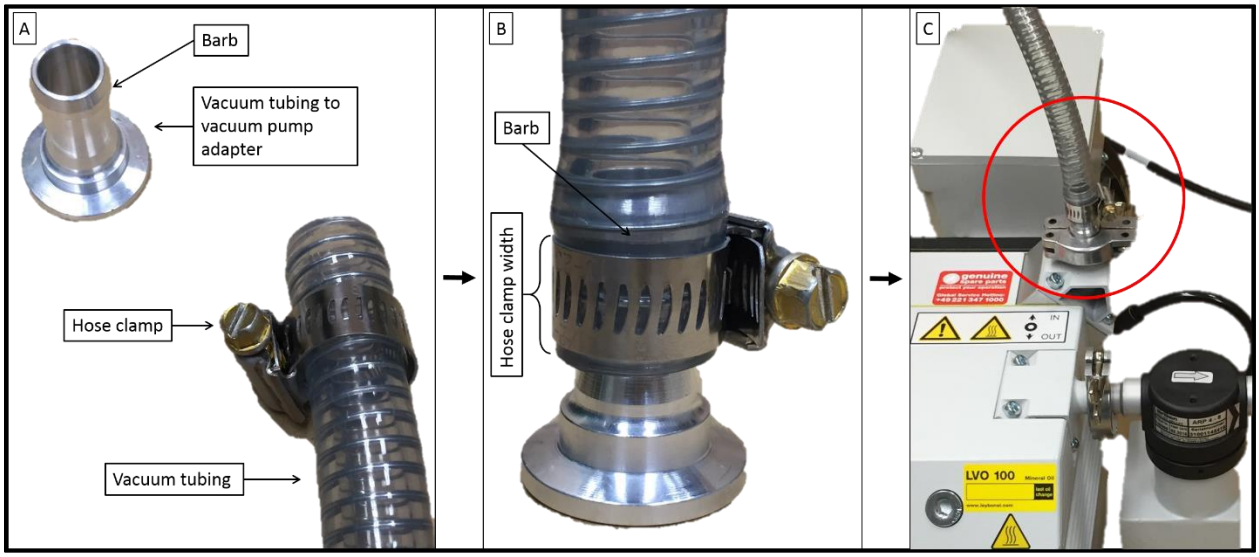

Figure 4. *Connecting vacuum pump to pressure reservoir.*

Unscrew the metal securing sleeve from the plastic quick-disconnect fitting. Slide the metal securing sleeve over the $^{3}/_{8}$" OD blue tubing, then insert the barb of the plastic quick-disconnect fitting into the $^{3}/_{8}$" OD blue tubing (Fig. 6B). Tighten the metal securing sleeve onto the plastic quick-disconnect fitting. Connect the male quick-disconnect fitting to the female quick-disconnect fitting (Fig. 6C). Connect the open end of the $^{3}/_{8}$"

OD blue tubing to the ***SYSTEM*** Port on the back of the FlexLink®.

FINAL ASSEMBLY OF VACUUM PUMP AND PRESSURE RESERVOIR

Connect the vacuum pump power cable by lining up the indentation on the male plug with the post on the female end. Screw the connection by hand until it is secure. Connect the power cable to a mains wall outlet. Figure 7 below shows the fully assembled vacuum pump-pressure reservoir system. Make sure all connections match the indicating colored arrows and text.

