Rec 10/3/14

24

MTSU Clean Energy Initiative Project Funding Request

There are five (5) sections of the request to complete before submitting. See http://www.mtsu.edu/sga/cleanenergy.shtml for funding guidelines. Save completed form and email to cee@mtsu.edu or mail to MTSU Box 57.

1. General Information	
Name of Person Submitting Request **Dr. Keying Ding and Ngee Sing Chong**	
Department/Office **Chemistry/SCI 3024; SCI 3067**	Phone # (Office) **898-2475; 898-5487**
MTSU Box # **Box 68, MTSU**	Phone # (Cell) **612-961-4048; 615-556-5509**
E-mail **Keying.Ding@mtsu.edu**; **nchong@mtsu.edu**	Submittal Date **10/3/2014**

2. Project Categories (Select One)			
Select the category that best describes the project.			
	Energy Conservation/Efficiency	**X**	Sustainable Design
	Alternative Fuels		Other
	Renewable Energy		

3. Project Information

a. Please provide a brief descriptive title for the project.
b. The project cost estimate is the expected cost of the project to be considered by the committee for approval, which may differ from the total project cost in the case of matching funding opportunities. **Any funding request is a 'not-to-exceed' amount. Any proposed expenditure above the requested amount will require a resubmission.**
c. List the source of project cost estimates.
d. Provide a brief explanation in response to question regarding previous funding.

3a. Project Title **Replacing the Use of Helium and Hydrogen Cylinders in the New Science Building with Hydrogen Generated via Electrolysis**

3b. Project Cost Estimate **Total Amount Requested $15,116.30**

Hydrogen Generator Model H2PEMPD-510-100; Flowrate: 500mL/min **$15,116.30**
Including dessicant cartridge

3c. Source of Estimate

Restek price quote and website list price (http://www.fishersci.com/)

3d. If previous funding from this source was awarded, explain how this request differs?

The previous funding (Fall 2013) was for the purchase of a hydrogen gas generator to replace the non-renewable helium used in the operation of gas chromatographs in Chemistry GC Lab. The generator has been moved from the Davis Science Building and is now installed in the new Science Building and help reduce the amount of expensive helium cylinders purchased in the chemistry department. We would like to request a second hydrogen generator to duplicate the success of the first one in reducing the use of non-renewable helium, lowering the cost of laboratory gas supply, and avoiding the need to transport the high pressure (2600 pounds per square inch) cylinders that require many safety precautions. The requested generator will be placed in a research lab to serve at least 3 research groups and the needs of about 40 students over a period of 7-10 years.

4. Project Description

(Completed in as much detail as possible.)

a. The scope of the work to be accomplished is a detailed description of project activities.
b. The benefit statement describes the advantages of the project as relates to the selected project category.
c. The location of the project includes the name of the building, department, and/or specific location of where the project will be conducted on campus.
d. List any departments you anticipate to be involved. Were any departments consulted in preparation of this request? Who? A listing may be attached to this form when submitted.
e. Provide specific information on anticipated student involvement or benefit.
f. Provide information for anticipated future operating and/or maintenance requirements occurring as a result of the proposed project.
g. Provide any additional comments or information that may be pertinent to approval of the project funding request.

4a. Scope: Work to be accomplished

MTSU Chemistry currently uses helium gas to operate gas chromatography (GC) instrumentation in the laboratory in the Science Building. The annual usage of helium is about $18,000 in the 2013-14 academic year. The price of one helium cylinder is over $400 now after the most recent price increase. Due to the rapidly rising cost of helium, a non-renewable resource, many laboratories in industries and universities have switched to the use of hydrogen gas for operating their GC instrumentation. In order to both eliminate the cost of helium and achieve the sustainable design of using the electrolysis for generating hydrogen that can be used for GC instrumentation, this proposal aims to purchase a hydrogen gas generator to meet all our GC needs at MTSU. The use of hydrogen gas for GC has been well documented for its technical soundness, operational safety, and is considered environmental friendly because it avoids the use of the dwindling supply of helium which also require energy for processing it into a high purity gas stored in high pressure cylinders (Reference 1).

