LACO TECHNOLOGIES

VACUUM DEGASSING CHAMBERS AND SYSTEMS

OPERATIONS AND MAINTENANCE MANUAL

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1.0 INTRODUCTION

This manual outlines the components, safety information, recommended maintenance, LACO Technologies' Vacuum Degassing Systems. Following these recommended procedures will ensure that your degassing system is performing at its highest level. This manual also includes product information for your degassing system, including accessories, options, and replacement parts.

1.1 MAKEUP OF A DEGASSING SYSTEM

A typical vacuum degassing systems includes a vacuum chamber connected to a vacuum pump for removing trapped gases from compounds. With the appropriate vacuum pump degas chambers are used to reduce the pressure above the surface of the material and permit escape and subsequent removal of entrapped air and other gases that could induce failure of the final product. Degas chambers and pumps are available with several options and accessories for a complete vacuum degas system to meet your requirements. This manual will include information on vacuum degassing principles as well as on accessories, options and spare parts.

1.2 PRODUCT SUPPORT

For technical assistance or to order replacement parts call, fax or email from the information listed below.

LACO Technologies
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2.0 SAFETY

2.1 VACUUM PUMP SAFETY

A complete manual will be provided for the vacuum pump and should be referred to for safety issues relating to the particular vacuum pump purchased.

2.2 VACUUM CHAMBER SAFETY

All degas chambers are designed for holding full vacuum but any defects, cracks or severe wear items on the chamber should be replaced or reported to LACO for advisement. Vacuum chambers are not designed for pressure applications. If slight pressure is needed (5 psi or less) the chamber must be provided with necessary lid hold downs and a pressure safety relief valve.

3.0 VACUUM DEGASSING SYSTEM COMPONENTS

A vacuum degassing system comprises of two main items with options for several accessories. Systems are available in modular configurations or as complete setups mounted onto carts or stands.

3.1 VACUUM CHAMBERS

The most common vacuum degas chamber is a cylindrical vessel, fitted with vacuum control valve, vacuum release valve, vacuum dial gauge, "L" type gasket and a clear acrylic or metal lid. Preferred and stock sizes are shown on our website at www.lacotech.com in diameters of 6", 8", 10", 12", 18" and 24" with heights ranging from 6" up to 24". Custom built units as well as cube chambers are available for your specifications

The cost of cylindrical vacuum chambers tend to increase far more with increases in diameter than length. Horizontal chambers will also be more than corresponding vertical chamber due to the need for cradle supports and lid hinging. This orientation is preferred if the product is easier to load and monitor. A common option for horizontal chambers include shelf support rails and removable shelves. Vacuum degas chambers are most commonly made from 304 stainless steel however LACO offers vertical chambers also in aluminium and all clear acrylic for full viewing.

To select a chamber for your purpose, ensure that your container will fit into the chamber, also that there is sufficient space in your container to allow for expansion of the liquid to be degassed. Initially, fill your container one quarter with mixture, experience will show the limit of mixture level permissible.

3.2 VACUUM PUMP AND HOSE

Based on the application the vacuum pump can be the largest dollar item and the most critical for successful degassing. Choices range from dry membrane pumps capable of vacuum levels down to 60 torr or 27 inHG for single stage models and 7 torr or 29 inHG for two stage models. These dry pumps have pumping speeds or cfm values ranging from 1 to 7 cfm. For higher vacuum levels and cfm values, oil sealed rotary vane vacuum pumps are used. Single stage models are capable of vacuum down to 0.5 torr and cfm from 1 to 100 cfm. Two stage models are capable of vacuum down to 0.005 torr or 5 millitorr and range in cfm from 2 to 50 cfm.

When selecting a pump it is necessary fully degas the mixture before it even begins to gel or set. Knowing the pot life of the material will help in selecting the right speed or cfm of pump. The manufacturer of the material may recommend a vacuum level based on the properties of the material. If you are unsure of the vacuum level requirement it is always easier to have more vacuum than less.

