

-85 C to +150 C -121 to +302 F

PCL & PAO

PCL, Portable Liquid Chillers,
PAO, Polyalphaolefin Liquid Chillers

Description:

Select the highly advanced Bemco PAO-II Polyalphaolefin Liquid Chiller or the sophisticated Bemco PCL-III Portable Liquid Chiller to provide a precisely conditioned and controlled, cooled or heated fluid for your high energy electronic product, space simulator, thermal vacuum system, or environmental test chamber.

PAO (Polyalphaolefin) fluid, manufactured in accordance with MIL-C-87252, is designed for use in electrical and electronic cooling of ground based and airborne electronic cooling systems.

PAO "Contains no ingredients known to be hazardous by OSHA." It is a "clear, colorless to light yellow fluid" with a "mild odor."

It has superior oxidative stability and is harmless to normal metals of construction. It is an excellent dielectric. Bemco PAO-II Liquid Chillers are optimized for use with PAO

Why settle for the appearance of testing when you can have a system that actually works?

Choose Bemco, the true experts in liquid pumping and conditioning systems.

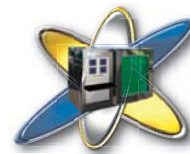
Environmental Test and Space Simulation Systems



Bemco is the largest volume manufacturer of Aerospace grade PAO fluid cooling and heating systems and Thermal Vacuum fluid circulating systems in the United States.

Contact us for a free quotation or additional information.

Bemco Inc, since 1951



Bemco Inc.
Focused on Excellence

Portable Liquid Chillers

PCL-III Fluid Conditioners



Recommended Circulating Fluids for Bemco Liquid Chillers

Fluid Manufacturer's Name	Primary Advantages As a Circulated Fluid	Primary Disadvantages As a Circulated Fluid	Temperature Range Maximum
d-Limonene	Citrus based food grade chemical	Combustible, odor, and residue (1)	-85 C to +150 C
FC77 Fluorinert	No residue dielectric fluid	Limited range, environmental (2)	-85 C to +100 C
Galden HT170	No residue dielectric fluid	Very expensive, environmental (2)	-85 C to +150 C
Lexol 408	Common in older systems	Combustible and residue (1)	-55 C to +150 C
Paratherm CR	Synthetic hydrocarbon	Combustible at high temperature	-85 C to +150 C
Coolanol 25	Low volatility dielectric fluid	Residue and high viscosity	-45 C to +125 C (3)
PAO (4)	Low volatility dielectric fluid	Residue and high viscosity	-45 C to +125 C (3)

- (1) Applies if spilled or if a leak develops in the shroud or base plate under vacuum.
- (2) Has potential environmental problems due to long life of the chemical in the atmosphere.
- (3) High viscosity at low temperature makes pumping difficult. Recommended range is 10 C higher than shown.
- (4) Bemco is the largest volume maker of PAO Chillers for the Aerospace Industry in the United States.

PCL-III Free Standing Fluid Conditioners

Bemco PCL-III fluid conditioners are furnished as free standing caster mounted systems, ready to provide a reliable and precisely controlled flow of temperature conditioned fluid.

To save floor space, these systems are also packaged with larger space simulators and thermal vacuum systems. Bemco's A6H Standard Space Simulators, described in our AH Series Bulletin, each include a fully integrated and appropriately sized PCL-III fluid conditioner.

They also make an ideal upgrade to an existing vacuum chamber or bell jar without thermal capability or an older thermal vacuum system or space simulator with obsolete controls, leaking pumps, dangerous circulating fluids, or environmentally unfriendly refrigerants.



Standard PCL-III fluid conditioners use d-Limonene, a product of Florida Chemical Company and a derivative of citrus peel oil. This material has a strong citrus odor, has a GRAS rating (Generally Recognized As Safe) from the US FDA, and is commonly used in modern space simulators and thermal vacuum

chambers. Other fluids can be substituted. If another fluid is preferred, consult your Bemco technical representative for a recommendation.

Bemco makes custom fluid chillers over the temperature range of -115 C to +200 C. No single fluid covers the entire range. Special fluids, not shown above, many with unique challenges, are available on request.

Fluid circulating systems are available with magnetically sealed gear pumps up to about 50 gpm at an external loop pressure drop of 50 psid. Above this flow rate, magnetically sealed centrifugal pumps are offered up to 150 gpm at approximately 20 psid external loop pressure drop. Higher pressure capabilities are available on request.

Please note that liquid nitrogen cooling is required below -65 C.



Request a free quotation or analysis of your testing needs. Our experienced engineers are ready to help you.

