4th International Workshop - Advances in Cleaner Production
São Paulo - Brazil - 22nd to 24th, May - 2013

ACS Chemistry for Life®

ACS Green Chemistry Institute®

ACS PRF

ACS Summer School in Green Chemistry and Sustainable Energy: fomenting awareness and creativity for innovative chemistry

Thaíla de Mello Florêncio – MSc Student PMPIT/ICTE/UFTM
Geoffroy Roger Pointer Malpass – Prof PhD DEQ/PMPIT/ICTE/UFTM

Instituto de Ciências Exatas e Tecnológicas;
Universidade Federal do Triângulo Mineiro,
Minas Gerais, Brazil

UFTM

Departamento de Engenharia Química

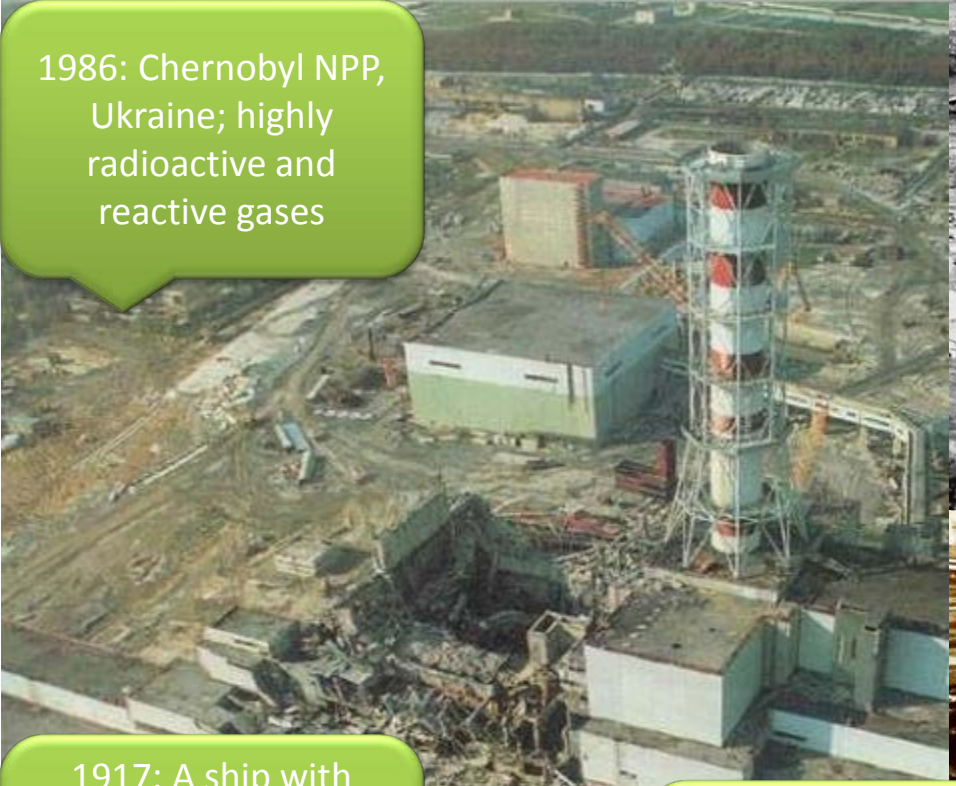
Programa de Mestrado em Inovação Tecnológica

