



# Environmental Challenges in Managing Production Waste Streams

## Chapter 2

**R. David Shiels, P.G., CHMM**

(214) 577-5987

[david@shielsengineering.com](mailto:david@shielsengineering.com)



# Introduction

- Oil & gas operators are faced with the challenge to meet ever demanding requirements to **reduce water use, reduce waste generated** and **provide “Green” completions** in the oil patch when conducting exploration and production (E&P) activities.

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- Federal and state governmental agencies, as well as private sector groups, are placing pressure on operators to comply with increasingly complicated and cumbersome environmental regulations with regard to the management of their operations.



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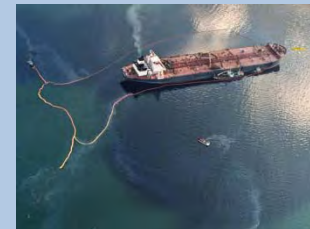


- Now that the oil & gas operations are moving into suburbia in multiple states across the Union, the oil patch is under the gun to comply with environmental laws;
- There are many things that the oil & gas industry can do to lead the way toward **reducing waste, conserving resources, and making greener completions and operations.**



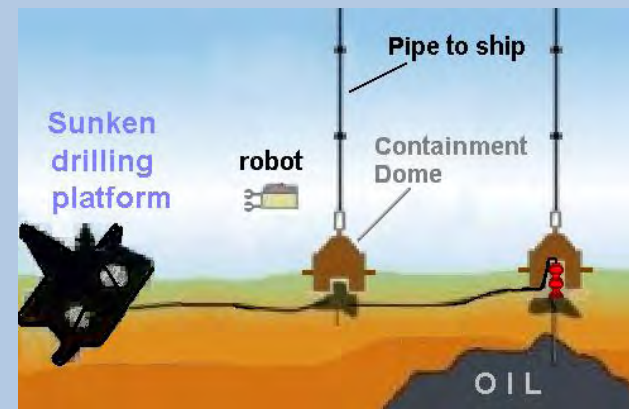
# Public Image

- From the beginning years in the late 1800s to the present, a big oil spill always makes the news;
- Just after midnight on March 24, 1989 the single-hulled Exxon tanker Exxon Valdez ran into Bligh Reef in Prince William Sound and spilled approximately 11 million gallons (262,000 Bbls) of crude oil into the marine environment;
- An eye witness reported that Captain Fitzroy consumed five double vodka beverages on the night of the disaster.





- The Exxon Valdez spill was the largest in US history until April 20, 2010 when BP's Macondo well spewed approximately 50,000 barrels of oil per day into the Gulf of Mexico;
- It was miraculously capped some three months later.





- A total of 4.5 million barrels of crude oil was spilled.
- According to Dr. Scott Tinker of the Texas Bureau of Economic Geology, the world economy burns through 4.5 million barrels of crude oil in a little over one hour each day;
- [WWW.SwitchEnergyProject.com](http://WWW.SwitchEnergyProject.com)



# Moonscapes

- Salt water & old crude spills in Monahans, Tx.





# Waste Management

- E&P wastes can generally be divided into four broad categories. These categories are:
  - Non-hazardous wastes;
  - Hazardous waste;
  - Exempt hazardous waste;
  - Other regulated wastes (NORM, asbestos, PCBs, and other special wastes).

# What is a Waste

- A waste is a material that, when generated, no longer has a use, is abandoned or is inherently waste-like.



# Waste Stream

- A waste-stream is the pathway that the waste travels from the point of creation to its final resting place. All rivers and streams have a point of origin and a final destination; so do wastes. It is imperative that the operator examine these waste streams and look for ways to reduce their volume and/or reduce their toxicity.



# Evaluate Your Waste Streams

- Each waste-stream generated by E&P activities must be individually evaluated to determine how that waste will be categorized and regulated. The operator should look at each waste-stream and closely study the process by which it is created.



# Look for Alternative Products

- Getting a handle on waste streams includes reviewing the various products that the operator uses and seeing if less toxic alternatives are available.
  - Example: Use diesel fuel as a parts cleaner rather than a chlorinated solvent or a high flashpoint solvent like mineral spirits.