3.3 COMMON ACCESSORIES

- Vacuum traps to protect the vacuum pump from contaminates from the degassing process and to also prevent any backstreaming of pump oil into the vacuum lines or chamber.
- Absolute rated digital vacuum gauges with units in torr or millitorr to accurately monitor and repeat the process at the same vacuum level.
- Chamber mixers with rotary shaft feedthroughs
- Chamber internal platen heaters
- A heating blanket fitted around the vacuum chamber cylinder to achieve higher wall temperatures. Heaters are NOT suitable for use with clear acrylic doors.
- Electrical and thermocouple feedthroughs
- Liquid feedthroughs and valves

4.0 OPERATIONAL PROCEDURE FOR A VACUUM DEGASSING CHAMBER

Degassing of a liquid mixture is the removal of air bubbles which become entrapped in the mixture when mixing the components. See the appendix for a complete discussion on vacuum degassing. The following is a quick review of procedures to follow to remove air bubbles from resin mixes, RTV silicone and similar liquids.

1. Close the vacuum valve connected to the vacuum pump and switch on the vacuum pump and allow to warm up.
2. Open the vacuum release or vent valve and remove the chamber lid.
3. Mix the materials to be degassed in a suitable container not more that 1/3 to 1/2 full and place this container in the chamber.
4. Replace the lid, making sure it fully covers the gasket on the vacuum chamber.
5. Close the vacuum release valve.
6. Open the vacuum valve.
7. Watch the mixture and the vacuum gauge. When the chamber is undergoing the evacuation the mixture will begin to rise, slowly at first. At nearly full vacuum the mixture will have swollen up to fill the mixing vessel, air bubbles will appear and burst at the mixture surface. After a few seconds, this mixture will collapse to near its original volume. Occasional bubbles will appear at the surface.
8. If the mixture rises too fast and is likely to overflow the container then momentarily reduce the vacuum by opening and closing the vacuum release valve or closing the vacuum valve. Repeat if necessary.
9. Wait for about 30 seconds after the collapse and close the vacuum valve.

   NOTE: One can also monitor the time and vacuum level on the vacuum gauge as well as the material, to determine the length of time to hold it under vacuum. The length of time to degas is highly dependent on the product and the particular application. Often an absolute pressure vacuum gauge is used to monitor the vacuum level of the system and determine if gases or solvents are evolving from the product. The vacuum chambers are equipped with a relative 0-30 in HG vacuum gauge, which is mainly used to determine that rough vacuum level. For more accurate measurement and control of the process, contact LACO about an absolute vacuum gauge.

10. Open the vacuum release valve and remove the lid.
11. Fill the mold(s) carefully to minimize trapped air.
12. If necessary, place the mold(s) into the vacuum chamber.
13. Repeat stages above as necessary.
14. Some bubble may appear at the mixture surface and burst.
15. Continue degassing for about 30 seconds at full vacuum.
16. Repeat steps 10, 11, 12.

5.0 RECOMMENDED PROCEDURES

RECOMMENDED PROCEDURES FOR VACUUM DEGASSING MAINTENANCE

5.1 VACUUM PUMP OIL CHANGES

The vacuum pump is the most critical maintenance item in a degas system. For oil sealed rotary vane vacuum pumps the most critical maintenance item is to change the pump oil as frequent as possible. The frequency will depend on the application and usage but it is recommend that if the oil ever turns cloudy, dark or is foul smelling, change it immediately. Any degassed solvents, water or other liquids will condense in the pump oil and lower the vacuum level the pump is able to achieve. Frequent oil changes will also extend the life of the vacuum pump.

When changing pump oil it is recommended to also use a flushing fluid to cleanse the pump. LVOFF is a hydrocarbon fluid specifically designed to assist in the internal cleaning of particles and sludge build-up in mechanical vacuum pumps. Its low viscosity helps free contamination from internal parts allowing it to be flushed from the pump through the drain valve.

5.2 FLUSHING PROCEDURE

A. Drain the used fluid from the pumps while still hot from operation and refill with LVOFF.
B. Run the pump blanked off or isolated for approximately 20-30 minutes or until pump is hot.
C. Drain the pump completely (open gas ballast and jog the pump to aid in removing oil).
D. Repeat the procedure if necessary then refill with LACO 19 grade oil for direct drive pumps of 195 grade for belt drive pumps or other oil as specified.

WARNING: Any foreign material left remaining in the vacuum chamber or vacuum hose lines can contribute to outgassing and reduce the performance of the system and the vacuum pump. It is recommended to keep clean the SS chamber and vacuum lines as necessary.

