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Microgravity Efforts in the Brazilian Universities - Space Shuttle Flight STS-95 and The VS-30 Brazilian Rocket Flight

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ABSTRACT. *The Microgravity Education Program - MEP, which is addressed in a companion paper in this congress, is one of many examples where students are provided with the opportunity to expand their horizon and learn more about space science. Instrumentation Technology Associates – ITA Inc., Exton, PA, United States, provides these opportunities as part of its outreach activities. Working in concert with the universities and other partners, ITA Inc. seeks through the MEP to substantially improve our understanding of natural process that microgravity can be taught as a scientific tool for a better understanding of many process phenomena.*

Key-Words: *Microgravity, Space Education, Education Program, Universities*

1. INTRODUCTION

Lots of activities in life have their own reward, like participating in education program. The present program which concern in microgravity education is designed to address the most fundamental questions involving student experiments and activities and research also.

The Agência Espacial Brasileira – AEB and others national non-space partners can grant financial and operational support to valuable microgravity experiments proposed by students and researchers. The support includes the utilization on the Shuttle flights via NASA and the Brazilian Sounding Rockets and its infrastructure.

The students of engineering, physics, material research, chemistry, biology, geology are given the chance to use microgravity as a tool for their research and to make a first contact with the fascinating field of space science and technology. As to scientific background of applicants, a successful completion of the basic course work is required at the Universities, high and elementary schools.

In the present work will be emphasized the utilization of the space by industry as a segment part of the MEP. The first experience in the STS-95 flight and VS-30 Rocket flight will be also discussed. Major areas of industrial research interest are related to automobile industry (combustion, materials), energy conversion (multi-phase flow), chemical and pharmaceutical industries (protein crystallography, zeolities, particle technologies) and environmental technologies (solar panel research and wind power stations).

2. GENERAL CONSIDERATIONS

For teachers, students and scientists the microgravity in space and by sub-orbital flights will turn on a special laboratory where weightlessness will allow a large variety of research and development of new materials and manufacturing processes.

Among others potential research areas of microgravity space science the following ones are possible:

- **Biotechnology** To learn more about the mechanisms of disease and how to combat them.
- **Materials Science** Without gravity's influence, the underlying mechanisms that occur during the gradual solidification of molten metal could be revealed.
- **Fundamental Physics** Based a power magnet device it can help search for particles of antimatter to gain clues about the evolution of the universe.
- **Fluid Physics** On Earth, lighter materials rise and heavier things settle. In microgravity, only atomic forces are at work. One application: understanding how soils "flow" during an earthquake, to help design safer buildings.
- **Combustion Science** Flame burns more cleanly in space. Researchers are looking for ways to burn fuels more efficiently.
- **Life Sciences** To study the lose bone and muscle mass in microgravity environment. Researchers will look for clues for how to help solve those difficulties, which may help aging people on Earth.

3. Space Shuttle Flight STS-95

According to the increasing importance that “life sciences” have in the worldwide scientific and technological development today, biotechnology offers a wide research field for many professionals including with no doubts, chemical engineers into this group. Biotechnological processes have grown in interest, due to the production of a large variety of proteins, enzymes, hormones, vaccines, and other bio-products which are important for pharmaceutical (human and animal health) and food industry, besides environmental control As an example the following description can show the experiments of the Brazilian universities on the STS-95.

3.1 FACULDADE DE ENGENHARIA INDUSTRIAL - FEI PERFORMS UNDERGRADUATION BIOTECHNOLOGY EXPERIEMENT ON SPACE

Due the growing interest on the formation of professionals prepared to work in this field, professors and students of the Chemical Engineering Department of FEI- Faculdade de Engenharia Industrial - S.B. Campo/Brazil – have been working on experiments and projects related to the industrial production and application of enzymes. At this level and counting on the cooperation of the “Núcleo de Atividades Espaciais Educativas” (NAEE) of the “Centro Técnico Aeroespacial/ Instituto de Aeronáutica e Espaço (CTA/IAE), São José dos Campos/ Brazil, experiments related to the olive oil hydrolysis by the enzyme lipase were executed under microgravity environment (reduced gravity), during the space shuttle flight STS-95.