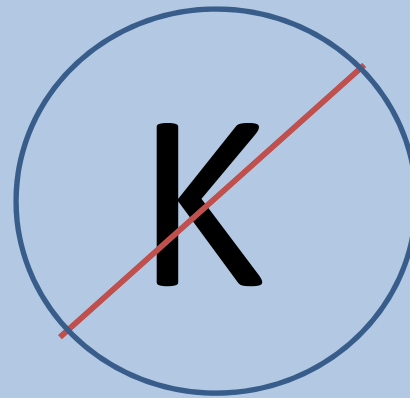
# Water Conservation

- Since the majority of wastes generated during E&P operations involve water, much effort should be made by industry to improve water conservation.
- The Railroad Commission of Texas estimates that 98% of all E&P wastes involve water.
- This is low hanging fruit that deserves attention!

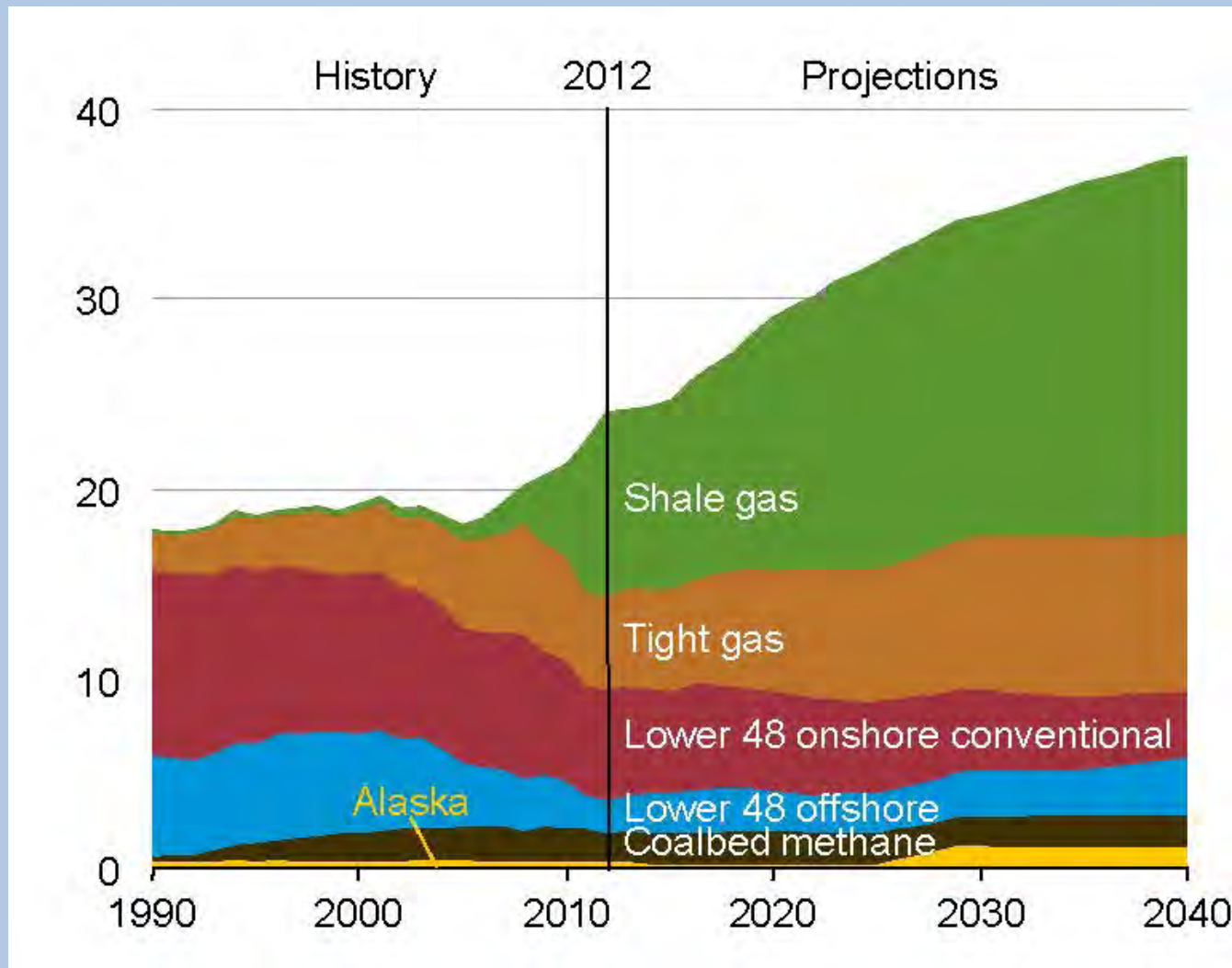


# Hydraulic Fracturing and Produced Water Fluid Management

- Hydraulic Fracturing (Fracing) has been a common practice in the oil & gas industry since the 1950s. However, it has become a household subject of discussion because we are fracing at a rate never seen before and our increased and projected production as a nation shows it.
- No k in Nuclear
- No k in Fracturing