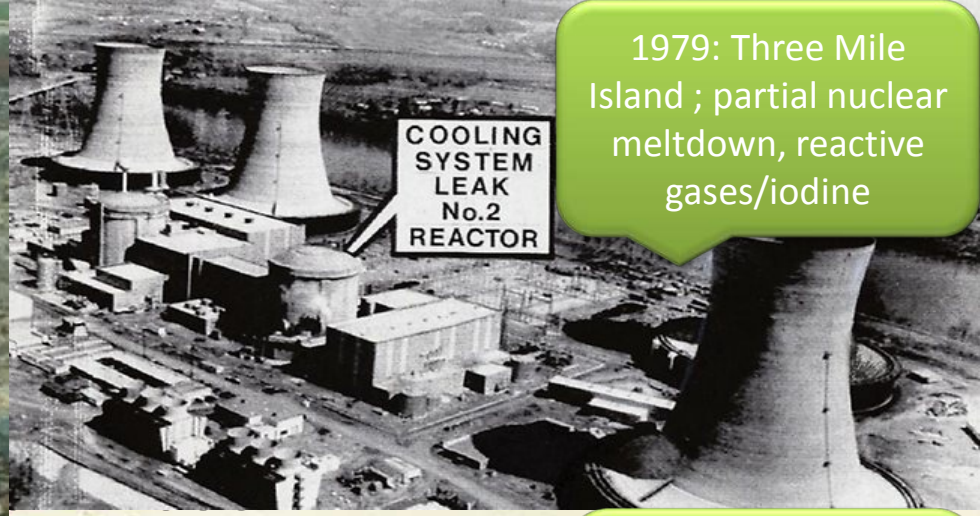
Academic Work

Introduction

- Negative view of chemical industry: accidents, environmental awareness,
- Responsibility: route of production, risks, hazards and exposure
- Ability to find environmentally friendly ways to synthesize a substance or to find less harmful, alternative substances.

1986: Chernobyl NPP, Ukraine; highly radioactive and reactive gases





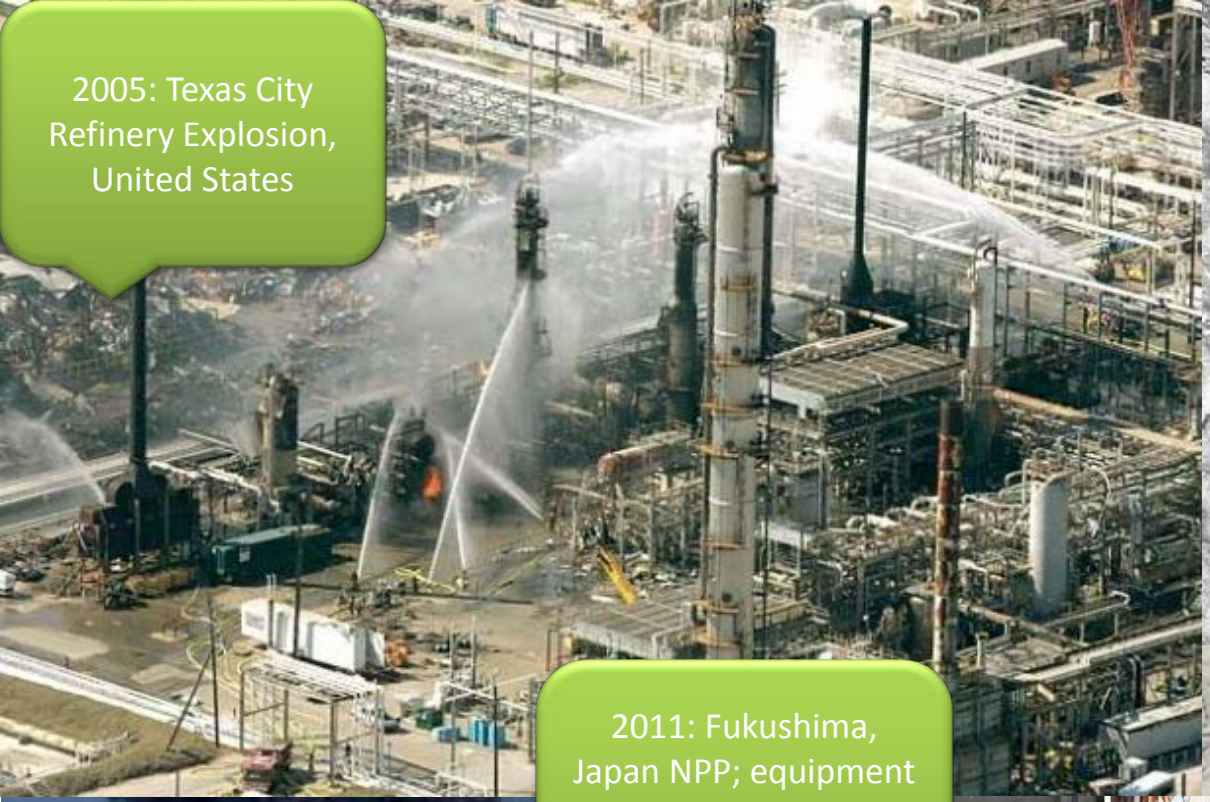
1979: Three Mile Island ; partial nuclear meltdown, reactive gases/iodine