This experiment intends to evaluate the efficiency ratio of lipase catalyzed reaction, using a soluble enzyme preparation, as well as, the enzyme immobilized into the surface of a solid carrier. The basis of the study is centered on the fact that diffusion/ mass transport, an important driving force in the catalysis, is dependent on gravity. Experiments were executed in modules developed by the American Company ITA – Instrumentation Technology Associates, Inc., to launched on NASA's Space Shuttle STS-95 in last October of 1998 and, on CTA/IAE's vehicle VS-30 in March 15 of 1999. As was expected, with these experiments in microgravity, important information was obtained and data for the modeling of the mass transport limitation in immobilized bio-catalysts was successfully understood. FEI's professors plan other experiments related to biotechnology to be done under microgravity, for the future.

3.2 UNIVAP - CONDUCT EXPERIMENT OF PLANARIANS REGENERATION IN MICROGRAVITY ENVIROMENT

During the year of 1998, it was registered an announcement of opportunities for the Brazilian participation in scientific experiments in microgravity environment. This will be the CIBX-1 mission of the American Space Shuttle STS-95, with its launching foreseen for Oct 29, 1998 and landing scheduled for Nov 7 of the same year in Cape Canaveral Base, Florida, United States. The CIBX-1 mission is under the responsibility of the Instrumentation Technology Associates Inc., from Exton, Pennsylvania, and also has the participation of the Brazilian Aerospacial Technical Center - CTA, through IAE/NAEE, with headquarters in São José dos Campos, São Paulo, Brazil.

Planarians are a class of mostly aquatic small, soft-bodied, leaf-shaped, completely ciliated flatworms (Platelmintes), non-parasitic of free life, that have the capacity to regenerate parts of their body, after amputation. There are planarians of several species: those that live in fresh water, others living in salt waters and even some that live in terrestrial environments. For this experiment, it was selected the species *Dugesia Trigina* from fresh water, a planarian with 1.5 cm of length.

The experiment strictly speaking is about the investigation of the regenerative process of this planarian in the microgravity environments. The scientists have interest to know if the microgravity accelerates or retards the regeneration process.

To complete this study, some planarians will have part of their body amputated. A complete transversal cutting will be done in part of their body and head, as well as in their eyes. It is known that the morphology of the planarian eyes could furnish important track about the philogyny. All the amputated animal will be photographed trough a special camera adapted on a magnifying glass. The photo documentation will be important, besides the registering, to do measurements about the animal dimensions, essential parameter to the regenerative phase accompaniment.

Two or three amputated exemplars will travel in the space shuttle arranged in a small recipient called LMA(Liquid Material Apparatus) provided by ITA Inc., having only fresh water. This recipient is produced by the Instrumentation Technology Associates Inc. - ITA, a company that is responsible for this enterprises.

The material will be collected from the space shuttle approximately about six hours after the landing. In addition, all of them will be also photographed and measured. These data will be used to compare the regenerative stage between animals that live in microgravity and the one in the ground. Since the flight has a duration foreseen for then days, it is expected that the regenerative process had not been completed in this period. This way, the spatial regenerative planarians pointed with their ground cousin will be back to Brazil, where their regeneration

process will be accompanied and registered, till the complete reconstitution of the analyzed animals. It is important to know if the variation in the regeneration rate will be maintained, if it exists, when the planarians return to the normal gravity environment.

Although others animals also presents regenerative cycles, planarians are perfect to this kind of experiment, they are small, and space is a critical condition in space flights, besides the fact that they could survive till two weeks without food, in an environment without light and oxygen.

3.3 USP - UNIVERSITY OF SÃO PAULO STUDY THE INFLUENCE OF MICROGRAVITY ON SUGAR CRYSTALLIZATION

The sucrose crystals obtained in microgravity will be compared with sucrose crystallized in the ground, in respect to their properties such as melting point, morphology, size, angle of crystal formation, rate of crystal growth among others.