We Deliver

Bemco chambers really simulate the environments expected. We take your specifications and requirements literally. Our equipment does what we promise and you specify. We are truly focused on Excellence.

Portable Liquid Chillers

PCL-III Fluid Conditioners



Standard PCL-III Portable Liquid Chillers								
Model Number	Flow gpm	~ External Load, Watts	~ Loop Rise Full Load, C	Temperature Range, C	Cooling Type	Refrigeration Horsepower	Circulating Fluid	Circulating Pump Type
PCL3L-III	3	1500	5	-55 to +150	LN ₂	None	d-Limonene	Mag Gear
PCL3M-III	3	1500	5	-55 to +150	Mechanical	2 x 2	d-Limonene	Mag Gear
PCL8L-III	8	4000	5	-55 to +150	LN ₂	None	d-Limonene	Mag Gear
PCL8M-III	8	4000	5	-55 to +150	Mechanical	6.5 x 6.5	d-Limonene	Mag Gear
PCL15L-III	15	8000	5	-55 to +150	LN ₂	None	d-Limonene	Mag Gear
PCL15M-III	15	8000	5	-55 to +150	Mechanical	10 x 10	d-Limonene	Mag Gear
PCL20L-III	20	10000	5	-55 to +150	LN ₂	None	d-Limonene	Mag Gear
PCL20M-III	20	10000	5	-55 to +150	Mechanical	15 x 15	d-Limonene	Mag Gear

PCL-III's Include:

The third generation PCL-III Portable Liquid Chiller combines the outstanding features developed in over 60 years of manufacturing these systems with modern controls, safer fluids, advanced heat exchangers, and convenient packaging.

Bemco refrigeration systems are all water cooled. They use environmentally friendly refrigerants, industrial grade semi-hermetic compressors, and include automatic hot gas bypass unloading as well as Bemco's exclusive, high performance coaxial cascade heat exchanger.

Heaters are interlocked with a separate heavy duty power contactor and a factory preset high temperature safety control.

All electrical wiring meets the United States National Electric Code.

Fluid System:

The standard Bemco PCL-III fluid circulating system includes a magnetically sealed, positive displacement gear pump capable of producing rated flow at 50 psi between the supply and return connection.

The fluid system includes: shutoff valves, a bypass modulating valve to allow system preconditioning, discharge and suction pressure gauges, and a relief valve to protect the system from over pressurization.

The system also has a fluid reservoir with a sight glass to monitor fluid level as well as a nitrogen gas pressurization system to prevent boiling, water condensation, and to allow the fluid to expand and contract with temperature. Discharge and suction pressure switches protect the system. The PCL-III is enclosed in a carbon steel case painted Bemco blue.

Instrumentation:

Each PCL-III includes a microprocessor based programmable 1/4-DIN solid state 256-step ramping temperature controller with a 4-line LCD interface display and a large red LED display.

An RS232 and RS485 interface is standard. The protocol is Modbus™. LabVIEW™ drivers are available.

A Factory Mutual Approved high and low temperature safety control with audible and visual alarm is included at no extra cost.



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Portable Liquid Chillers

PAO-II Fluid Conditioners



PAO (Polyalphaolefin) Liquid Properties ⁽¹⁾ MIL-C-87252						
Temperature C / F	Viscosity Centipoise	Density lb/ft ³	Dielectric KV	Conductivity btu-ft/hr-ft ² -F	Specific Heat btu/F-lb	Vapor Pressure mm Hg
-54 C (-65 F)	831.3	53.9	35	0.096	0.46	0.007
-40 C (-40 F)	461.9	53.1	35	0.095	0.48	0.011
0 C (+32 F)	86.2	50.8	35	0.092	0.51	0.046
40 C (104 F)	16.1	48.4	35	0.088	0.54	0.189
100 C (212 F)	1.3	44.9	35	0.083	0.59	1.565
135 C (275 F)	.3	42.9	35	0.081	0.61	5.371

⁽¹⁾ Consult manufacturer's literature for definitive values. The above information is offered as a convenience.

PAO (Polyalphaolefin) Liquid Chillers

In the Aerospace environment, high density, high performance, electronic systems are in demand. Removing heat from these progressively more compact and higher heat dissipating systems has become an important factor in system reliability.

Many successful heat transfer solutions involve direct fluid contact or spray cooling using a dielectric fluid such as Coolanol or the more modern Polyalphaolefin (PAO), a highly branched, compact, and very stable synthetic hydrocarbon that offers exceptional heat transfer



performance over a wide temperature range.

PAO, a fluid that does not react with water and is compatible with most metals, is the basis of the Bemco PAO-II series of fluid conditioners.

