

## A discussion of the role of Non-evaporable getter pump technology in portable mass spectrometry.

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SAES Getters

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## Outline

- Requirements for small portable Mass Spectrometry Systems
- Vacuum pumping requirements for portable Mass Spec Systems
- Pumping options
  - Ion pump for portable Mass Spec System
  - CapaciTorr for portable Mass Spec System
  - NEXToTorr for portable Mass Spec System
- Weight savings of CapaciTorr and NEXToTorr vs Ion Pump
- Recommended configuration
- Turbo Pump Stations
- Summary

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## Requirements of Harsh-Environment Mass Spectrometry portable Mass Spectrometers

- The Workshop on Harsh-Environment Mass Spectrometry (HEMS) was created in 1999 as a means of encouraging interaction among people involved in deploying mass spectrometers outside of the typical laboratory setting.
- These environments are diverse, ranging from volcanoes and battlefields, to ocean depths, outer space and other rugged locales.
- Building mass spectrometers to withstand the rigors of such harsh and remote environments places a unique burden on engineering design and science objective planning, where operational requirements for **power, size and durability** must be met while achieving the goals of the scientific mission.

Source: <http://www.hems-workshop.org/aboutus.html>

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## Requirements of Vacuum pumps for Portable Mass Spectrometers for HEMS applications.

- The pumping system must be portable and mount easily to the Mass Spectrometer
- The pumping system must be small and lightweight
- The pumping system must supply ample speed and capacity for the system.
- The pumping system must be able to operate with minimal power consumption



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## Portable systems with an Ion Pump

- ❑ A portable system with an ion pump will need a battery system.
- ❑ A Portable system with an ion pump system will lose the ability to pump when the batteries run out.
- ❑ Weight is the big disadvantage of this option
  - ❑ 20 lbs + 17 lbs for Batteries = at least 37 pounds

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## Portable systems with an Ion Pump

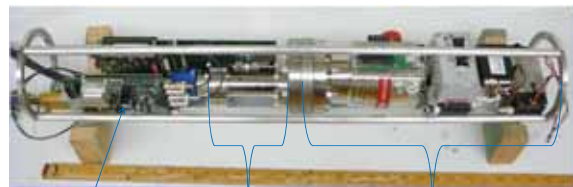
- ❑ If a small ion pump is already available or already installed in the portable system, a NEG pump can be added
- ❑ The typical NEG pump to be added because of size and performance is the CapaciTorr D 400.
- ❑ The CapaciTorr D 400 provides 400 L/S of H<sub>2</sub> pumping, 180 L/S of CO and 270 L/S of O<sub>2</sub> pumping.
- ❑ The CapaciTorr D 400 weighs a mere 1.3 pounds and is less than 7.5 inches in total length and protrudes into the vacuum system less than 5 ¼ inches.

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## Submarine sampling system



ART MS Single Board Controller

ART MS Sensor

Turbo Pump Station

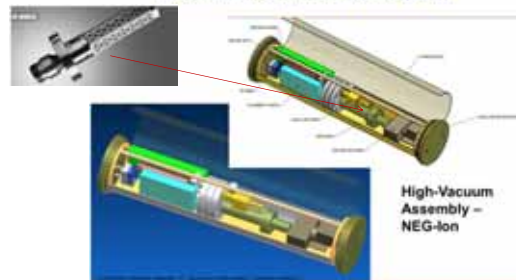
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## CapaciTorr in a portable sampling system

### Scientific/Technical Description



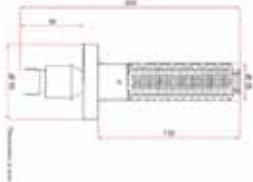
High-Vacuum Assembly - NEG-Ion

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## CapaciTorr D 400



### Typical Pump Characteristics

Alloy Type	316L (304)
Alloy Composition	Zr/Wc
Center Mass (g)	45
Center Surface (mm <sup>2</sup> )	200
Pumping Inlet Dia.	4.86
Pumping Outlet Dia.	1.90
Surfaces	300
Capacity (Bar <sup>0</sup> )	CO Stream Temperature
CO Temp	500

Note: Pumping speed data refers to the inlet volume of the pump. Actual pumping speed is heavily based on speed table (1) (2)

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## Additional CapaciTorr Pumps



D 50 & D 100



D 200

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## Portable System with NEXTorr

### NEXTorr Pump

- ❑ A portable system with a NEXTorr Pump will require a battery pack to operate the Ion pump portion
- ❑ A portable system with a NEXTorr pump will retain the ability to pump when batteries run out.
- ❑ Weight with the controller is an issue  
5 lbs + 7 lbs + batteries = at least 12 pounds
- ❑ Reduction of 25 lbs

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## Portable Systems with NEXTorr

### NEXTorr Pump

- ❑ The use of a pumping Turbo station is suggested to reach a good base pressure.
- ❑ When ultimate pressure is achieved, the portable system can be removed from the pumping station.
- ❑ The portable system will be pumped by the NEG during transportation saving battery power for sampling.
- ❑ NEG pumping during transportation provides quicker recovery to base pressure.

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## Less is better!