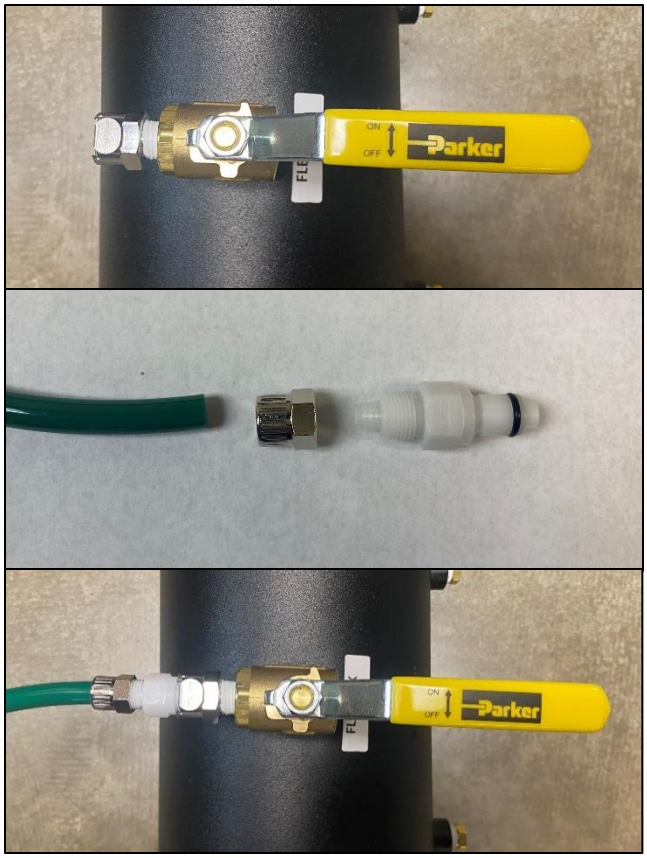

Figure 5. *Connecting 3/8" OD tubing to pressure reservoir.*

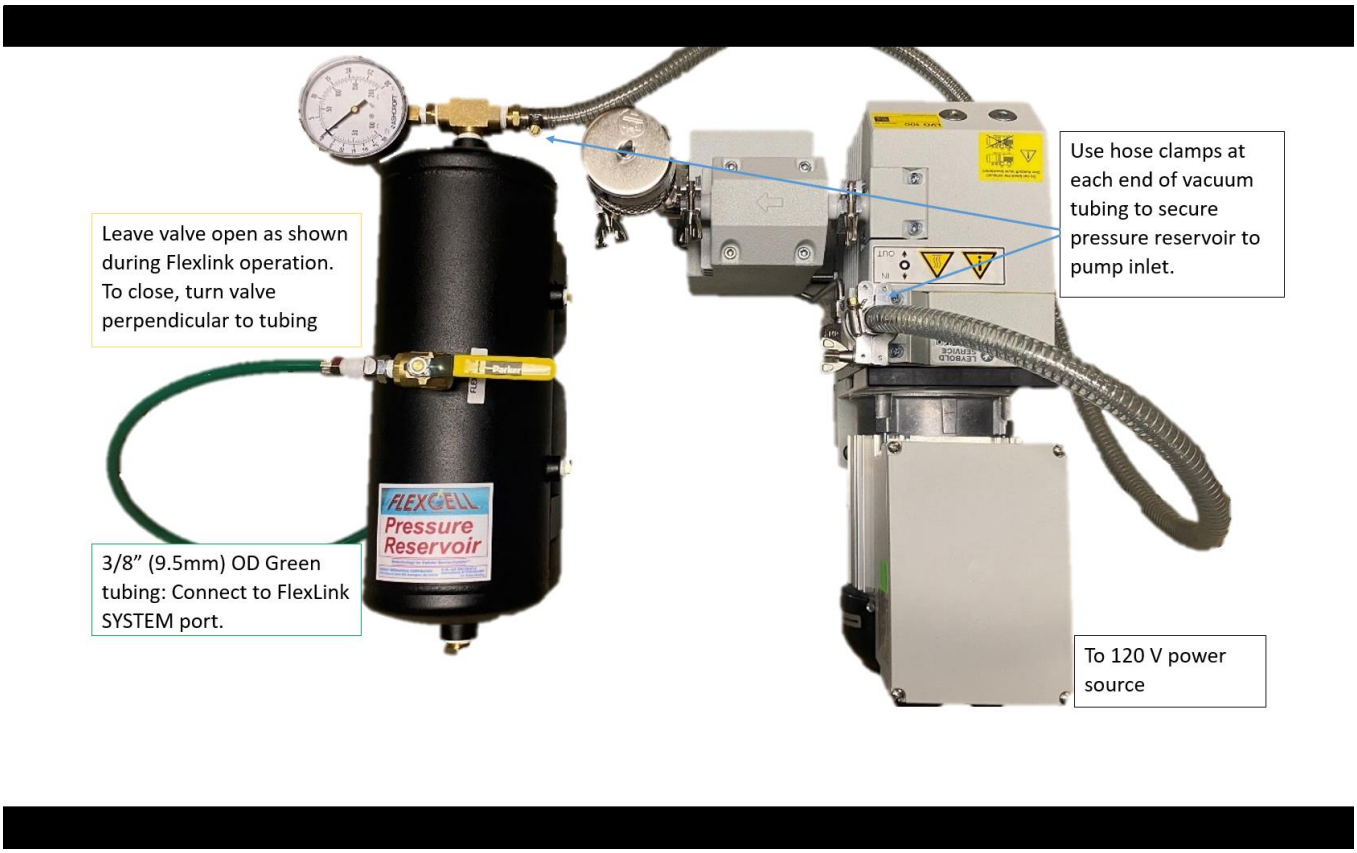

Figure 6. *Fully assembled vacuum pump and pressure reservoir.*

CONNECTING THE LEYBOLD D8B VACUUM PUMP WITHOUT THE PRESSURE RESERVOIR

Figure 8 below shows the proper means to connect the Leybold D8B vacuum pump directly to the ***SYSTEM*** port on the back of the FlexLink®. Use this connection when you do not have the Pressure Reservoir. Connect the $^{3}/_{8}$" OD blue tubing to the FlexLink® ***SYSTEM*** port and connect the power cable to a mains wall outlet. The vacuum pump assembly without the pressure reservoir is now complete. Make sure all connections match the indicating colored arrows and text.