Similar to the Bemco PCL Chillers, PAO-II Liquid Chillers are furnished as free standing caster mounted systems, ready to provide a reliable and precisely controlled flow of temperature conditioned PAO fluid.

These systems are optimized for use with Polyalphaolefin fluid in an Aerospace environment.

Standard systems include a magnetically sealed gear pump designed to produce rated flow at an external pressure drop of up to 50 psid.

Custom systems, up to about 50 gpm at an external loop pressure drop of 50 psid, are available with magnetic gear pumps. Above



this flow rate, magnetically sealed centrifugal pumps are offered up to 150 gpm at approximately 20 psid external loop pressure drop. Higher pressure capabilities are available on request.

PAO systems usually include a number of optional systems. The most commonly selected are desiccant and particulate filters, high and low temperature limits, automatic flow control, mass flow monitoring, and PLC (Programmable Logic Control) sequencing of process events. All of these options are described in this bulletin in the following pages.



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We Deliver

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Portable Liquid Chillers

PAO-II Fluid Conditioners



Standard PAO-II Polyalpaolefin Liquid Chillers								
Model Number	Flow gpm	~ External Load, Watts	~ Loop Rise Full Load, C	Temperature Range, C	Cooling Type	Refrigeration Horsepower	Circulating Fluid	Circulating Pump Type
PAO1L-II	1.5	600	5	-40 to 100	LN ₂	None	PAO	Mag Gear
PAO1M-II	1.5	600	5	-40 to 100	Mechanical	1 x 1	PAO	Mag Gear
PCL3L-II	3	1200	5	-40 to 100	LN ₂	None	PAO	Mag Gear
PAO3M-II	3	1200	5	-40 to 100	Mechanical	2 x 2	PAO	Mag Gear
PAO8L-II	8	3500	5	-40 to 100	LN ₂	None	PAO	Mag Gear
PAO8M-II	8	3500	5	-40 to 100	Mechanical	6.5 x 6.5	PAO	Mag Gear
PAO15L-II	15	7000	5	-40 to 100	LN ₂	None	PAO	Mag Gear
PAO15M-II	15	7000	5	-40 to 100	Mechanical	10 x 10	PAO	Mag Gear
PAO20L-II	20	8500	5	-40 to 100	LN ₂	None	PAO	Mag Gear
PAO20M-II	20	8500	5	-40 to 100	Mechanical	20 x 20	PAO	Mag Gear

PAO-II's Include:

Although invented in the 1930's PAO's use as a heat transfer fluid is comparatively modern. Bemco's second generation PAO-II Chiller incorporates all of the advanced features of the PCL-III Liquid Chiller with the additional equipment needed to reliably handle PAO fluid in an industrial environment.

Packaged in a rugged, angle reinforced carbon steel case painted Bemco Blue, PAO-II Chillers have a built-in stainless steel pan to contain smaller spills.

Liquid nitrogen systems include an exclusive Bemco designed LN₂ to PAO heat exchanger with both a liquid nitrogen level control, set-up solenoid, and a high pressure relief valve.

Bemco refrigeration systems, when specified, are air cooled on the PAO-1L and all water cooled on the larger sizes. They use environmentally friendly refrigerants, industrial grade hermetic or semi-hermetic compressors, and include automatic hot gas bypass unloading as well as Bemco's exclusive, high performance coaxial cascade heat exchanger.

Heaters are interlocked with a separate heavy duty power contactor and a factory preset high temperature safety control.

All electrical wiring meets the United States National Electric Code.

Fluid System:

The standard Bemco PAO-II fluid circulating system includes a magnetically sealed, positive displacement gear pump capable of producing

rated flow at 50 psi between the supply and return connection.

The fluid system includes: shutoff valves, a bypass modulating valve to allow system preconditioning, discharge and suction pressure gauges, a relief valve to protect the pump, and a relief valve to protect the system from over pressurization.



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Portable Liquid Chillers

PAO-II Fluid Conditioners



interface display and a large red LED display.

An RS232 and RS485 interface is standard. The protocol is Modbus™. LabVIEW™ drivers are available.

A Factory Mutual Approved high and low temperature safety control with audible and visual alarms are included at no extra cost.



Mechanical Options:

- 300 series stainless steel exterior construction. See the front cover of this bulletin for an example.
- Micron sized, large desiccant and particulate filters in the return flow with isolation valves, a bypass valve, a differential pressure gauge, and a bypass

solenoid to filter the system flow and remove entrained moisture if present. Dual sets are sometimes specified for continuous system operation.

- A micron sized filter in the supply flow with isolation valves, a bypass valve, and a differential pressure gauge to remove contaminants in the supply flow.