1921: Oppau Exp. In Germany, BASF plant; Ammonium Nitrate and Ammonium Sulphate

1917: A ship with explosives is ignited in a collision in the Halifax harbor, Canada

1984: Lethal methyl isocyanate gas leaks. Pesticide plant in Bhopal, India

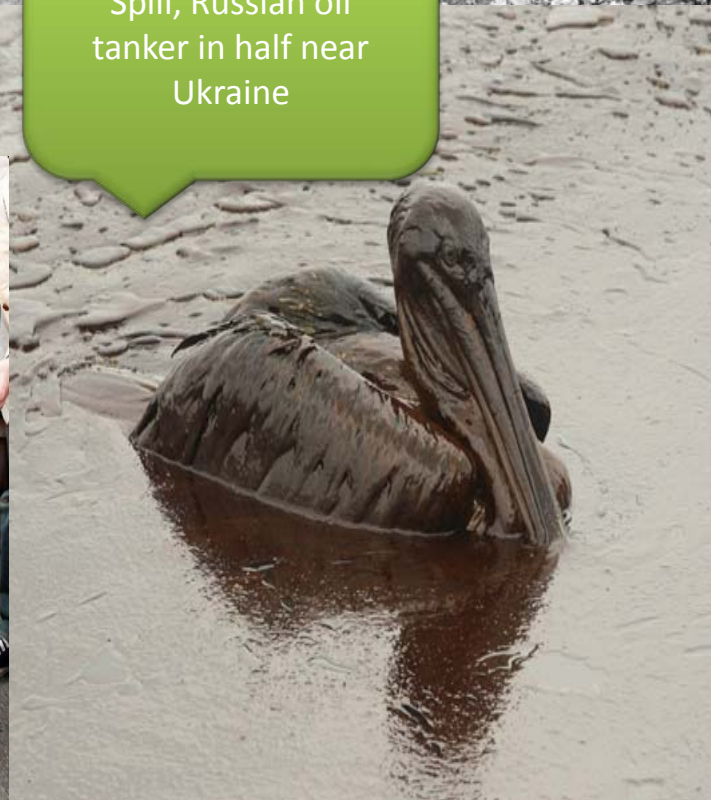
1956: Minamata, Japan; Mercury dumped in Minamata Bay – Minamata disease



2005: Texas City Refinery Explosion, United States

Bhopal, India

2011: Fukushima, Japan NPP; equipment failure, nuclear meltdown, release of radioactive materials