NOTE: *Keep the length of the blue tubing as short as possible. Flexcell® does not recommend a maximum length, but keep in mind that unnecessarily long tubing can decrease performance of the system by lowering the vacuum supply flow rate.*

NOTE: *The 3/8" OD blue tubing to vacuum pump adapter is only sent with systems that do not have a pressure reservoir. If your system has a pressure reservoir, this adapter will not be present, and it is recommended to use the pressure reservoir connections as described in the previous sections.*

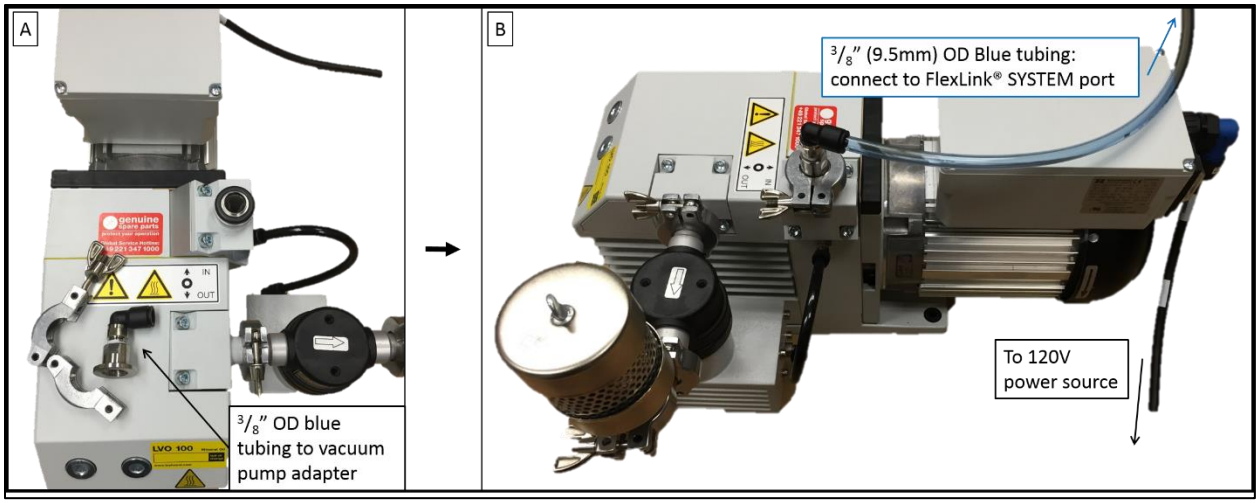

Figure 7*. Connecting vacuum pump without pressure reservoir.*

CONNECTING A HOUSE VACUUM SYSTEM AND THE PRESSURE RESERVOIR

Figure 9 below shows the proper means to connect a house vacuum system to the pressure reservoir and FlexLink®. Use this connection when you have a house vacuum system and a pressure reservoir. Make all connections as indicated by the colored arrows and text.

NOTE: *Keep the length of the blue tubing as short as possible. Flexcell® does not recommend a maximum length, but keep in mind that unnecessarily long tubing can decrease performance of the system by lowering the vacuum supply flow rate.*

NOTE: *The outlet on your house vacuum system may need to be adapted to fit the reinforced vacuum supply tubing shown in Figure 9.*

Figure 9*. Connecting* the P*ressure* R*eservoir to* a *house vacuum supply.*

CONNECTING A HOUSE VACUUM SYSTEM WITHOUT THE PRESSURE RESERVOIR

To connect a house vacuum system directly to the FlexLink®, you will need to adapt the outlet on your house vacuum to fit the $^{3}/_{8}$" (9.5mm) OD blue vacuum tubing supplied with the Tension System. The blue vacuum tubing should be connected directly from the house vacuum source to the ***SYSTEM*** port on the back of the FlexLink®.

NOTE: *Keep the length of the blue tubing as short as possible. Flexcell® does not recommend a maximum length, but keep in mind that unnecessarily long tubing can decrease performance of the system by lowering the vacuum supply flow rate.*

PHYSICAL SPECIFICATIONS

Oerlikon D8B Vacuum Pump w/ ARP 4-8 Oil Return

(Item# LBV-4000):	Size (unit only), L x W x H:	19 ½" x 10 ¾" x 10" (49.5 x 27.3 x 25.4 cm)
	Power Requirements:	115 volts, 60 Hz
	Weight (unit only):	55.8 lbs (25.3 kg)

Oerlikon D8B Vacuum Pump w/ ARP 4-8 Oil Return, Power Cable, and Smoke Eliminator

	Size L x W x H:	21 ½" x 14 ½" x 13 $^{7}/_{8}$" (54.6 x 36.8 x 35.2 cm)
	Power Requirements:	115 volts, 60 Hz
	Weight (unit only):	57.6 lbs (26.1 kg)

Pressure Reservoir

(Item# PR-4000):	Size (unit only), L x W x H:	16 $^{3}/_{16}$" x 16 $^{3}/_{16}$" x 9 $^{3}/_{8}$" (41.1 x 41.1 x 23.8 cm)
	Power Requirements:	N/A
	Weight (unit only):	26.5 lbs (12.0 kg)


FLEXCELL
Pressure
Reservoir