Fluid System:

The system also has a fluid reservoir with a sight glass to monitor fluid level as well as a nitrogen gas pressurization system to prevent boiling, water condensation, and to allow the fluid to expand and contract with temperature. Discharge and suction pressure switches protect the system.

A small micron size particulate and water absorbing filter in a manually controlled bypass loop is provided to allow preconditioning of PAO fluid on system startup. Test ports at strategic locations throughout the system are standard.

Instrumentation:

Each PAO-II includes a microprocessor based programmable 1/4-DIN solid state 256-step ramping temperature controller with a 4-line LCD



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Portable Liquid Chillers

PAO-II Fluid Conditioners



- An automatic pressure regulation bypass valve to maintain discharge pressure at a preset value.
- A manual three-way reservoir bypass valve to allow captured gas bubble relief on initial connection to a load.
- Automatic flow isolation solenoid valves.
- Self sealing quick disconnect fittings.
- Automatic flow modulation valves with automatic bypass modulation.
- Fluid sampling ports to allow evaluation of fluid quality.
- Outdoor fluid enclosures mounted on over-the road truck running gear with inflated tires and Ackermann

(the front wheels turn with the yoke) steering.

- Field generator sets to allow operation without a source of electricity. Please note that these systems are usually specified with an air cooled refrigeration system.
- Substitution of Coolanol 25 or another suitable fluid for PAO. Consult your Bemco technical representative for a recommendation.
- Dual heat exchanger loops, tanks, one for hot and one for cold with automatic mixing valves to allow a smooth rapid thermal transition between systems for temperature cycling between extremes.

Instrument Options:

- 24 hour or 7 day, digital indicating, self chart printing, circular recorders for temperature.
- Single pen or multi-pen strip chart recorders.
- Programmable logic control sequencing of test processes or fluid system sequencing including totally automatic control of all system functions. Systems can include calibration and maintenance screens and graphic representation of the system. Bemco recommends Allen Bradley (ABB) PLC's and software.
- Touchscreen HMI's (Human Machine Interfaces).
- RS232, RS485, and Ethernet communication interfaces.
- Engraved or silk screened graphic control panels.



- Digital liquid flow meters, either indicating or totalizing, calibrated in gpm.
- Flow meters to indicate total system mass flow.
- Automatic low and high level sensing and alarm in the fluid reservoir.
- Automatic level sensing transducers in the fluid reservoir.
- Low and high flow switches with audible and visual alarm and electrical interlocks.
- Low and high pressure switches on the system discharge or suction line to protect the test item.
- Precision pressure transducers on the fluid discharge and suction lines interlocked with display devices or system process controls.
- Graphic display of control switches, system processes, set points, actual values, and status.



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Portable Liquid Chillers

PAO-DII Fluid Distribution Panels



PAO-DII Fluid Distribution Panels

As a further convenience, we offer our PAO-DII Fluid Distribution Panels to individually distribute, monitor, and protect one or more of your high value products from the higher than required flow of a larger second generation PAO-II Chiller.

You can also use PAO-DII Fluid Distribution panels with any other source of temperature controlled fluid.

These systems are individually assembled to match the product being tested. They can be designed for mounting in standard Electronic Industries Association (EIA) 19" or 24" relay rack consoles or as free standing, wall, table, or floor mounted systems.

They are usually divided into a Control Interface Panel and a Fluid Coolant Panel.

The Control Interface Panel typically includes:

- A digital display of coolant flow calibrated in GPM interlocked with a flow transducer.
- A digital display of coolant pressure interlocked with a precision pressure transducer.
- A change filter indicator light interlocked with a micron size filter in the fluid supply to the device under test.
- A mushroom process interlock with audible and visual alarm.
- A system on-off switch

The Fluid Coolant Panel typically includes:

- Self sealing fluid supply and return quick disconnect connections.

- A multi-turn flow control valve.
- A precision pressure regulator.
- A coolant supply shutoff valve.
- Device under test self sealing fluid quick disconnects.

Often, a single unit is designed to distribute and control fluid to three or more loads simultaneously. Each one with their own regulator, flow isolation valve, pressure gauge or pressure transducer, and display and flow monitoring equipment. Fluid test ports, electronic temperature limit monitoring and alarm systems, and automatic relief and bypass unloading systems are also sometimes selected.

Many of the instrument options described on the previous page are also available.

Contact your Bemco technical representative for an analysis of your application.



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Combined Environments

Temperature, Humidity, Altitude, Vibration, Vacuum, Rain, Sunshine, Salt Spray, Sand and Dust, and Gasses. Space Simulation Systems, Walk-in Chambers, Drive-in Rooms, PAO Fluid Chillers, and Air Servos.