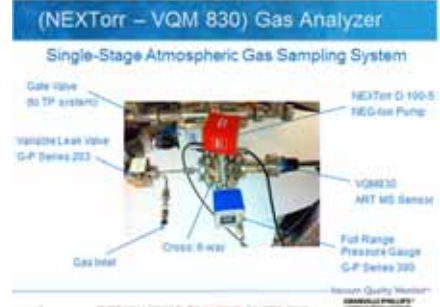
50 L/5 20.9 pounds Requires Controller	30 L/5 30.8 pounds Requires Controller	25 L/5 22 pounds MP requires requires Controller	100 L/5 8 pounds MP requires requires Controller	100 L/5 7 pounds MP requires requires Controller
Controller Requires 120 V Requires a UPS or battery power Weight: 13.5lb	Controller Requires 120 V Requires a UPS or battery power Weight: 13.5lb	Controller Requires 120 V Requires a UPS or battery power Weight: 17.5lb	Controller Requires 120 V Requires a UPS or battery power Weight: 7.5lb	Controller Requires 120 V Requires a UPS or battery power Weight: 7.5lb

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## NEXTorr in a portable sampling system



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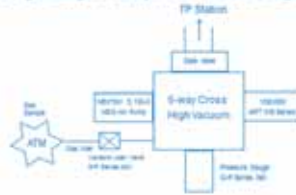
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## NEXTorr and VQM 830

### (NEXTorr - VQM 830) Gas Analyzer

#### Single-Stage Atmospheric Gas Sampling System



With permission from Brooks Automation

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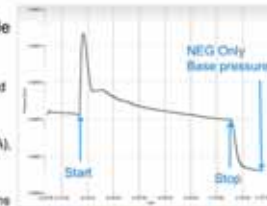
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## NEXTorr Activation

The NEG Pump must be activated in order to provide full pumping speed and capacity:

- Gate Valve open, Leak Valve closed
- Ion Pump Off
- SAES NICOPS-02 Power Supply automates Timed Activation (5V, 5A),
- Built in heating element (500°C, 1 hour)
- TP provides High Vacuum conditions
- Close Gate Valve at end of activation
- Turn ION Pump on at end of activation
- Pump is ready.



NEG	Se-I Torr
NEG+ION	6.5E-9 Torr

Courtesy of Gerardo Brucker, Brooks Automation

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## Activation



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## Pump Comparisons

Pump	Speed	Power	Size	Weight	Capacity	Back Pump	Gas Species Dependent	Inert Gas
Ion	>5	Green	Red	30Lb @ 60L/s	Yellow	Green	Yellow	Yellow
NEG	>100	Green	Green	Green	Red	Green	CH <sub>4</sub>	Red
NEG + ION	Green	Green	Green	Green	Yellow	Green	Yellow	Yellow

Courtesy of Gerardo Brucker, Brooks Automation

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## NEXTorr® D 100-5 pump

Total weight (magnets included)	2,2 kg
Volume	0,5 l

Gas	Initial pumping speed (l/s)	
	NEG activated	NEG saturated
O <sub>2</sub>	100	3.5
H <sub>2</sub>	100	-
CO	70	6
N <sub>2</sub>	40	5
CH <sub>4</sub>	15	7
Argon	6	6



150 - 165 pounds



NEXTORR is a SAES Trade mark. Patent pending.

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## The NEXTorr® family

□ During 2013 the NEXTorr family has grown :

- Pumps with large pumping speed up to 500 l/s have been developed
- The same SIP 5 l/s (N<sub>2</sub>) is used: improved performance/size ratio



NEXTorr D100-5 D200-5 D300-5 D500-5 D1000-10

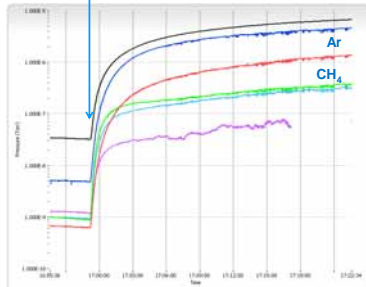
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## NEG Only Sampling

- NEG Only Operation requires no external power but has no pumping speed for inert gases and reduced for methane.
- NEG Only operation is not recommended for Air sampling as Ar and Methane will rapidly build up in the chamber.



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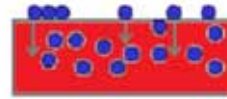
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## Use of the Getter with an elevated temperature

Using the getter pump at an elevated temperature

Heat getter to 200 - 300 deg C



Reactive gases will now hit the surface of the getter then diffuse into the bulk.

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## NEG Only Operation

- Advantages:
  - No power required to operate NEG pump
  - Extends battery life
  - Extends the period between activations
- Disadvantages:
  - Will not pump noble gases
  - Total pressure rise can be seen after repeated cycles
  - Decreases total life of getter material
- Comments:
  - There are customers using this configuration with great success.

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## Suggested Configuration

- CapaciTorr pump mounted onto compact sampling system with an Ion Pump already installed.
  - Connect to Turbo pumping system to reach best vacuum
- NEXTorr Pump mounted onto compact sampling system
  - Connect to Turbo pumping system to reach best vacuum
- Comments on NEG portion of pump
  - For high gas load sampling operate the getter pump at a higher temperature (250 deg C – 300 deg C)
  - NEG pumping during transportation will minimize time to recover to best vacuum.

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## Turbo Pump Carts



Typically \$4,500.00 to \$8,800.00

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## Summary

- There are two product lines suitable for portable Mass Spec systems
- The CapaciTorr is very light weight with a very small volume and is compatible with any Ion Pump.
- The CapaciTorr can provide pumping from 50 L/S to 3500 L/S for a wide variety of applications.
- The NEX Torr product combines CapaciTorr and Ion Pump capacity in an unprecedented small, lightweight package.
- The NEX Torr is lightweight, requires low power to operate and with a very small volume. Provides a Single vacuum connection!
- The NEX Torr can provide pumping from 100 L/S to 2000, L/S

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Thanks  
for your attention

Many thanks to the following contributors:  
Gerardo Brucker, Brooks Automation, Gary  
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Stop by and see the pumps!

Bob Garcia  
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