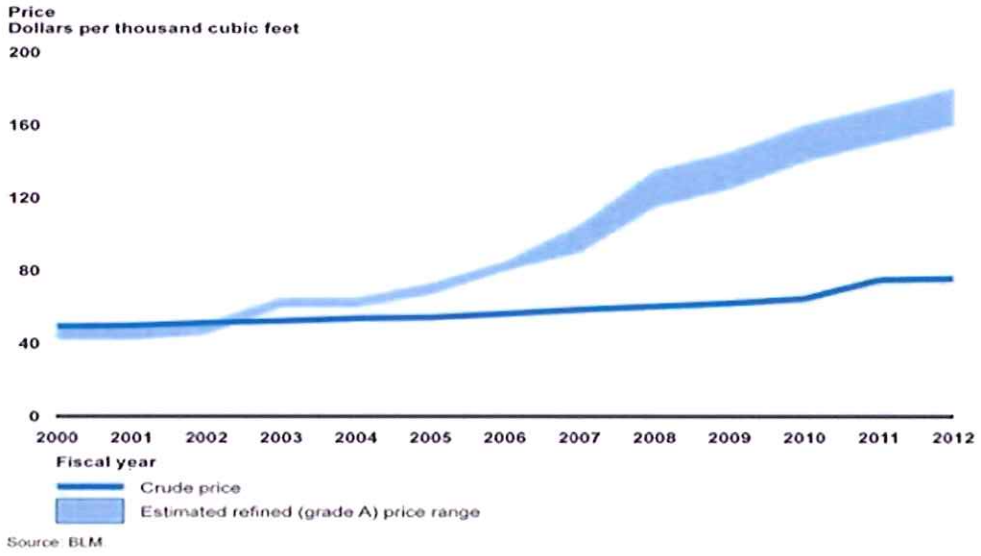
In addition to providing the high purity gas for operating GCs, the requested hydrogen generator will provide the gas needed for hydrogenation, which is one of the most common experiments to prepare saturated chemicals (Reference 2). In Ding research group, one of the ongoing projects is focused on the hydrogenation of carbon dioxide to make valuable chemicals by non-precious metal catalysts, which is a green and environment and energy benign reaction. The hydrogenation reactions can be performed in batch reactors or continuous flow systems. The hydrogen gas used in this

transformation is traditionally from H_2 gas cylinder. The hydrogen generator in this proposal is a promising substitute for the hydrogen gas cylinder due to higher gas purity (> 99.9999%) and better safety features since the highly reactive and explosive gas is generated on an "as-needed" basis as opposed to 2600 psi of hydrogen that may leak out if the gas regulator is damaged or the cylinder fell down accidentally. As a result, Dr. Ding is very interested in integrating the hydrogen generator into her research project at SCI 3021. This hydrogen generator will be set up for GC use in SCI 3070 and for other hydrogenation projects performed in synthetic research labs SCI 3021 and 3007.

4b. Scope: Benefit Statement

The primary benefit of this project is to reduce operating expenses for GC used in MTSU Chemistry Department. Additional benefits include environmental sustainability (i.e. helium is a non-renewable chemical resource), operational simplicity since it is no longer necessary to order, move, and change helium cylinders every 1-2 weeks, improved safety by eliminating the need to store and transport pressurized helium cylinders. The benefit of reduction in GC gas expense is obvious because the price of high purity helium has increased 450% since the year 2000 as shown in the following figure. It is estimated that for a hydrogen gas generator with a capacity of 500 mL/min, the savings at the end of the 5th year is about $29,226 (Reference 3). Most generators have a useful lifetime of 7-10 years and can be expected to yield greater cost savings.

Figure 2: BLM Crude Helium Price and Refined (Grade A) Price Estimates, Fiscal Years 2000 through 2012



Source: BLM

4. Project Description (continued)

4c. Location of Project (Building, etc.)

MTSU Department of Chemistry (Science Building Room 3070, 3021, and 3007)

4d. Participants and Roles

Keying Ding – Overseeing the use of the generator for hydrogenation experiments in the laboratory and arranging for the use of the generator by faculty and students for analytical and synthesis applications.