# U.S. Dry Natural Gas Production Trillion Ft.<sup>3</sup>



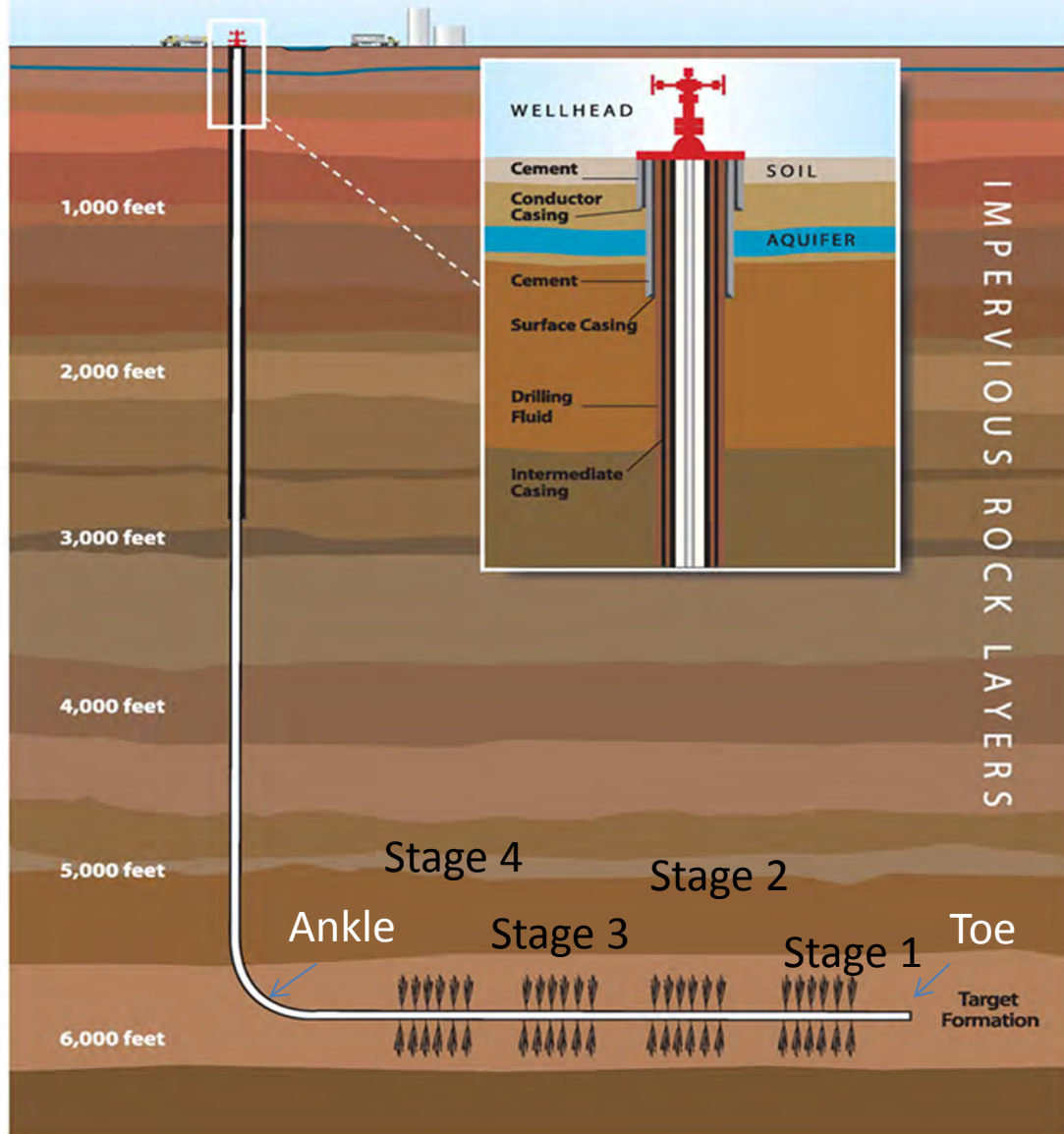
Source: U.S. Energy Information Administration | Annual Energy Outlook 2014



# Improved Technology

- Our improved horizontal drilling and completion techniques allow an operator to complete multiple frac stages in a single well. It is the equivalent to a 50 foot thick reservoir on its side and making it a mile or more thick. See illustration below.