6.0 RECOMMENDED SPARES

It is recommended to have on hand one gallon of vacuum pump oil and one gallon of flushing fluid along with a spare chamber lid gasket. Also, silicone vacuum grease is also helpful for lubrication on the lid gasket to ensure quick and easy vacuum sealing. If the chamber is equipped with a filter trap, replacement elements are also recommended.

Below is a listing of various element types available for the clear vacuum traps.

TABLE 1 *Element Types for Clear Vacuum Types*

COPPER GAUZE	Large surface area traps condensable particles and oil vapors
STAINLESS STEEL GAUZE	Same as copper, but with added corrosion protection
MOLECULAR SIEVE	Reduces mechanical pump backstreaming and traps water vapor
SODASORB®	Minimizes migration of corrosive chemicals and neutralizes acidic vapors
ACTIVATED CHARCOAL	Removes organic vapors
ACTIVATED ALUMINA	Removes Lewis acids, polar compounds, other acids, water and particles
POLYPRO 2 MICRON	Traps high volumes of solids and particulates as small as 2 microns; available in three sizes
POLYPRO 5 MICRON	Same as above
POLYPRO 20 MICRON	Same as above

See appendix for details for ordering and spares or accessories.

7.0 APPENDIX A: DISCUSSION ON THE REMOVAL OF AIR BUBBLES FROM LIQUIDS BY VACUUM DEGASSING

7.1 APPLICATIONS

RTV Silicone Rubber, Polyester Resin, Casting Plaster, Polyurethane Resin, Epoxy Resins, Araldite, Plastasols, Polysulphide Rubber, Adhesive Mixes, Investment Plaster

7.2 INTRODUCTION

When any of the above listed materials are mixed with the required additives, accelerator, filler etc., then air bubbles become trapped within the mixture. If not removed before the material cures then the air bubbles will cause defects such as nodules, cavities, hollows in the finished cast. Sometimes such defects remain out of sight just below the surface only to appear after a period of use. With electrical and electronic encapsulation then these cavities can give rise to electrical breakdown. On art figures cavities or nodules require correcting, which increases the time and costs for a piece.

Mixing can be done by hand or an electric mixer before degassing, depending upon the quantities involved. A flat blade, slower speed type is possibly better. It depends on the amount and type of filler and resin.

The components are mixed in the container. It is essential that the resulting mixture behaves as a liquid, i.e., flows and can be poured.

When this mixture is put into the vacuum chamber and the air pressure above it reduced, i.e., evacuated, then the air bubbles which were formed at atmospheric pressure now expand and rise to the surface where they burst. The air thus released is pumped away.

In practice, degassing causes the whole mixture to expand to about two to six times its original volume. As the bubbles burst at the surface, the expansion decreases. This process can take from one to several minutes depending upon the nature of the mixture, the volume of the vacuum chamber and the speed of the vacuum pump used with it.

After expansion has subsided, bubbles can still appear at the surface, mainly caused by the escape of minute traces of remaining air plus volatile components of the mixture boiling off. The vacuum should only be held for a further 30 seconds to 60 seconds at this stage, otherwise the composition of the mixture will be altered and setting time will change due to volatile components being removed by the vacuum.

This degassed mixture is then poured into your mold taking care to minimize any trapped air. When your mold has been filled if you desire you can put the whole mold with mixture into the vacuum chamber and evacuate as before. This time only one or two bubbles should appear from air, which was trapped in undercuts or adhering to the mould surface. Again, beware of boiling off the volatile components, only a few seconds or so at full vacuum should be sufficient.

You should be able to complete the above process long before the material begins to gel or increase in viscosity. If de-airing is too slow, then you may need to either increase the evacuation speed, i.e., change the pump (to a larger cfm) or the decrease chamber size to reduce the pump down time, or decrease the accelerator or possibly keep the components warm in very cold weather.

7.3 COMMON CAUSES OF BUBBLES IN CASTINGS

- Air inclusion during mixing the resin and hardener together.
- Air trapped in moulds.
- Air trapped due to improper casting/moulding techniques.
- Air introduced by suction as the material shrinks or due to a leaking tool.
- Trapped residual solvent vapors from certain types of mould releases.
- Volatile components being stripped out of the materials while casting under vacuum.
- Gases generated during the reaction (hardening) process.
- Gases formed during improper storage (moisture contamination etc.)
- Gases introduced through pressurized systems.
- Air from improperly de-aired resin and/or hardener.