Ngee Sing Chong – Estimating the usage requirements of each GC in Instrumentation Laboratory, purchasing the hydrogen gas generator, and replacing the dessicant cartridges as needed; evaluating cost efficiency by switching from gas cylinders to the hydrogen generator.

Jessie Weatherly – Installation and maintenance of the new hydrogen gas generator.

Other Chemistry Faculty and Students – Use the generators and report usage duration to track the volume of hydrogen used and thus the cost savings by eliminating helium use.

4e. Student participation and/or student benefit

The continuous supply of hydrogen by the generator would allow uninterrupted use of the GC, thereby facilitating instructional and research use of the GC instrumentation. It also reduces the need to have students move heavy pressurized helium or hydrogen cylinders to the GC and to improve safety by eliminating the need to handle high pressure gas cylinders. The cost savings that can be achieved via the use of generator may also help keep the student lab fees at a constant level. The use of hydrogen generator will also provide a less obvious benefit of facilitating lab research among female students who may be discouraged by the thought of having to deal of moving very heavy gas cylinders in the laboratory.

4f. Future Operating and/or Maintenance Requirements

Jessie Weatherly in the Department of Chemistry is in charge of maintenance for all lab equipment including the GC and the proposed hydrogen generator. The replacement of the dessicant cartridge is typically once every 0.5-1 year and the cartridge cost of $349.50 is minimal and can be paid through the savings in gas expenditure. The generator can also be moved to the new science building without the need to hire the vendor engineers.

4g. Additional Comments or Information Pertinent to the Proposed Project

1. **Hydrogen: A Carrier Gas Alternative to Helium**
   http://www.sigmaaldrich.com/technical-documents/articles/reporter-us/hydrogen-a-carrier.html

2. **Generation of Hydrogen Via an In-House Hydrogen**
   http://www.rdmag.com/articles/2008/04/generation-hydrogen-house-hydrogen-generator

3. **Gas Supply for Gas Chromatography: How to Compare the Costs of Cylinders and Generator**
   http://www.sigmaaldrich.com/etc/medialib/docs/Supelco/Bulletin/4545.Par.0001.File.tmp/4545.pdf

5. Project Performance Information

Provide information if applicable.

a. Provide information on estimated annual energy savings stated in units such as kW, kWh, Btu, gallons, etc.
b. Provide information on estimated annual energy cost savings in monetary terms.
c. Provide information on any annual operating or other cost savings in monetary terms. Be specific.
d. Provide information about any matching or supplementary funding opportunities that are available. Identify all sources and explain.

5a. Estimated Annual Energy Savings (Estimated in kW, kWh, Btu, etc.)

Not Applicable. This proposal is about the sustainable design of replacing helium with hydrogen generated by electrolysis.

5b. Annual Energy COST Savings ($)

It is not possible to determine energy cost savings due to the various methods of extracting and purifying helium.

5c. Annual Operating or Other Cost Savings. Specify. ($)

Detailed operating cost savings has been calculated for a different brand of hydrogen gas generators using helium cost information from several years ago. The price then was $171 per helium cylinder and MTSU Chemistry Department is paying $360.22 per cylinder now.

0.5 liters/minute (x 1/1000m³/liter x 60 min/hr x 24 hr/day x 365 days/year = 262.8m³/year or 9,280.6ft³/year)

Packard Model 9400 Hydrogen Generator, 500cc/minute

Time	Item	Cost ($)	Cumulative Total ($)
1st year	generator	7,595	
	desiccant cartridge	150	7,745
2nd year	desiccant cartridge	150	
	deionizer pk.	66	7,961
3rd year	desiccant cartridge	150	
	deionizer pk.	66	8,177
4th year	desiccant cartridge	150	
	deionizer pk.	66	8,393
5th year	desiccant cartridge	150	
	deionizer pk.	66	8,609

Hydrogen generator versus hydrogen cylinders:
savings after 5 years: $9,517

Cylinders[1]

