

REQUIRED COVER PAGE

APPLICATION FOR FACULTY RESEARCH GRANT

**All questions must be completed to be considered for grant award.

Choose one: <input type="checkbox"/> Creative <input checked="" type="checkbox"/> Research	Date of Last FRG Award (Semester and Year awarded): <u>none</u> Date of ATU Faculty Appointment (Semester and Year): <u>Fall, 1991</u>
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1. Project Title: Engine Test Facility for ATU Biodiesel Fuel
2. Name of Principal Investigator/Project Director: John L. Krohn - PI, Gill Richards - Co-PI
3. School (abbrev): SS 4. Department: Mechanical Engineering
5. Campus Mail Address: CES 104 6. PI/PD Campus Phone: 0259
7. Amount Requested: \$ 2,000 8. Total Cost of Project: \$ 5,500
9. Does this project involve: 10. Duration of Project: 12 months

Yes No

- ☐ ☒ human subjects?
☐ ☒ animals/animal care facility?
☐ ☒ radioactive materials?
☐ ☒ hazardous materials?
☐ ☒ biological agents or toxins restricted by the USA Patriot Act?
☐ ☒ copyright or patent potential?
☐ ☒ utilization of space **not** currently available to the PI/PD?
☐ ☒ the purchase of equipment/instrumentation/software currently **available** to the PI/PD?

NOTE: If the answer is "yes" to any of the above questions, the investigator must attach appropriate documentation of approval or justification for use/purchase.

SIGNATURES

Department Contribution (if applicable): \$ 2,000

Account Number: 217220-5000

John L. Krohn 10/15/04
Chairperson Date

School Contribution (if applicable): \$ _____

Account Number: _____

Dean Date

This Section to be completed by the Office of Academic Affairs

FSBA Committee Award Recommendation: Yes _____ No _____
FSBA Committee Proposal Rank: _____ of _____ Total Proposals.
Recommendation of VPAA: Yes _____ No _____
Recommendation of President: Yes _____ No _____
Award Date: _____

Engine Test Facility for ATU Biodiesel Fuel

Abstract

The purpose of this project is to construct an engine test lab in which to test engine performance of a small diesel engine when powered by biodiesel fuel produced by the ATU Chemistry department. The initial effort involved will be in the design and construction of the testing lab. At the present time, a number of alternative designs are being pursued through an undergraduate research project funded by the Arkansas Center for Energy, Natural Resources, and Environmental Studies (ACENRES). Once the lab equipment is procured and installed, the lab will be used to perform standard engine performance tests on biodiesel fuel obtained from Dr. Bob Allen's laboratory. In addition to tests on pure biodiesel fuel, it is proposed to perform the same testing on various mixtures of biodiesel and standard (petroleum derived) diesel fuel. The project aims to provide information on two areas in which minimal previous work has been done. Firstly, to document the performance of an engine operating on biodiesel produced from used cooking oil, and, secondly, to study any variance in performance as the ratio of biodiesel to standard diesel is varied in a blended fuel.

Purpose and Objectives

The objectives of this project can be stated as three primary objective statements:

1. To assemble a diesel engine testing facility that will allow for standard engine performance tests (engine efficiency, power and torque production, other operating characteristics and simple estimates of emissions) to be carried out.
2. To perform a testing program on biodiesel fuel derived from used cooking oil produced by the ATU Chemistry department and compare results to those published for biodiesel produced from virgin (unused) vegetable/seed oils.
3. To perform a testing program of mixtures of biodiesel fuel and standard (petroleum derived) diesel fuel in various ratios to determine if there are significant differences in engine performance with mixture ratio and, if so, to determine an optimum mixture ratio.

Significance/Need

The production and use of biodiesel fuels is a topic of high interest in today's society. This interest is reflected in the recent passage of a tax incentive for the use of biodiesel and biodiesel blended fuels. The ATU Chemistry Department, and, specifically, Dr. Bob Allen has been producing small quantities of biodiesel from used cooking oil for several months. Dr. Allen is currently in the process of studying the chemical characteristics of this fuel. The use of used cooking oil as a biodiesel feedstock is not new. However, a search of the National Biodiesel Board's (www.biodiesel.org)

website database of papers revealed only one paper in which used cooking oil was considered as a feedstock for production of biodiesel fuel. That single paper was from Ireland and was written in 1994 and focused on the potential for this feedstock. There was very little regarding any actual production and results.

Thus, it appears from at least a preliminary literature search that, although the use of used oil as a feedstock is not a new concept, the focus in the research and development area has been on other sources of feedstock (soybean and oil seed oils, tallow, and algae are the sources noted most often). The utilization of used cooking oil as a feedstock for biodiesel is attractive due to its cost and the fact that this would provide a means of disposing of the used product without additional burden on sewage or other systems. The characterization of biodiesel produced from this source, both from a chemical approach and from the performance measures proposed here, would be extremely important in gaining acceptance for the fuel.

