Water Desalination

Obtaining reliable fresh water supplies from challenging water sources

Fresh Water Needs

- Economic expansion
- Agriculture and food
- Public health
- Quality of life

Why Desalination?

TeachEngineering.org – Free STEM Curriculum for K-12

- 75% of the Earth's surface is covered by water
- 97.5% of that water is oceans
- Only 1% is available for drinking
- 80 countries suffered from water scarcity by the mid-1990s
- 1.5 billion people lack ready access to drinking water

Show video at:

http://www.gewater.com/images/multimedia/desal/index_flash.html

Can we drink salt water?

The Rime of the Ancient Mariner

Water, water, everywhere
And all the boards did shrink
Water, water, everywhere
Nor any drop to drink

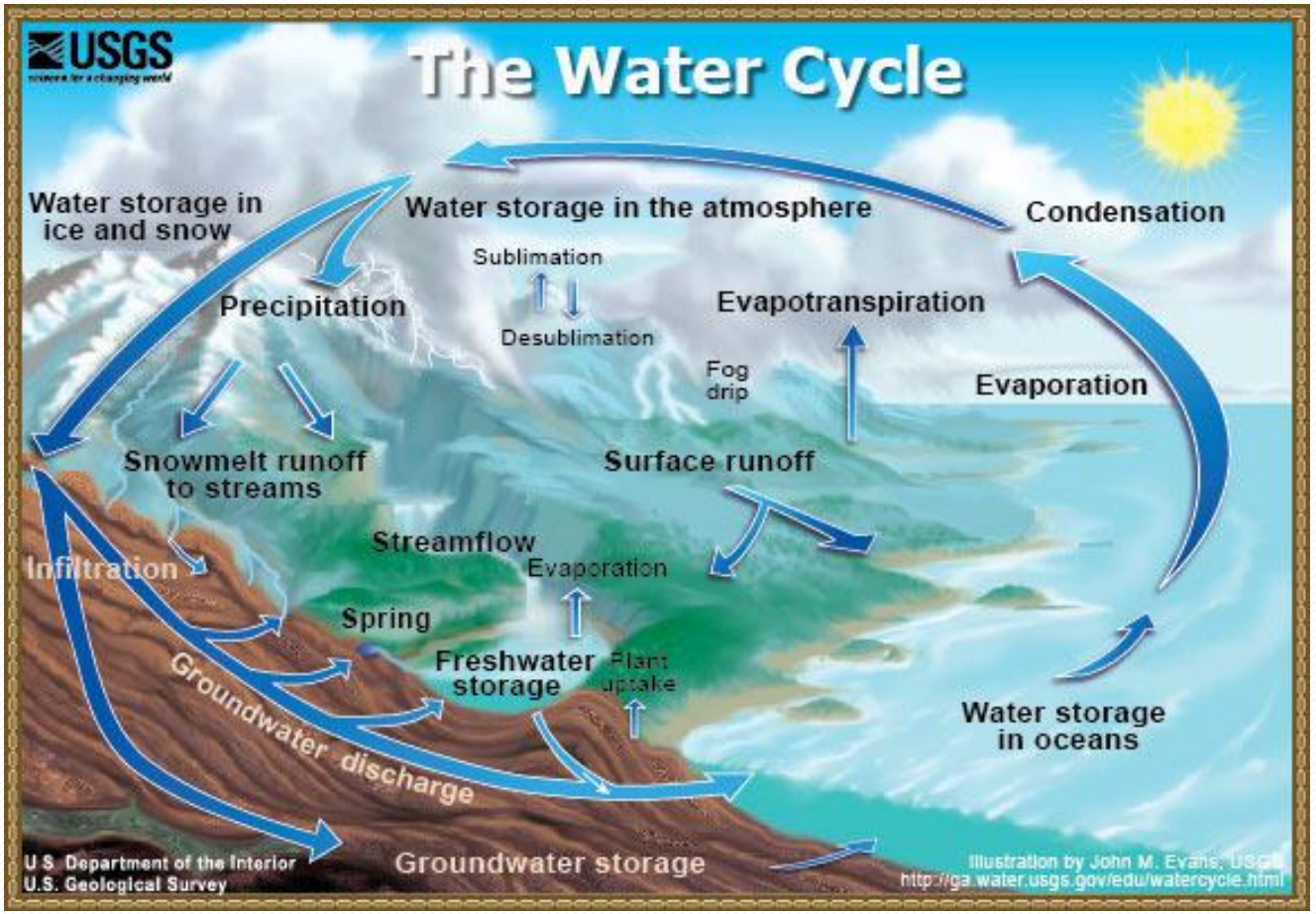
-Samuel Taylor Coleridge

- Small quantities are not harmful, but it is counterproductive (it just makes you more thirsty!)
- Eventually, it can be dangerous, ultimately producing fatal seizures, heart arrhythmias and kidney failure

Natural Desalination: Water Cycle!