## Groundwater Protection through Proper Well Construction



Source: American Petroleum Institute, Hydraulic Fracturing: Unlocking America's Natural Gas Resources; July 19, 2010.

# Large Volumes of Water

- It can take millions of gallons of fresh water to complete a frac.



# Flowback

- The frac fluid that returns to the surface after use is called Flowback.
- Managing this waste is an issue.
- Most operators dispose of this fluid into a Class 2 injection/disposal well.
- In March of 2013, the Texas Railroad Commission adopted new rules to lift permitting burdens on operators and encourage them to recycle frac fluids.

# Produced Water

- Another waste water source is produced water.
- Produced water is usually heavy with chlorides.



# Eliminate or Minimize

- The key to all waste problems is to eliminate or minimize the waste stream on location in the first place. This concept is known as source reduction and waste minimization.
- Look for alternatives.....

# Waterless Fracturing

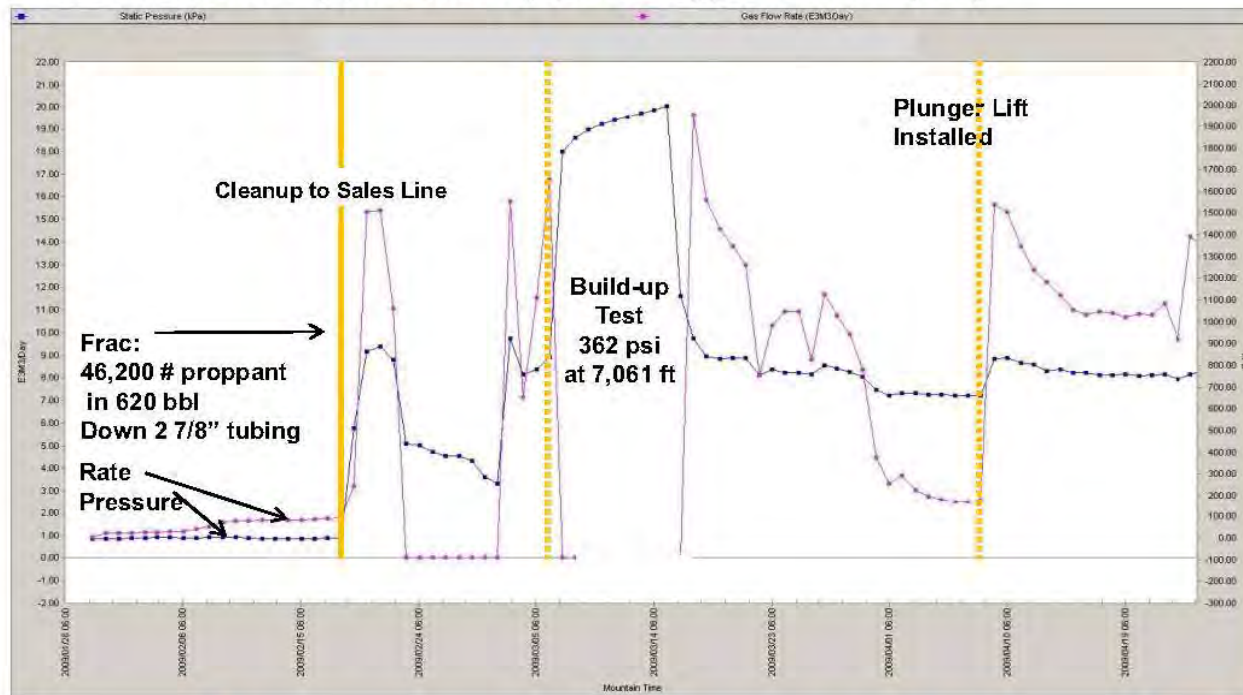
- Gas Frac Energy Services, Inc. developed a fracturing technique by using liquefied petroleum gas (LPG) instead of water.
- They have found that with this technique, old plugged out reservoirs are often revived with their Gas Frac technology.



# The Alternative Proved More Profitable

## LPG Frac Fluid Application – Gas L.P.

- Low Pressure Application (7,061 ft @ BHP 362 psi):



Initial Rate:  
60 Mscf/day

Final Rate:  
520 Mscf/day & 15.8 bbl  
condensate/day @ 112 psi



# Naturally Occurring Radioactive Material (NORM)

- Scale buildup from produced water.
- Dissolved solids carrying Radium 226 or 228 precipitate out onto piping/ancillary equipment.
- Gas processing plants see precipitation of Lead 206.
- What can be done with this radioactive waste?