Item	Cost ($) Hydrogen	Helium	You
Cylinders/year (N)	(47)	(43)	
Price/cylinder	$ 70	$ 171	
Cost of gas/year	3,315	7,280	
Cylinder rental/year ($4.87 xN)	231	207	
Regulator (1st year only)	350	350	
Cylinder fasteners (1st year only)	50	50	
1st year costs	3,945	7,887	
2 year costs (cumulative)	7,490	15,374	
3 year costs (cumulative)	11,035	22,861	
4 year costs (cumulative)	14,580	30,348	
5 year costs (cumulative)	18,126	37,835	

Hydrogen generator versus helium cylinders:
savings after 5 years: $29,226

5d.Matching or Supplementary Funding (Identify and Explain)

Department of Chemistry will pay for the consumable cost of the dessicant cartridges needed for the hydrogen generator. The recovered funds (~$1500) from the indirect cost charged to an EPA project may be used to offset the cost of purchasing or maintaining the hydrogen gas generator.

RESTEK
110 Benner Circle
Bellefonte, Pa 16823
(814) 353-1300
(800) 356-1688
fax: (814) 353-1309
www.restek.com

To ensure correct pricing, please reference

Sales Quote #: Q42966

Cust Ref Chg #	Quote Date	Date Expired	Page
	11-11-13	02-09-14	1

Bill To Address
18055 MTSU PO Box X067 Murfreesboro, TN 37130 United States

Ship To Address
18055*1 MTSU Davis Sci Bldg Rm 231 1500 Greenland Dr Murfreesboro, TN 37132 United States

Sales Rep	Cindy Ross	Freight Terms	Prepaid & Add
Quote Originator	Lauren Brooks	Ship Via	UPS NEXT DAY AIR

Item Number	Description	Current* Lead Time	Quote Qty	Sell UM	List Price	Unit Price	Dsc %	Extended Price
22144	Generator, Hydrogen PEMPD Model, H2PEMPD-510-100 510 cc/min generating capacity Warranty: 1yr on system and 3yrs on cell life. Domestic orders drop shipped from manufacturer. Ships via UPS only. Must ship UPS Red during winter months.	50	1	EA	14831.00	13347.90	10	13347.90
23069	Desiccant Cartridge Replacement, for H2 PEM Generators	0	1	EA	179.00	161.10	10	161.10
23070	6 Month Maintenance Kit for H2 PEM Generators, Kit Includes: 1 Deionizer Cartridge, 1 Water Filter, 3 Environmental Filters	14	1	EA	220.00	198.00	10	198.00
23071	24 Month Maintenance Kit for H2 PEM Generators, Includes: 1 Deionizer Cartridge, 1 Water	14	1	EA	1077.00	969.30	10	969.30

*** Delivery dates relative to quote acceptance date**
Current Lead Time is in Calendar Day(s)

Total	

Ord By : Ngee Chong Phone #: 6158985487 Fax # :

RESTEK
110 Benner Circle
Bellefonte, Pa 16823
(814) 353-1300
(800) 356-1688
fax: (814) 353-1309
www.restek.com

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Sales Quote #: Q42966

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Sales Rep	Cindy Ross	Freight Terms	Prepaid & Add
Quote Originator	Lauren Brooks	Ship Via	UPS NEXT DAY AIR

Item Number	Description	Current* Lead Time	Quote Qty	Sell UM	List Price	Unit Price	Dsc %	Extended Price
	Filter, 3 Environmental Filters,1 Float (water level sensor),1 Water Pump,1 Desiccant Cartridge, Domestic orders drop ship from manufacturer via UPS							
	Additional Charges Freight Charges							440.00

Freight Charges are estimated for this order.
Please note the Generator ships from our vendor and the maintenence kit ships from Restek.

*** Freight Charges Are Pre-Paid and Added Unless Otherwise Noted. ***

Total	$15,116.30

*** Delivery dates relative to quote acceptance date**
Current Lead Time is in Calendar Day(s)

Ord By : Ngee Chong Phone #: 6158985487 Fax # :