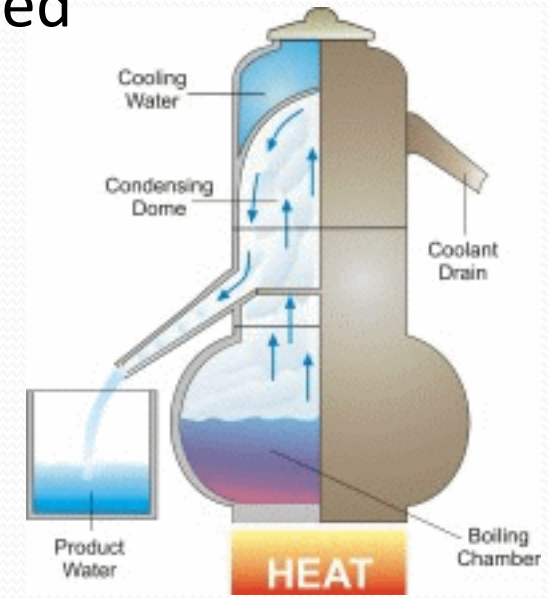
Major Stages

1. Evaporation
2. Condensation
3. Precipitation
4. Collection



Desalination Technologies

1. Thermal Desalination Processes
   - Similar to the Earth's natural water cycle
   - Water is heated, evaporated and collected
   - Produces clean water and brine



Example: Multi-Stage Flash Desalination

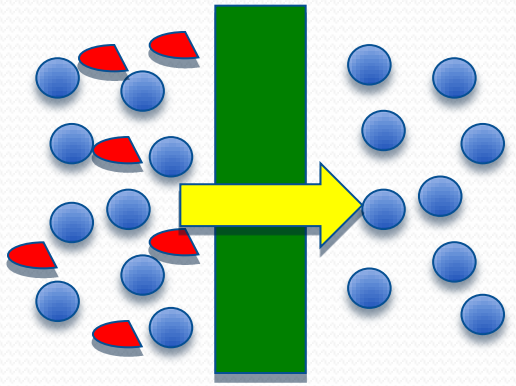
- Process uses multiple boiling chambers kept at different atmospheric pressures
- Saltwater enters the system and is boiled and evaporated in each chamber
- Process produces clean water and brine

Desalination Technologies

2. Membrane Desalination Processes
   - Saltwater is forced through membrane sheets at high pressures
   - Membrane sheets are designed to catch salt ions
   - Process produces clean water and brine

Example: Reverse Osmosis

- Saltwater is forced through a membrane at 600 to 1000 psi
- Multiple layers of membranes remove as many of the salt ions as possible



Desalination Plants around the World

Jabel Ali Desalination Station in Dubai

Jebel Ali Desalination Staion, Dubai
Lahmeyer International

- Capacity: 140 million gallons per day
- Opened June 2010

More Desalination Plants

Abu Dhabi, United Arab Emirates (3)

Aruba (1)

Australia (3 in use, 3 under construction, 1 planned**)**

Cyprus (1)

Israel (3 in use, 2 under construction)