2007: Black Sea oil Spill, Russian oil tanker in half near Ukraine

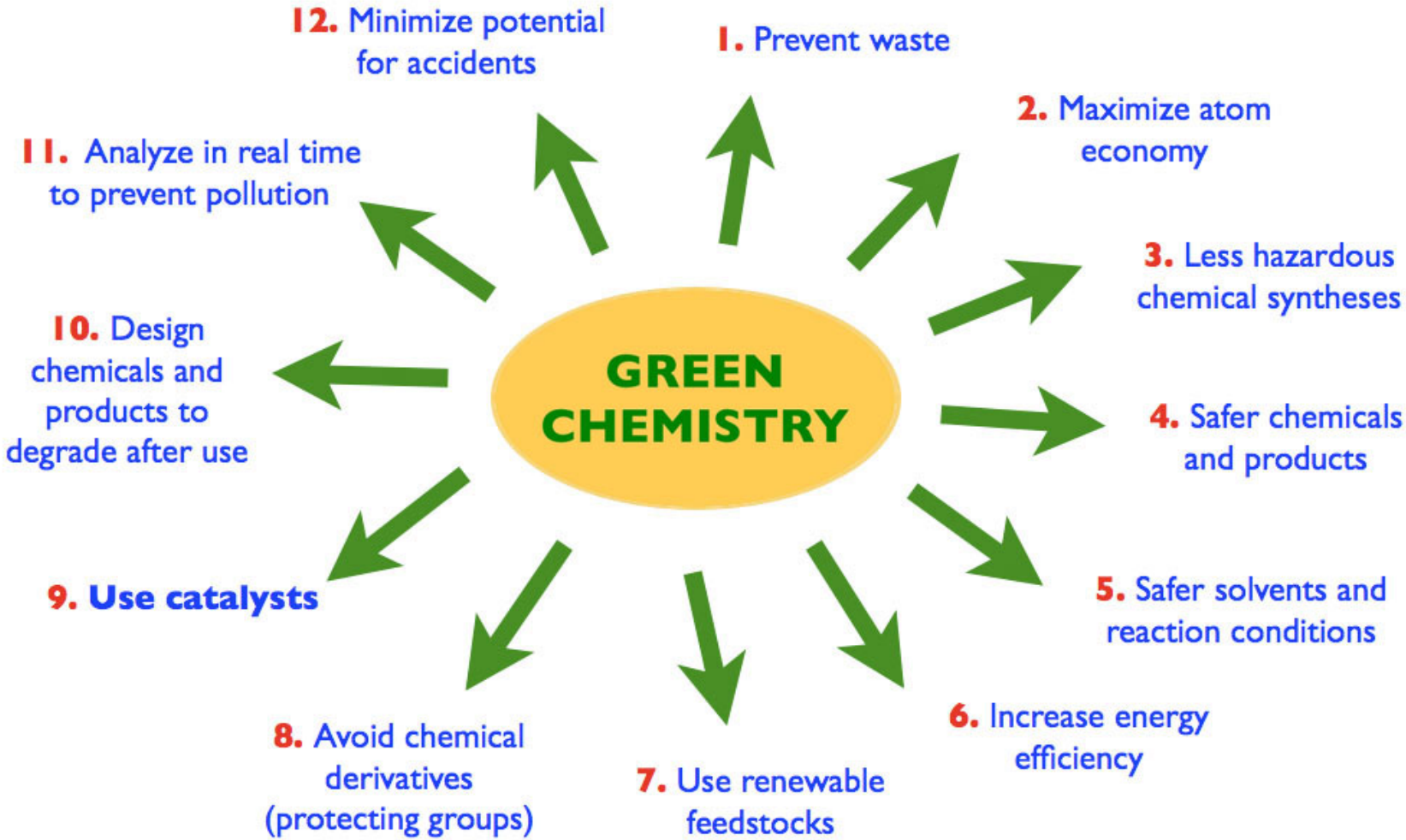
Burned Into History

The Cuyahoga River today and on February 20, 1936, one of several fires that burned on the river since 1868. (1936 photo courtesy of The Cleveland Public Library Photograph Collection)

1969, around 12pm, floating pieces of oil slicked debris were ignited on the river by sparks caused by a passing train.
River caught fire 13 times, since 1868!

- This idea can be summed up as Green Chemistry (GC) environmentally benign chemical synthesis, alternative synthetic pathways for pollution prevention that are benign by design (ANASTAS, WARNER, 1998).
- GC: 12 principles; reduce and/or eliminate hazardous substances, also optimization of efficiency and economy and practical considerations

12 Principles of Green Chemistry



Anastas and Warner (1998)

- Prevention

It is better to prevent waste than to treat or clean up waste after it has been created.

- Atom Economy

Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.

- Less Hazardous Chemical Syntheses

Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.

- Designing Safer Chemicals

Chemical products should be designed to affect their desired function while minimizing their toxicity.

- Safer Solvents and Auxiliaries

The use of auxiliary substances (e.g., solvents, separation agents, etc.) should be made unnecessary wherever possible and innocuous when used.

- Design for Energy Efficiency

Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.

- Use of Renewable Feedstocks

A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.

- Reduce Derivatives

Unnecessary derivatization (use of blocking groups, protection/ deprotection, temporary modification of physical/chemical processes) should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.

- Catalysis

Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.

- Design for Degradation

Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

- Real-time analysis for Pollution Prevention

Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.

- Inherently Safer Chemistry for Accident Prevention

Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.

- **What about GC in Brazil?**

- Recognizing this need and aiming to perform this task with excellence, the American Chemical Society, supported financially by their sponsors, meet the expectations of a great number of researchers and students, providing the "ACS Summer School on Green Chemistry & Sustainable Energy".

