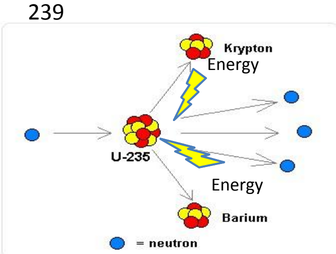
LAFAYETTE

Nuclear Power Fact Sheet

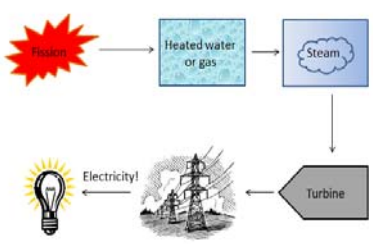
EGRS 352.01
Ivan Basurto

Overview

- Nuclear power provides almost 15 percent of the world's electricity
- Produce and control the release of energy from the splitting of atoms by fission (shown below)
- fissile atomic nucleus such as uranium-235 (^{235}U) or plutonium-239

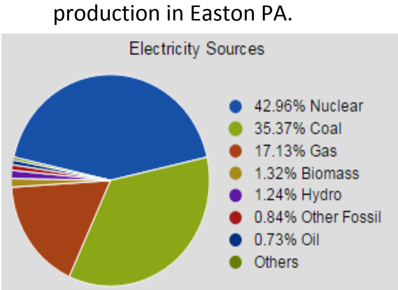


- Nuclear Power energy generation

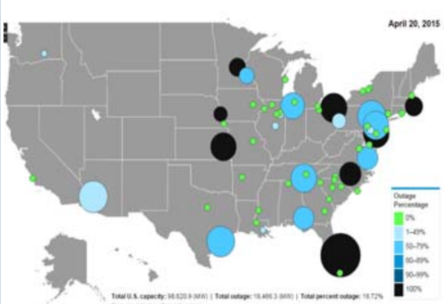


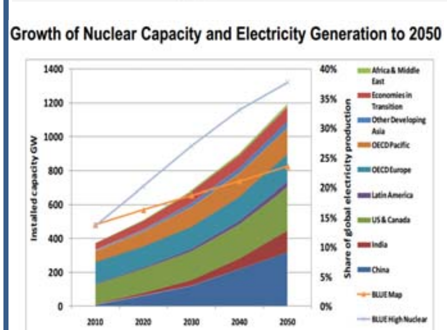
Current Use of Nuclear Power

- Breakdown of electricity production in Easton PA.



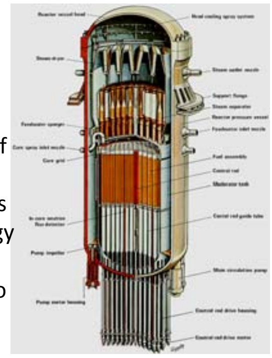
- Status of U.S. Nuclear energy outages



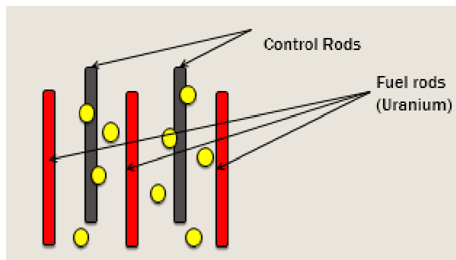


Traditional Reactor Design

- Fission is a run away reaction which produces a large amount of heat.
- Uses large amount of water for cooling.
- A kg of ^{235}U produces 3 million more energy than a kg of coal.
- Complications due to waste storage and disposal.



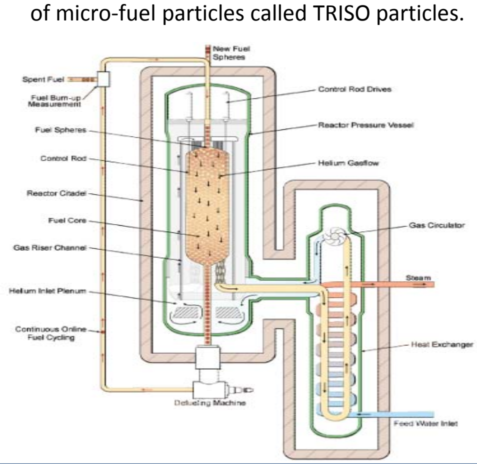
- Moderator: water, 'heavy' water, graphite
  - Slow down neutrons
  - Allows for sustained reaction



- Control Rods: rods composed of boron, silver, indium, or cadmium
  - Absorb neutrons,
  - Must be regularly replaced
- Resulted in a number of catastrophes
  - Three Mile Island 1979
  - Chernobyl 1986
  - Fukushima 2011
- Public opinion generally opposes nuclear power due nuclear meltdown
- Decline in nuclear use domestically and abroad

Design of Pebble Bed Reactors

- Energy production is governed by same principles as traditional reactor
- Pebbles contained in reactor
  - Circulate about 5 times a year
- Inert (helium, etc.) gas cooling
- Gas circulated through vessel
  - Heated gas runs a turbine
- Temperature controlled
- Pebbles are made of pyrolytic graphite(which acts as the moderator), and contain thousands of micro-fuel particles called TRISO particles.