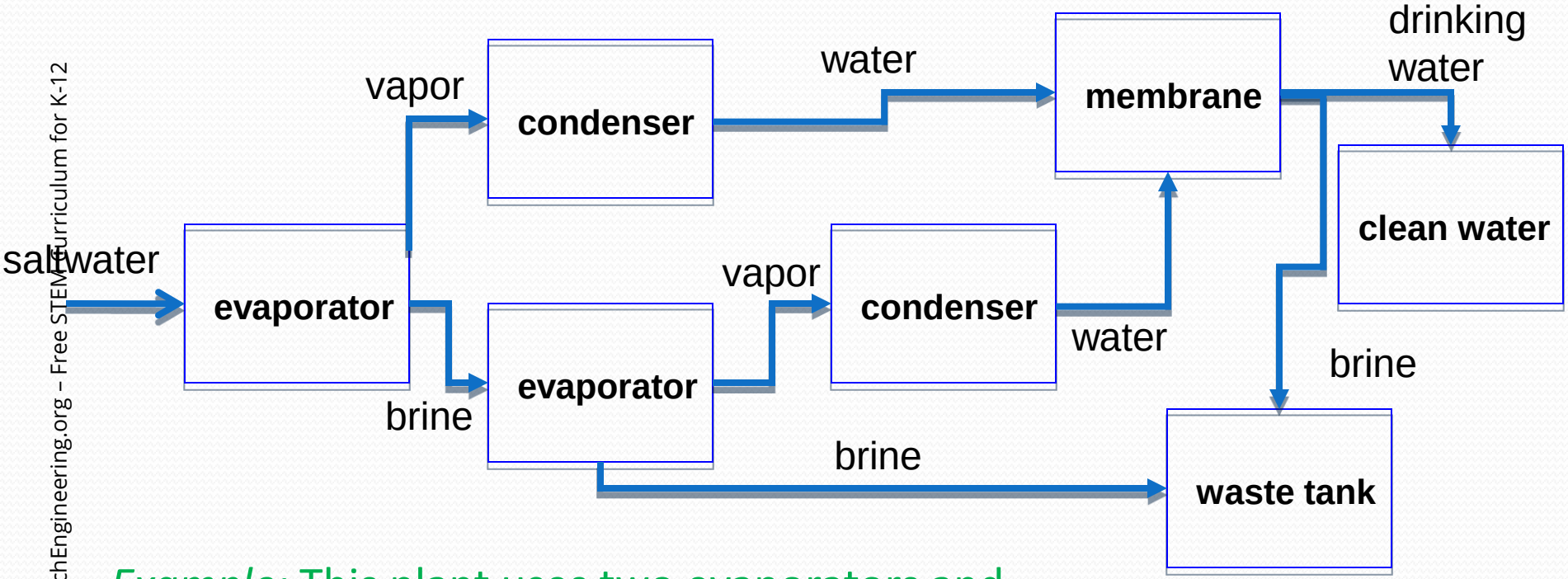
USA

- Yuma (Arizona), opened 1992
- El Paso (Texas) opened 2004
- Tampa Bay (Florida) opened 2007
- Monterey (California), in the planning stages

Republic of Trinidad and Tobago (1)

Systems and System Diagrams

- *System:* An object that receives inputs and transforms them into outputs
- *System diagram:* A block diagram that describes operation of a system



Example: This plant uses two evaporators and condensers along with a membrane filter to clean saltwater (follow the arrows though the diagram)

The end

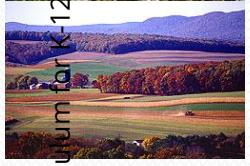
References

- Thirsty? How 'bout a cool, refreshing cup of seawater?, USGS Water Science for Schools, Updated March 29, 2010. U. S. Geological Survey, U.S. Department of the Interior. Accessed May 1, 2010. http://ga.water.usgs.gov/edu/drinkseawater.html
- Texas A&M AgriLife: Texas Water. Texas A&M University. Water Resources Education. Accessed May 1, 2010. http://texaswater.tamu.edu/
- Wikipedia.org, Wikipedia Foundation Inc., Accessed May 1, 2010. (Source of vocabulary definitions with some adaptation.) http://wikipedia.org
- Desalination, Existing facilities and facilities under construction. Wikipedia: the free encyclopedia. Accessed May 29, 2010. http://en.wikipedia.org/wiki/Desalination

Image sources

Cow: http://www.ars.usda.gov/is/graphics/photos/dec04/k11662-1.htm

Wheat: http://en.wikipedia.org/wiki/Wheat



Farm: http://www.ars.usda.gov/is/graphics/photos/sep09/k5052-5.htm

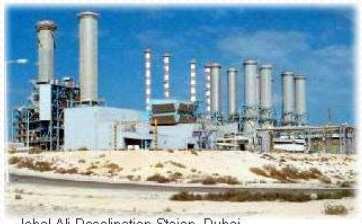
City : http://www.ars.usda.gov/is/graphics/photos/may02/k5369-5.htm

Boat: http://en.wikipedia.org/wiki/File:Amerigo_vespucci_1976_nyc_aufgetakelt.jpg

Sonoran desert soil: http://en.wikipedia.org/wiki/File:Drought.jpg

Girl with hose: Microsoft clipart →
←Ocean: Microsoft clipart

Image sources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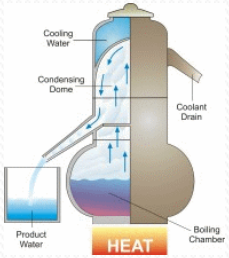
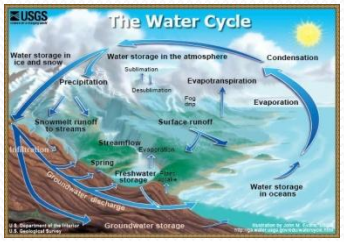
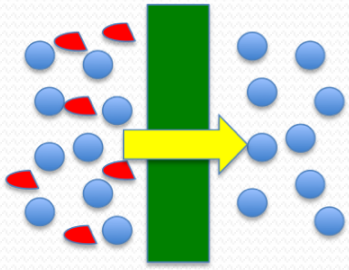


Thermal desalination process animation:
http://ga.water.usgs.gov/edu/drinkseawater.html

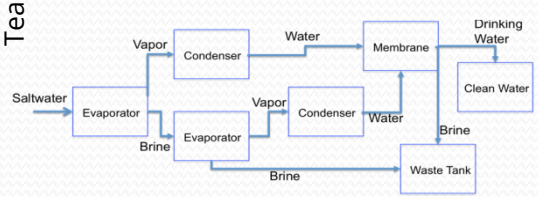
Desalination plant photo:
http://ga.water.usgs.gov/edu/drinkseawater.html



Water cycle diagram:
http://ga.water.usgs.gov/edu/watercycle.html



Membrane diagram created by Juan Ramirez Jr., ITL Program, College of Engineering, University of Colorado at Boulder, 2009



Flow chart created by Juan Ramirez Jr., ITL Program, College of Engineering, University of Colorado at Boulder, 2009