Process for Attainment of Objectives

The objectives of this proposal will be met through the procurement of suitable equipment and the development of a test protocol based on that equipment that measures engine performance and operating characteristics when using the experimental fuel.

The tests that can be performed and the protocol used to measure various characteristics will depend upon the equipment ultimately procured. Due to the large variances in price, space and safety requirements, the equipment to be procured has not yet been identified. To a large extent, the equipment that is used will ultimately depend upon the success of this and other funding requests. The budget included as part of this proposal has been established assuming a rather modest engine dynamometer lab. This would most likely include a small (5-10 hp) engine with an electrical generator and resistance loading. If the opportunity for securing larger funding levels (on the order of \$70,000-\$100,000), we would propose a multi-cylinder (stock) automobile engine and associated dynamometer which would, for safety reasons, be located in a small enclosure (that currently does not exist).

Regardless of the equipment that is ultimately obtained, we propose to conduct tests to measure and compare at least the following operating characteristics while operating with both biodiesel and standard diesel fuel (and, possibly, mixtures thereof):

- Engine power at constant rpm
- Fuel economy at constant load
- Engine torque at constant rpm
- Operating temperature

In addition, subject to capabilities and the accuracy of "grab" samples, we propose to measure the following emissions:

- CO
- CO₂

NO_x
SO₂
Unburned hydrocarbons
Particulates

Guidance in establishing the particular tests and methods will be gained from following where possible American Society for Testing and Materials standard practices.

Again, the particular method of measuring each of the above operating characteristics will depend on a large part on the equipment used and the equipment that is used will ultimately depend on the levels of funding obtained in support of this project.

Dissemination of Results

There are various avenues available for dissemination of the results of this research project. The project has already receive an Undergraduate Research grant and the students involved will make a presentation at the ATU Undergraduate Research Symposium in the spring of 2005. The PI and co-PI are members of a number of professional societies (ASME, IEEE, ASEE among others) which present a number of opportunities for paper submissions and presentations. In addition, the above mentioned National Biodiesel Board has a large database of papers related to biodiesel and holds annual conferences giving another opportunity for paper submission.

Budget

The budget presented here is, as noted earlier, based on a rather modest funding level as can be foreseen at this time from within ATU (Undergraduate Research Grant, Faculty Research Grant, School Capital fund, departmental equipment funds). We plan to pursue other possible funding sources and, if successful, the overall budget may increase substantially (at minimal, if any, additional costs to ATU). All funds requested in this proposal are for equipment. No travel, faculty salaries, student labor or other support are requested from this grant.

Expenses

1.	Diesel engine	\$ 2,000
2.	Generator/dynamometer	2,000
3.	Fuel injector controller	360
4.	Engine test stand	300
5.	Piping/etc.	200
6.	Electrical/controls	250
7.	Emissions testing	350
8.	Connectors, etc.	<u>40</u>
Total		\$ 5,500

Source of Funds

Undergraduate Research Grant	\$ 1,000
Faculty Research Grant	2,000
Departmental equipment	<u>2,500</u>

Total	\$ 5,500
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It is anticipated that the PI and co-PI will both devote 10-15% of their time to this project through the Fall and Spring semesters. The PI will devote 25-30% of his time to this project during the 2005 summer sessions.

John L. Krohn

Academic Rank	Associate Professor and Head of Mechanical Engineering Full-time, tenured.
Degrees	Ph.D. Nuclear Engineering - Texas A&M University, 1992 M. S. Mechanical Engineering - University of Arkansas, 1983 B. S. Mechanical Engineering - University of Arkansas, 1981
Years on Faculty	Associate Professor and Department Head of Mechanical Engineering, Arkansas Tech University, July 1996 to Present. Director, TECH Honors Program, Arkansas Tech University, May 1996 to September 1997. Original appointment as Assistant Professor of Engineering, Arkansas Tech University, August 1991.
Other Experience	1987-1991: Texas A&M Nuclear Science Center Assistant Director. Duties: Assisted in management of NSC and auditing compliance with regulations; responsible for preparation of safety analysis reports for experiments and facility modifications. 1986-1987: Texas A&M Nuclear Science Center Manager, Reactor Operations. Duties: Responsible for overseeing day-to-day operations of 1MW reactor including compliance with NRC regulations, training and requalification programs and emergency plan. 1984-1991: Texas A&M Nuclear Science Center Manager, Technical Services. Duties: Providing technical assistance to experimenters, providing technical assistance to reactor facility staff regarding neutron spectrum measurement, experiment design, oversight of student workers and engineers in Technical Services group, managing neutron activation lab, radioassay program, radioisotope production program, and facility's computer system including programming efforts. 1981-1983: Mechanical Engineering Dept. , University of Arkansas Graduate Teaching Assistant. Duties: Primary responsibility for "Basic Nuclear Engineering" with secondary responsibility in various labs.
Consulting	1988-1991: A.A.E./B.C.S. Traders, Inc., Globe, AZ Radiation Safety Officer. Duties: Served as responsible charge for Texas radioactive material license of company handling radioactivated minerals. Duties included record keeping, surveying, sorting and shipping of radioactive materials.
Registration	Registered Professional Engineer, State of Arkansas.