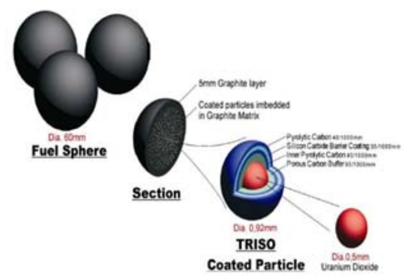


Criticisms

- Combustible graphite
  - If graphite of pebbles were to burn, fuel material could be released in smoke
- Lack of containment building
  - More vulnerable to outside attack
- Radioactive waste
  - Takes up larger volume in already limited storage areas
  - Radioactive dust from pebbles rubbing together

Pebble Design

- Figure of pebble and composition shown below. ^{235}U surrounded by a coated ceramic layer of silicon carbide
- Produces 1000 times less radioactive gas than US equivalents



Benefits

- High temperature leads to higher efficiency than conventional nuclear plants
- Continuous fuel replacement
  - No month-long shutdown
- Considered passively safe and removes the need for redundant safety systems
- No risk of meltdown
  - Proximity and geometry of fuel causes a strong Doppler Effect
  - Negative feedback: as nuclear fuel heats up, uranium atoms move faster (harder to absorb neutrons & split), reduces reactor power
- Low fuel density of pebbles magnify negative feedback
- Fuel spheres remain intact and undamaged
- No radioactive fluids
  - Gasses do not dissolve contaminants or absorb neutrons as water does used in traditional reactors

Current Applications

- Germany, U.S., and South Africa have experimented with the PBMR
  - Technical problems, lack of funding
- China
  - Test pebble-bed reactor operating for over 10 years now (Tsinghua University, north of Beijing)
  - Plan to build 50 nuclear reactors in next 5 years
  - First commercial PBMR under construction in Shandong Province (19 units) (2011-?)

Nuclear Reference Sheet

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Overview

Martin, William. "Nuclear Power." *Encyclopedia Britannica*. Encyclopedia Britannica. Web. 15 Apr. 2015. <http://www.britannica.com/EBchecked/topic/421749/nuclear-power>.

Nuclear . 19 April 2015. <http://www.iea.org/topics/nuclear/>.

Current Use of Nuclear Power

Nuclear and Uranium . 19 April 2015. <http://www.eia.gov/nuclear/>

Nuclear and Uranium . 19 April 2015. <http://www.eia.gov/nuclear/>

Nuclear . 19 April 2015. <http://www.iea.org/topics/nuclear/>.

Traditional Reactor Design

Martin, William. "Nuclear Power." *Encyclopedia Britannica*. Encyclopedia Britannica. Web. 15 Apr. 2015. <http://www.britannica.com/EBchecked/topic/421749/nuclear-power>.

Nuclear . 19 April 2015. <http://www.iea.org/topics/nuclear/>

Design of Pebble Bed Reactors

Koster, A., HD Matzner, and DR Nicholsi. "PBMR Design for the Future." *Nuclear Engineering and Design* 222.2-3 (2003): 231-45. Print.

Reitsma, Frederik. *The Pebbel Bed Modular Reactor Design and Technology Featuers* . Johannesburg, South Africa: IAEA Interregional Workshop, 2011.

Criticisms

Koster, A., HD Matzner, and DR Nicholsi. "PBMR Design for the Future." *Nuclear Engineering and Design* 222.2-3 (2003): 231-45. Print.

Fig, David. *Nuclear Energy Rethink? The Rise and Demise of South Africa's Pebble Bed Modular Reactor* . Pretoria, South Africa : Institute for Security Studies , 2010.

Pebble Design

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Benefits

Koster, A., HD Matzner, and DR Nicholsi. "PBMR Design for the Future." *Nuclear Engineering and Design* 222.2-3 (2003): 231-45. Print.

Emily Grubert, Brian Parks, Erich Schneider, Srinivas Sekar. "Pebble Bed Modular Reactors Vesus Other Generations Technologies: Cost and Challenges for South Africa." *Proceeding of Global 2011* (2011): 1-8.

Current Applications

Fig, David. *Nuclear Energy Rethink? The Rise and Demise of South Africa's Pebble Bed Modular Reactor* . Pretoria, South Africa : Institute for Security Studies , 2010.

[Anonymous]. "US and China to Combine Forces to Develop Pebble Bed Reactors." *Professional Engineering* 16.20 (2003): 8- Print.