The experiment in the space as well as in the ground will be performed in duplicates. In the top of DMDA(Dual Material Dispersion Apparatus) provided by ITA Inc., using the well type 2, the liquid 1 will be a magma sample (80μl), which contains a fixed number of sucrose crystals. The liquid 2 corresponding to a sample (120μl) of saturated sucrose solution will be placed in the bottom well. Them the liquid 1 will be mixed with liquid 2 and kept still i.e., without a slightest movement in order to allow a slow crystal growth. At the end of experiment the liquid in the top well as well as the liquid in the bottom well be collected for further examinations in the laboratory. If the above protocol is not feasible, the second option will be: a mixture of (40μl) of liquid 1 in the top well and (60μl) of the liquid 2 in the bottom well, also in duplicates. All the mixtures are expected to be recovered for studies.

The expected results are that a better quality of sucrose will be formed in microgravity than in the ground environment. Thus, it is expected that features of sucrose crystals from microgravity and those from the ground will be different. From the nutrition standpoint, to have an even physiological absorption of sucrose requires homogeneous sucrose crystals which is difficult to be produced under normal gravity field. Thus, the preparation of sucrose matrices in the space will be of great interest for industries, and consequently for further commercial applications.

4. The VS-30 Brazilian Rocket Flight

4.1 FEI PERFORMS EXPERIEMENTS SUB-ORBITAL FLIGHT

These experiences will be relative to the stability of the emulsion water/oil (the same used in Space Shuttle) using two tense active different bio-compatible: soy lecithin and AOT/dioctil sulfosuccinato of sodium. This experiment will be simpler than those with enzymes. In the module MDA/simples (Material Dispersion Apparatus) the emulsion will be thrown, that after the arrival of the module will be analyzed with relationship to its stability and variations in the pH. The ideal volume for this experience would be the capacity of 3 to 4 ml. In the case of the module DMDA would be interesting 10 to 15 vials of 250μl, for rehearsal with enzymes. In case you have difficulties in the control of the temperature of the useful load, we can accomplish just the experiments with the tense active, that they don't demand rigorous control of temperature and time.

4.2 USP - UNIVERSITY OF SÃO PAULO IMPROVE BIO-TECHNICAL PHARNACEUTIC TECHNOLOGY IN MICROGRAVITY SUB-ORBITAL FLIGHT

This present experimentation proposal is about the last stage of obtaining of a chemical substance with high action against bacteria. In this stage a reaction will be initiated (reaction of formation of Bases of Schiff) with immediate crystallization of the product. The accomplishment of this experiment in microgravity is justified in function of the need of obtaining of crystals of better quality to allow the availability of cristalografy studies, since under normal gravity (ground) the formation of these crystals gives him an amorphous way being, therefore, inadequate for crystallographic studies.

The reaction happens in a little strongly acid environment and the crystallization of the product happens immediately, that is to say, the measurement of the reagentes which is consumed by the reaction till the crystallization is also important. For this reason it is supposed that a time of four minutes under microgravity can be enough for the formation of crystals with the expected quality.

4.3 UNIVAP - CONDUCT EXPERIMENT OF PLANARIANS REGENERATION IN MICROGRAVITY ENVIROMENT VIA SUB-ORBITAL FLIGHT

For this experiment all will be similar as that one carried out in STS-95 Space Shuttle mission with the following size vial: 15 cm of length x 1,0 cm diameter. As before, the vial must be clean, that is, without any chemical product into it, which could kill the planarian. The number of vials should be as large as possible , in order to have some measurable average and/or if we lost some planarian, that is, just in case of some of them (planarian) die.

5. CONCLUSION

ITA's Inc. student space education program, successfully established and up and running for 7 years, is now at the point of its consolidation on international level with Brazilian schools and academic community. This step in the microgravity space education in Brazil has two main purposes: to give young people a unique real-life learning experience and to communicate the benefits of space.

Some of the experiments have gone beyond the initial goal of solely for educational purposes. They have, in fact, not only produced a better understanding of their initial objectives, but also opened a new motivation for the teachers and students in the space area activities. The Brazilian space program had for many years its conquers unaware by the Brazilian people. So, now is the time to put together the Brazilian space program facilities and the Brazilian schools and academic community to make use of the microgravity benefits.

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