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Cryogenic Delivery and Storage Systems

MVE

Tech Tips

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MVE-HE SERIES VS. CBS LOW TEMPERATURE FREEZERS:

We have had several MVE Distributors request information comparing the MVE-HE Series with the CBS Low Temperature Freezers. Listed is the compilation of information concerning these units.

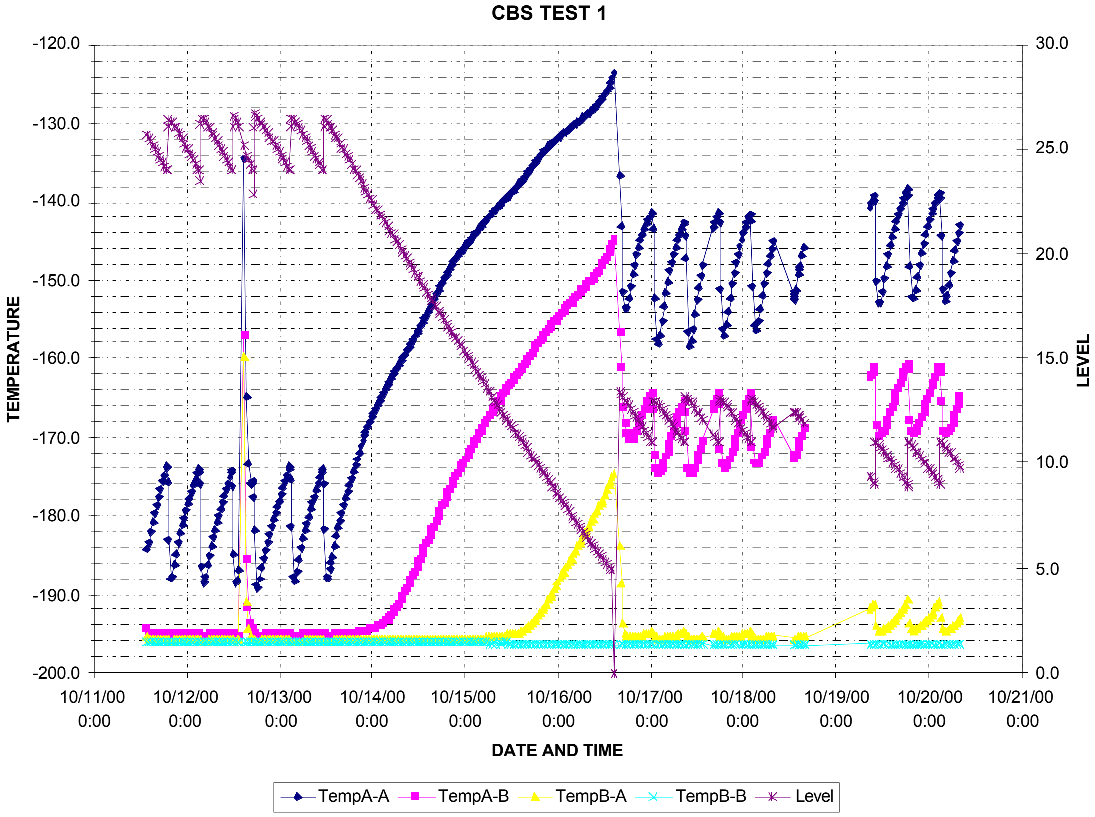
Liquid Nitrogen Usage.

The liquid nitrogen usage in any vapor system is proportional to only one variable. This variable is simply the quantity of heat leak into the system. In order for the required temperature to be attained, the liquid must absorb any heat leak as it vaporizes, simply the more heat, which enters the system; the more liquid is used. Total systemic liquid usage however comprises other factors. Every time the system fills, the transfer system must be cooled to LN2 temperatures before liquid will flow to the system, in addition, the initial gas passing into the system will vaporize liquid already present and lead to a loss before any filling occurs. It is therefore a combination of heat compensation vaporization and transfer losses (which are roughly inversely proportional to the fill cycle time), which determine the total liquid cost.
In any cryogenic tank, heat leak through the vacuum insulated surfaces is minimal. The vast majority of heat leak into the system is through the lid. For a normal tank, where the lid is the same diameter as the tank, the lid accounts for around 15 to 20% of the surface area. In a HE style tank, the lid surface is a mere 3 to 5% of the surface. It is in this simple fact that much of the exceptional liquid usage efficiency is achieved. This effect can be seen in the following graph. Note the long period between fills and the exceptional hold time with the nitrogen source removed. This provides vital safety time in the event of any accident or disruptions occurring with LN2 cylinder supply electrical failure or fill valve mis-function.