# NORM Decontamination



- Why aren't service companies providing NORM cleaning services at the well site?
- Before a well is worked over or plugged, the equipment and piping could be flushed back into the well with a cleaning chemical similar to boiler treatment until the piping and equipment are "NORM Free".
- The service company could certify, by trained and licensed NORM survey technicians, that the equipment or piping was NORM free and the metal tubulars could be recycled rather than rotting at the old well head location.





# Innovative Technologies for E&P Waste Water Treatment

- The main hurdles to overcome with respect to E&P waste water treatment lies in these four areas:
  1. Bacterial contamination;
  2. Dissolved solids;
  3. Suspended solids; and
  4. Organic residue.

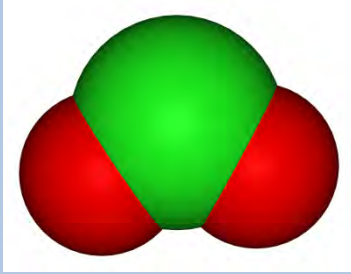


# Bacteria

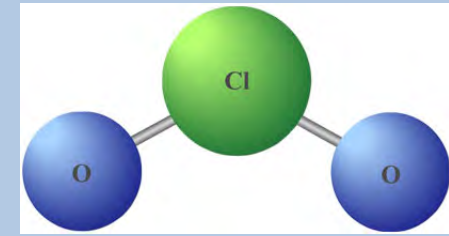


- Bacteria can damage a well and ruin the geologic formation immediately around the borehole.
- This bacterial slime can clog reservoir pore space and slow or stop the flow of reservoir fluids into the production stream.
- The bacteria byproducts can also have toxic side effects with the generation of hazardous materials such as hydrogen sulfide gas ( $H_2S$ ).
- $H_2S$  is generated when the bacteria feed on nutrients that are introduced into the formation if untreated.





# Chlorination



- Bleach is inefficient and only partially effective;
- Chlorine Dioxide gas ( $\text{ClO}_2$ ) has proven to be quite effective.
  - The gas is infused into the water stream as fracturing fluids are mixed with other treatment ingredients and sent down the borehole to fracture the geologic formation. The  $\text{ClO}_2$  is made on or near location by mixing an acid ( $\text{HCl}$  or  $\text{H}_2\text{SO}_4$ ) and  $\text{NaClO}_2$ .

