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?

- 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:
Can we drink salt water?

- 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

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
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

- 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 through the diagram)
The end
References

Image sources

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