The data also graphically indicates that the temperature of all the boxes in the rack remain on an isotherm. Further that they are unaffected in terms of absolute temperature as the liquid level falls for over 10 days after the interruption of further LN2 supply. For several days beyond, the temperature is still at least 30 degrees below the glass transition temperature (-132°C, below which no biological activity, and hence sample degradation, is possible). It is also worth noting that the unit is only filling every 5 days, and with high and low fill points set at 7 and 9 inches. A more standard 5 and 9 inch setting would only require a fill every 10 days or so (typically in service these units use less than 0.4 inches of liquid per day).

In a submerged (or surrounded) chamber system, the heat transfer mechanism is different. Heat conduction through the wall of the submerged chamber is the major heat transfer route. This creates 2 noticeable effects. Most importantly, the temperature in the inner space will only be maintained (the gradient only remains isothermal) up to the top level of the liquid. Since the temperature level relationship is a dynamic, not static as in the case of the reservoir system, it is important to keep the level in the tank constantly high. The latter is obviously not necessary in the HE design as the graph shows. This requirement, in conjunction with the fact that the surrounding LN2 vessel is relatively narrow (around 2.5cm), means that the level drops sharply as liquid is consumed. Even if the unit consumed at the same rate as the HE design, the system would need to be filled much more frequently as the level would have to be maintained. As an example, for a 100cm tank, with a 105cm surrounding reservoir, the differential volume is around 0.85 liters per cm of column height, or 2.04

Liters per inch. The 1520 HE has a validated NER of 4.5 liters per day. MVE's standard 100cm tank has an NER of 8 to 10 liters per day (and whatever anyone tells you this is a best in industry number). In the submerged tank design (which has the same heat leak characteristics as a 39" tank) this equates to 4 inches per day at a minimum.



This graph shows the fill cycles and level and volume relationship within a test submerged chamber system in MVE's development department. Note the fill cycle times and the relationship of the top box temperature and level, and the subsequent failure of the isotherm as the level falls lower. Note also that the total time period for the top box to reach and exceed the critical temperature is less than 4 days.

LN2 cost is also an issue here. The following table shows a cost of storage comparison with any 39" wide mouth tank and the HE design, taking into account
Actual in use LN2 consumption including transfer losses and transactional work within the tank;

Freezer	Capacity 2ml vials	Cost/1000 at $40/Cylinder	Cost/1000 at $70/Cylinder	Cost/1000 at $100/Cylinder
16"	N/A	N/A	N/A	N/A
21"	8800	121.0	212.0	303.3
25"	12100	1021.8	179.8	257.0
31"	19800	62.8	110.1	157.3
39"	33000	53.9	94.2	134.7
810 HE	15600	29.7	51.9	74.1
1520 HE	36400	14.7	25.7	36.7
1830 HE	79950	13.4	23.4	33.4

As can easily be seen, the HE design proves an economical choice despite a higher initial cost.

The ease of use of the HE is also worthy of note. The exceptionally light Aluminum inner tray rotates to ensure easy ergonomic access from a single front point, using the built in step. Racks are always removed vertically, lessening the chance of strain and tank damage and the unique design allows the temperature inside the unit to remain at –190°C for over 2 hours with the lid removed. Also, since there is no requirement for side or rear access to the freezer to remove racks, the effective floor space requirement is much lower than standard tanks and the floor space / capacity ratio is the best in the industry.
Other benefits include an industry leading 5-year warranty and the knowledge that the world's largest cryogenic systems producer manufactures these units.

Some of the information within this document is commercially sensitive. We would ask you to share information with your colleagues only.

ALSO ATTACHED IS THE CURVE COMPARING TEMPERATURE AND VOLTAGE OF THE SILICON DIODE TEMP PROBE THAT IS SUPPLIED BY LAKESHORE:

Standard Curve 10

Standard Curve 10: Measurement Current = 10 µA ±0.05%

T (K)	Voltage	dV/dT (mV/K)	T (K)	Voltage	dV/dT (mV/K)	T (K)	Voltage	dV/dT (mV/K)
1.40	1.69812	-13.1	16.0	1.28527	-18.6	95.0	0.98564	-2.02
1.60	1.69521	-15.9	16.5	1.27607	-18.2	100.0	0.97550	-2.04
1.80	1.69177	-18.4	17.0	1.26702	-18.0	110.0	0.95487	-2.08
2.00	1.68786	-20.7	17.5	1.25810	-17.7	120.0	0.93383	-2.12
2.20	1.68352	-22.7	18.0	1.24928	-17.6	130.0	0.91243	-2.16
2.40	1.67880	-24.4	18.5	1.24053	-17.4	140.0	0.89072	-2.19
2.60	1.67376	-25.9	19.0	1.23184	-17.4	150.0	0.86873	-2.21
2.80	1.66845	-27.1	19.5	1.22314	-17.4	160.0	0.84650	-2.24
3.00	1.66292	-28.1	20.0	1.21440	-17.6	170.0	0.82404	-2.26
3.20	1.65721	-29.0	21.0	1.19645	-18.5	180.0	0.80138	-2.28
3.40	1.65134	-29.8	22.0	1.17705	-20.6	190.0	0.77855	-2.29
3.60	1.64529	-30.7	23.0	1.15558	-21.7	200.0	0.75554	-2.31
3.80	1.63905	-31.6	24.0	1.13598	-15.9	210.0	0.73238	-2.32
4.00	1.63263	-32.7	25.0	1.12463	-7.72	220.0	0.70908	-2.34
4.20	1.62602	-33.6	26.0	1.11896	-4.34	230.0	0.68564	-2.35
4.40	1.61920	-34.6	27.0	1.11517	-3.34	240.0	0.66208	-2.36
4.60	1.61220	-35.4	28.0	1.11212	-2.82	250.0	0.63841	-2.37
4.80	1.60506	-36.0	29.0	1.10945	-2.53	260.0	0.61465	-2.38
5.00	1.59782	-36.5	30.0	1.10702	-2.34	270.0	0.59080	-2.39
5.50	1.57928	-37.6	32.0	1.10263	-2.08	280.0	0.56690	-2.39
6.00	1.56027	-38.4	34.0	1.09864	-1.92	290.0	0.54294	-2.40
6.50	1.54097	-38.7	36.0	1.09490	-1.83	300.0	0.51892	-2.40
7.00	1.52166	-38.4	38.0	1.09131	-1.77	310.0	0.49484	-2.41
7.50	1.50272	-37.3	40.0	1.08781	-1.74	320.0	0.47069	-2.42
8.00	1.48443	-35.8	42.0	1.08436	-1.72	330.0	0.44647	-2.42
8.50	1.46700	-34.0	44.0	1.08093	-1.72	340.0	0.42221	-2.43
9.00	1.45048	-32.1	46.0	1.07748	-1.73	350.0	0.39783	-2.44
9.50	1.43488	-30.3	48.0	1.07402	-1.74	360.0	0.37337	-2.45
10.0	1.42013	-28.7	50.0	1.07053	-1.75	370.0	0.34881	-2.46
10.5	1.40615	-27.2	52.0	1.06700	-1.77	380.0	0.32416	-2.47
11.0	1.39287	-25.9	54.0	1.06346	-1.78	390.0	0.29941	-2.48
11.5	1.38021	-24.8	56.0	1.05988	-1.79	400.0	0.27456	-2.49
12.0	1.36809	-23.7	58.0	1.05629	-1.80	410.0	0.24963	-2.50
12.5	1.35647	-22.8	60.0	1.05267	-1.81	420.0	0.22463	-2.50
13.0	1.34530	-21.9	65.0	1.04353	-1.84	430.0	0.19961	-2.50
13.5	1.33453	-21.2	70.0	1.03425	-1.87	440.0	0.17464	-2.49
14.0	1.32412	-20.5	75.0	1.02482	-1.91	450.0	0.14985	-2.46
14.5	1.31403	-19.9	80.0	1.01525	-1.93	460.0	0.12547	-2.41
15.0	1.30422	-19.4	85.0	1.00552	-1.96	470.0	0.10191	-2.30
15.5	1.29464	-18.9	90.0	0.99565	-1.99	475.0	0.09062	-2.22

Shaded portion highlights truncated portion of Standard Curve 10 corresponding to the reduced temperature range of DT-471 diode sensors. The 1.4 K to 325 K portion of Curve 10 is applicable to the DT-450 miniature silicon diode sensor.

LakeShore
Measurement and Control Technologies

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We have available 14 – 38XC Dears that will use only 5 inch canisters. The part number is 11539749 and the price is $345. The specifications are as listed:

# Of Canisters	10
Liquid Capacity	38 liters
NER	.4
Normal Hold Working Days	68 Days
Neck Opening	5”
OAH	24.5”
Empty Weight	45 Lbs.
Full Weight	105 Lbs.

For copies of past Tech Tips or for more information on maintaining your nitrogen storage dewars please contact Jim Bachman at (952) 882-5168, Pager (612) 579-8367, Fax (952) 882-5175.