7.4 FACTORS THAT AFFECT THE REMOVAL OF GASES

- THE VISCOSITY OF THE MIX.
  The higher the viscosity the more difficult it is to remove gases
- THE SURFACE TENSION OF THE MATERIALS
  Can be reduced by heating and the addition of surfectants
- THE TEMPERATURE OF THE MIX.
  Heating the material will reduce the viscosity. Be sure to consider the pot life and gel time before heating any mixed materials.
- THE AMOUNT OF MATERIAL BEING DE-AIRED AT ONE TIME.
  The depth to surface ratio is important. The larger the surface that is exposed to the vacuum the better. The lower the amount of product the rising bubbles have to travel through the better.
- AGITATION
  Agitation (mixing) during the de-airing process (while under vacuum) will speed the removal of air.

- VACUUM PUMP SIZE
  The size or pumping speed of your vacuum pump usually noted in terms of cubic feet per minute or cfm as well as the ultimate pressure or vacuum level your pump can achieve.
- CHAMBER SIZE AND PIPING
  Chamber size and the diameter and length of the vacuum hose can also effect the time for removal of gases. It is recommended to use at least the same diameter as your pump inlet and to use the shortest length hose as possible.

7.5 MIXING UNDER VACUUM

Some materials need to be mixed actually under vacuum in order to obtain an air free material. Some materials may also need heating before or during mixing. Such material may need constant agitation or vibration to keep them fluid so that they will actually flow as fluids to fill moulds and containers. In such cases we would consider each application individually and recommend suitable vacuum equipment.

7.6 COMPLETION OF PROCESS BY PRESSURE

After subjecting the liquid material to a vacuum to remove entrapped air the voids and spaces are probably still present but in vacuum. The final stage of the process is to release the vacuum in the chamber, i.e., admit the atmosphere which exerts a pressure of about 14.7 pounds on every square inch. It is this pressure that pushes the material into the voids undercuts and crevices of the mould. It is essential that the vacuum is released immediately after degassing. It may help to gently vibrate the mold full of material to temporarily overcome any tendency of the material to be thixotropic, i.e., non-flowing such as with certain casting plaster mixes.

If the material has already begun to set while in vacuum and the surface is not smooth but sponge like, then upon release of the vacuum air will enter the body of the material and create a gassy cast. Should this happen then vibration under vacuum and during vacuum release is needed so that the material flows in to all the cavities.

8.0 APPENDIX B: CARING FOR CLEAR ACRYLIC LIDS OR CHAMBERS

8.1 WASHING

Wash acrylic with a solution of mild soap or detergent and lukewarm water. Use a clean soft cloth, applying only light pressure. Rinse with clean water and dry by blotting with a damp cloth or chamois. Grease, oil, or tar may be removed with a good grade of hexane, aliphatic naphtha, or kerosene.These solvents may be obtained at a paint or hardware store and should be used in accordance with manufacturer's recommendations.

DO NOT USE: Window cleaning sprays, kitchen scouring compounds or solvents such as acetone, gasoline, benzene, alcohol, carbon tetrachloride, or lacquer thinner. These can scratch the sheet's surface and/or weaken the sheet causing small surface cracks called "crazing."

Acrylic can be cleaned with the following commercial cleaners without damaging the coated surface: Fantastik household cleaner, Formula 409 household cleaner, Glass Plus cleaner, Mr. Clean household cleaner, Top Job household cleaner, and Windex window cleaner.

It is not recommended to use abrasive cleaners.

8.2 POLISHING

Protect acrylic and maintain its surface gloss by occasional polishing with a good plastic cleaner and polish. Apply a thin, even coat with a soft, clean cloth and polish slightly with cotton flannel. Then wipe with a damp cloth to help eliminate electrostatic charges that can attract dust particles.

8.3 REMOVING SCRATCHES

Fine scratches can be removed by hand polishing. Apply a plastic scratch remover to a soft flannel pad and rub. When the scratches have disappeared, remove all residue and polish. For deeper scratches, first sand lightly with a 400-grit "wet or

dry" sandpaper, using plenty of water and rinsing the sandpaper frequently. Follow by buffing with a clean muslin wheel and a good polishing compound. For the highest gloss, use a clean-up wheel made of soft cotton or flannel sections and on which no compound is used. An electric drill with a buffing wheel is ideal.