# Other Bacterial Treatment

- Caustic or chemical treatment;
- Ultra violet Light

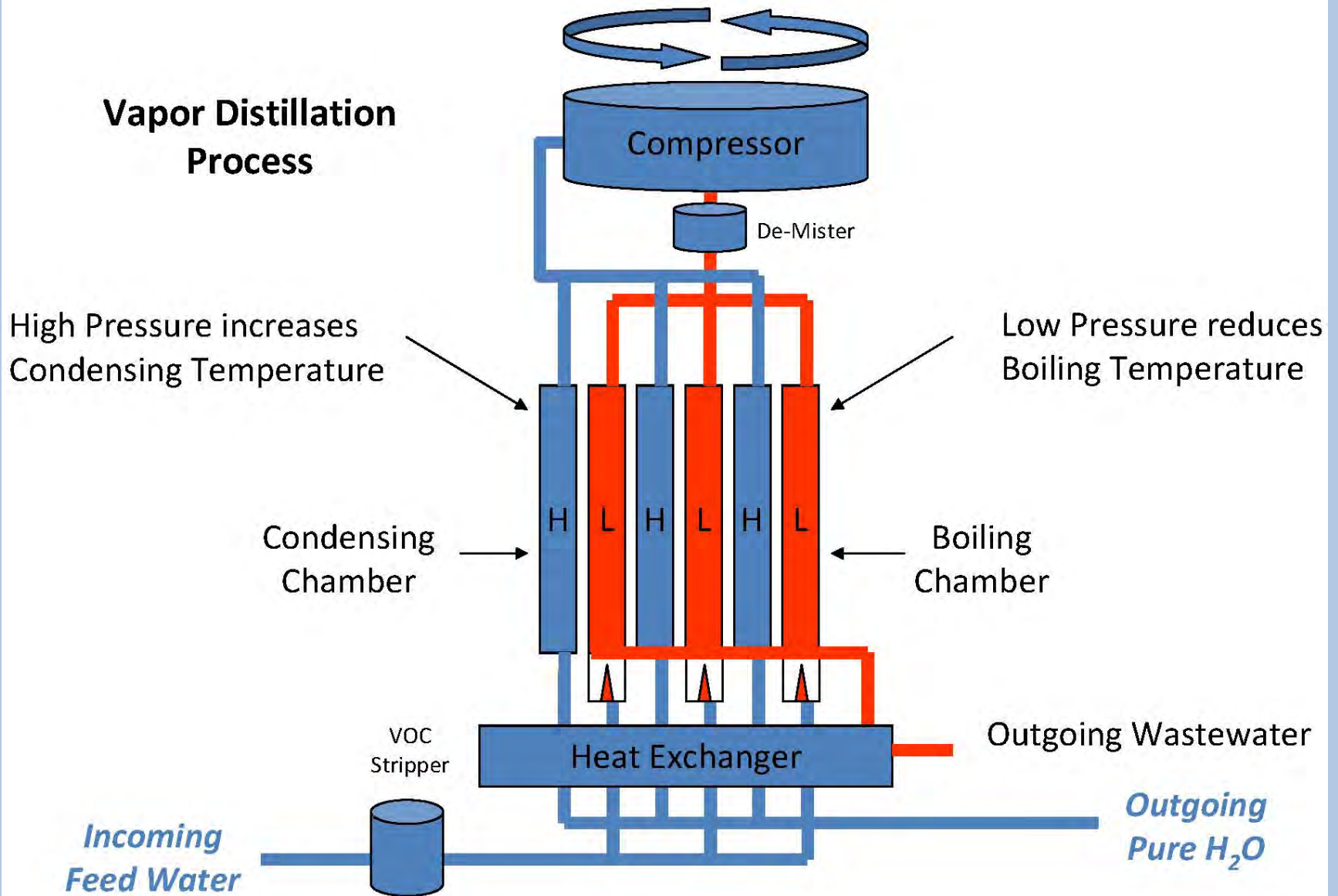


# Dissolved Solids-Salts (Chlorides) Treatment

- The removal of dissolved solids presents the greatest challenge to the operator who wants to recycle flowback fluid or produced water.
- Some folks claim they can chemically remove the salts.....fooeey!
- You must cook the water off, distill it or somehow separate the salts from the water.



# Vapor Distillation Process



# Suspended Solids Treatment

- Although one hopes for minimal suspended solids to return in the flowback or produced water, some solids are inevitable.
- These solids can be separated mechanically or chemically using conventional means such as filtration or flocculation.

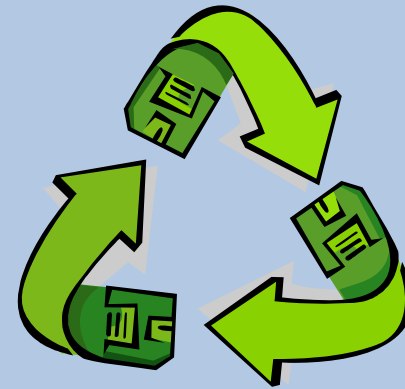


# Green Completions

- Recently, the New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP) related to the oil & gas industry have been amended;
- It will require all oil & gas operators to greatly reduce emission sources at the drilling rig and well head;
- The operator is now required to treat these organic compounds by flaring or running them through an internal combustion engine instead of releasing these organic compounds directly to the atmosphere.

# Turn Your Headache into Money

- Capture the VOC emissions and distill them into liquid hydrocarbons and send them to sales with a distillation unit or BTEX arrestor;
- Condensate brings an oil price; currently around \$50/barrel.



# A Bright Future with Less Waste

- The operator must embrace these environmental management concepts;
- Either management will embrace these concepts and the industry will take the lead or the regulators will force operators to comply through regulations.



# Industry Alliance Water Cooperative

- Add to corporate profits by turning produced water or flowback wastes into a saleable commodity;
- Operators have to purchase water from “someone”;
- Why couldn’t that “someone” be a water cooperative owned and operated by the oil & gas producers in a given area?



# Conclusion

- Water can be saved, reused and recycled rather than injected into the ground as a waste;
- The operator's environmental headache could be turned into dollars to add to the bottom line;
- Air emissions can be turned into liquids and sold in the oil market rather than emitted to the atmosphere all the while protecting our environment

# Finale'

- The old days of careless waste management are coming to a close;
- Soon, we will no longer see discharges of wastewater to the subsurface but to a treatment facility that is a profit center of our corporations where former waste by-products are turned into money in a timely manner.