Publications

“Energy and the Environment: An Energy Education Course for High School Teachers”, with S. Apple, ASEE Annual Conference, Nashville, TN, June 2003.

“Dwell Time Effects on Fatigue Life and Damage Mechanisms”, T. Goswami, J. Krohn and H. Hanninen, Future Mechanics Beyond 2000, Proceedings of 14th Biennial Conference on Fracture – ECF14, Cracow, Poland, Sept. 2002, Vol. I, pp. 615.

“Energy and the Environment: An Energy Education Course for High School Teachers”, with S. Apple, ASEE Midwest Section, Manhattan, Kansas, April 2001.

Societies

American Nuclear Society
American Society for Engineering Education
National Society of Professional Engineers
Arkansas Society of Professional Engineers
American Society of Mechanical Engineers

Awards

Tau Beta Pi
Pi Tau Sigma
Oxford Scholar, College of Engineering, University of Arkansas

Professional Service

Ex-officio member of Honors Council
President’s appointee to Faculty Athletics Committee
Member of Academic Review Committee for Math Program
Secretary – Arkansas ASME

Professional Development

ASEE Annual Conference, 2000, 2001, 2003
ASEE Midwest Section Meeting, 1995, 1999
ABET Annual Meeting, 1996, 1999
ASME/ABET Workshops, 1998, 1999
Foundation Engineering Coalition Summer Curriculum Workshop, 1998
ASME Region X RAC/RSC, 2003

Gill G. Richards

Academic Rank	Associate Professor of Electrical Engineering
Degrees	Ph.D., Electrical Engineering, University of Southern California, 1974. MS, Electrical Engineering, Stanford University, 1970. BS, Electrical Engineering, Swarthmore College, 1964.
Years on Faculty	Associate Professor, Arkansas Tech University, Fall 2000 to present Department Head, 2001 to present
Other Experience	University of New Orleans Department of Electrical Engineering Professor 1989-2000 Director, Center for the Industrial Application of Electric Power and Instrumentation (CIPI) 1992-98 Department Chairman 1989- 1992 Louisiana State University Department of Electrical Engineering Associate Professor 1982-89 Associate Dean of the Graduate School 1984-86 Assistant Professor 1976-82 University of Southern California Department of Electrical Engineering Teaching Assistant 1970-74 Rand Corporation Santa Monica, California Research Consultant, 1972 U.S. Navy (LTJG) 1966-1969 Hewlett-Packard Co. Palo Alto, California Associate Engineer 1965-66
Publications	<i>"Guidelines for Limiting Electromagnetic Reclosure torque Transients on Induction Machines with Two Rotor Circuits"</i> , Richards, G., Proceedings, North American Power Symposium 2001, October 21-22, 2001, College Station, Texas Richards, G.G., <i>"Estimating Induction Motor Shaft Stress Transients</i>

Under Shaft Resonant and De-Tuned Conditions", Electric Power Systems Research, Vol 44, No.2 (1999)

"Evaluating Distribution Transformer Capacity Reduction Due to Load Harmonics" Richards, G. 2nd Biannual Conference on Electric Simulation, Dar es Salaam, Tanzania, September 4-6, 1999

Richards, G.G., and Laughton, M.A., *"Limiting Induction Motor Shaft Torques Following Source Discontinuities"*, IEEE Transactions on Energy Conversion, Vol. 13, No. 3, September 1998, pp 250-256

**Professional
Development**

Fulbright Fellow, Univ. of Dar es Salaam, Tanzania 1999-2000

Associate Editor, Electric Power Systems Research, 1991-1996



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November 5, 2004

Dr. John L. Krohn
Dept. Head/Assoc. Prof. of Mechanical Engineering
Arkansas Tech University
Center for Energy Studies, Room 104
Russellville, AR 72801

Dear Dr. Krohn:

Congratulations! Academic Affairs is pleased to announce your application for the Spring, 2005 Faculty Research Grant has been recommended by the Faculty Salary, Benefits, and Awards Committee. Based on this recommendation, Academic Affairs has approved the \$2,000 budget for your research of an engine test facility for ATU biodiesel fuel. Requisitions regarding the grant will be processed through your Dean's office and should be expended by June 30, 2004.

Your research on this project is sure to not only benefit your department, but Arkansas Tech University as a whole. We wish you success with this endeavor.

Sincerely,

Jack Hamm

Vice President for Academic Affairs

Copy: Dr. John Watson
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