The ACS Summer School background information

- 2003: Pan-American Advanced Studies Institute (PASI) on Green Chemistry, held in Montevideo, Uruguay.
- 2004: Pittsburgh, PA, at Carnegie Mellon University, USA
- 2005: McGill University, Montréal, Québec, Canada.
- 2006: Headquarters of ACS, in Washington, DC, USA.
- 2007: PASI on Sustainability and Green Chemistry at Universidad Iberoamericana, Mexico City, Mexico.
- 2008-2010: ACS Summer School on Green Chemistry and Sustainable Energy at Colorado School of Mines (CSM), Golden, CO, USA
- 2011: McGill University, Montréal, Québec, Canada.
- 2012: CSM, Golden, CO, USA.

Sponsorship

- National Science Foundation – NSF (2003, 2007)
- Department of Energy – DOE (2003, 2007)
- American Chemical Society Petroleum Research Fund (2004, 2010, 2011, 2012)
- Exxon Mobil Foundation (2005, 2007)
- Johnson Family Foundation (2006)
- Argosy Foundation (2008)
- Ciba Foundation (2009)
- Colorado School of Mines (2008, 2009, 2010, 2012)
- New Belgium Brewery (2012)

Program Highlights and Benefits

- Leading researchers in GC and Sustainable Energy;
- Solving problems and participating in laboratory experiments;
- Research presentations: poster sessions;
- Engaging in discussions on the role of science and technology in solving global sustainability challenges;

- Providing transportation, housing and meals – no cost for participants;
- Interest on cultural and personal information background: i.e. diet restrictions (vegetarianism, etc);
- Encouraging interaction: athletic and

cultural activities.

Commitment

- Lectures available at ACS website (2009 – present)
- Academic and Industrial areas:

The professional is committed to scientific excellence, taking into account that such a state can only be achieved when economical, social, environmental and practical aspects are in harmony – a state that both sustainability and green chemistry focus on.

Fomenting discussions for a common purpose

- Each country has particular issues while dealing with their natural resources
- Discussion leads to interactive and creative solutions and/or improvements.
- Diversity of participants' formation and in research themes: deeper content as negative and positive points are confronted.

- This “brainstorm” induces new research ideas, motivates connections, modifies one’s thinking, and brings to light the problems faced by every community and how science can contribute to change this scenario.

How can I apply?

- Information is available on ACS website (http://portal.acs.org/greenchemistry).
  - Application form
  - Transcript of graduate courses
  - Letter of recommendation
  - Letter of Application
  - Résumé or *curriculum vitae*
- Submission of documents online.
- Graduate students and postdoctoral scholars studying in the Americas can apply. The application period starts in January/February. For more information or questions please contact gceducation@acs.org.

Acknowledgements

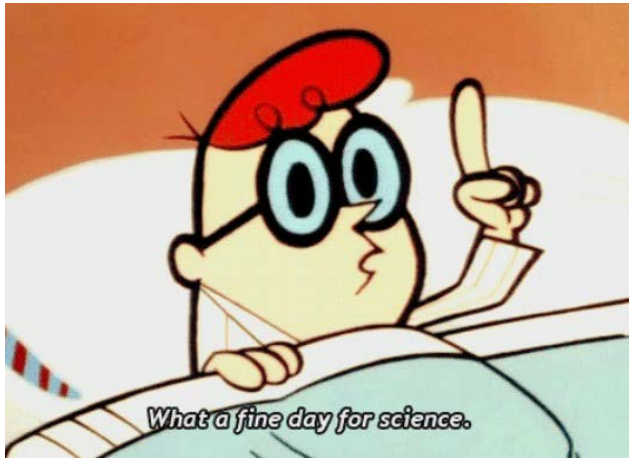
- Mary M. Kirchhoff for providing us with information;
- Tina Norris for her helpful assistance;
- Bob Peoples for collaborations;
- Colorado School of Mines;
- Supporters for making it happen, sponsoring both the event and all costs of the accepted students;
- FAPEMIG and CNPq.

References

- Anastas, P.T., Warner, J.C. 1998. Green Chemistry: Theory and Practice. Oxford University Press, New York.

- American Chemical Society. 2012. ACS Summer School on Green Chemistry and Sustainable Energy. http://portal.acs.org/ Last accessed November 2012.

Questions?



Thank you!

thailamello@gmail.com

geoffroy@icte.uftm.edu.br