9.0 APPENDIX C: SPARE PARTS & ACCESSORIES

For information on recommended spare parts and accessories, see the following tables:

- *TABLE 2. Vacuum Pump Oil and Grease*
- *TABLE 3. Oil Mist Eliminators*
- *TABLE 4. PVC Vacuum Hose with NW Flanges*
- *TABLE 5. Vacuum Hose Fittings*
- *TABLE 6. Vacuum Gauges*
- *TABLE 7. Vacuum Chamber Fittings and Valves*
- *TABLE 8. Chamber Lids and Gaskets*
- *TABLE 9. Clear Vacuum Traps and Replacement Elements*

TABLE 2 *Vacuum Pump Oil and Grease*

DESCRIPTION	1 QUART		1 GALLON		5 GALLON	
	P/N	PRICE	P/N	PRICE	P/N	PRICE
19 Grade, Direct Drive, VP1x10^{-5} torr	LVO191Q	$6.00	LVO191G	$16.00	LVO195G	$60.00
20 Grade, High Quality, VP 1x10^{-6} torr	LVO201Q	$12.00	LVO201G	$39.00	LVO205G	$160.00
Flushing Fluid, All Pumps, Low Viscosity	n/a	n/a	LVOFF1G	$7.00	LVOFF5G	$29.00
Silicone Vacuum Grease	LVO9140Z (4 oz Jar)	$14.50				

TABLE 3 *Oil Mist Eliminators*

P/N	DESCRIPTION	PRICE	SPARE ELEMENTS	
LOME10025	Auto Drain, NW In. Tube Outlet, 16 cfm	$205.00	LFG9	$36.00
LOME20025	Compact, NW24 In, 1/2" Outlet, 10 cfm	$130.00	LGL915	$32.00

TABLE 4 *PVC Vacuum Hose with NW Flanges*

P/N (XX - SPECIFY LENGTH IN FEET)	SIZE	PRICE (1ST FOOT)	PRICE (ADDT'L FOOT)
LVFP100N25-XX	1" D x NW 25	$47.60	$4.00
Clear PVC Tubing with molded-in metal reinforcing wire and glass-smooth interior Other sizes of tubing and flanges available upon request.			

TABLE 5 *Vacuum Hose Fittings*

P/N	DESCRIPTION	PRICE
LVFCN25A	Clamp-AL	$7.20
LVFGN25SV	Centering Ring SS/Viton	$6.60
LVFBN25S	Blank-Off, SS	$7.90
LVFFLWN25S	Flange Long Stub, SS	$15.80
LVFTN25S	Tee, SS	$79.00
LVFX25S	Cross, SS	$116.00
LVFE90N25S	Elbow, SS	$47.30
LVFAN25FP12S	1/8' FNPT Adaptor, SS	$20.00
LVFAN25FP25S	1/4' FNPT Adaptor, SS	$20.90
LVFAN25FP50S	1/2' FNPT Adaptor, SS	$55.00
LVFAN25FP75S	3/4' FNPT Adaptor, SS	$77.00

TABLE 6 *Vacuum Gauges*

P/N	DESCRIPTION	PRICE
LVG-VH-4	Thermocouple Gauge, Analog, 0-50 torr, 1/8" NPT	$299.00
LVG-100TC	Thermocouple Gauge, Analog, 0-20 torr, 1/8" NPT	$299.00
LVG-917APC	Pirani Gauge, Analog, ATM, $10x10^{-3}$ torr, 1/8" NPT	$510.00
LVG-945DPC	Pirani Gauge, Digital, 100 to $10x10^{-3}$ torr, 1/8" NPT	$570.00
LVG-3025B	0-30 in HG Vacuum Gauge, SS Case, 1/4" NPT Bottom Mount	$27.00
LVG-3025B	0-30 in HG Vacuum Gauge, SS Case, 1/4" NPT Rear Mount	$27.00

TABLE 7 *Vacuum Chamber Fittings and Valves*

P/N	DESCRIPTION	PRICE
LMSA8001	1/2" MNPT Adaptor - AL	$23.00
LMSA8002	3/4" MNPT Adaptor - AL	$29.00
LMSA8003	1/4" NPT Manual Valve	$8.00
LMSA8004	1/2" NPT Manual Valve	$12.60
LMSA8005	3/4" NPT Manual Valve	$16.00
LMSA8006	1/4" NPT Bronze Muffler	$2.20
LMSA8007	1/2" NPT Bronze Muffler	$4.00

TABLE 8 *Chamber Lids and Gaskets*

CHAMBER BUNA LID GASKETS			CHAMBER CLEAR LIDS		
P/N	CHAMB. DIA.	PRICE	P/N	CHAMB. DIA.	PRICE
LG06B	6"	$16.00	LMSA8008	6"	$57.00
LG08B	8"	$18.50	LMSA8008	8"	$60.00
LG10B	10"	$21.50	LMSA8008	10"	$60.00
LG12B	12"	$23.00	LMSA8008	12"	$86.00
LG18B	18"	$30.00	LMSA8008	18"	$200.00
LG24B	24"	$37.00	LMSA8008	24"	$285.00

TABLE 9 *Clear Vacuum Traps and Replacement Elements*

P/N	DESCRIPTION	PRICE
MV300005	4.5" Clear Trap, No Insert	$60.00
MV300010	9.5" Clear Trap, No Insert	$65.00
MV300100	9.5" Clear Trap, with Copper Gauze	$96.00
MV300105	4.5" Clear Trap, with Copper Gauze	$87.00
MV300200	9.5" Clear Trap, with SS Gauze	$107.00
MV300205	4.5" Clear Trap, with SS Gauze	$92.00
MV300300	9.5" Clear Trap, with Molecular Sieve	$120.00
MV300305	4.5" Clear Trap, with Molecular Sieve	$93.00
MV300400	9.5" Clear Trap, with Sodasorb	$100.00
MV300405	4.5" Clear Trap, with Sodasorb	$85.00
MV300500	9.5" Clear Trap, with Activated Charcoal	$100.00
MV300505	4.5" Clear Trap, with Activated Charcoal	$85.00
MV300600	9.5" Trap, with Activated Alumina	$95.00
MV300605	4.5" Clear Trap, with Activated Alumina	$85.00
MV300610	9.5" Trap, with PolyPro 2 micron	$93.00
MV300615	4.5" Trap, with PolyPro 5 micron	$78.00
MV300620	9.5" Trap, with PolyPro 5 micron	$93.00
MV300625	4.5" Trap, with PolyPro 5 micron	$78.00
MV300630	9.5" Trap, with PolyPro 20micron	$93.00
MV300900	Replacement Element, 9.5" Copper Gauze	$37.00
MV300905	Replacement Element, 4.5" Copper Gauze	$30.00
MV300910	Replacement Element, 9.5" Stainless Steel	$41.00
MV300915	Replacement Element, 4.5" Stainless Steel	$35.00
MV300920	Replacement Element, 9.5" Molecular Sieve	$50.00
MV300925	Replacement Element, 4.5" Molecular Sieve	$36.00

TABLE 9 *Clear Vacuum Traps and Replacement Elements*

P/N	DESCRIPTION	PRICE
MV300930	Replacement Element, 9.5" Sodasorb	$35.00
MV300935	Replacement Element, 4.5" Sodasorb	$27.00
MV300940	Replacement Element, 9.5" Activated Charcoal	$35.00
MV300945	Replacement Element, 4.5" Activated Charcoal	$27.00
MV400910	Replacement Element, 9.5" Activated Alumina	$35.00
MV400915	Replacement Element, 4.5" Activated Alumina	$29.00
MV400920	Replacement Element, 9.5" Polypro 2	$28.00
MV400925	Replacement Element, 4.5" Polypro 2	$28.00
MV400930	Replacement Element, 9.5" Polypro 5	$28.00
MV400935	Replacement Element, 4.5" Polypro 5	$28.00
MV400940	Replacement Element, 9.5" Polypro 20	$28.00
MV400945	Replacement Element, 4.5" Polypro 20	$28.00
LMSA8001	1/2"MNPT Adaptor to NW25 - AL	$23.00
LMSA8002	3/4"MNPT Adaptor to NW25 - AL	$29.00