





Fracking wastewater

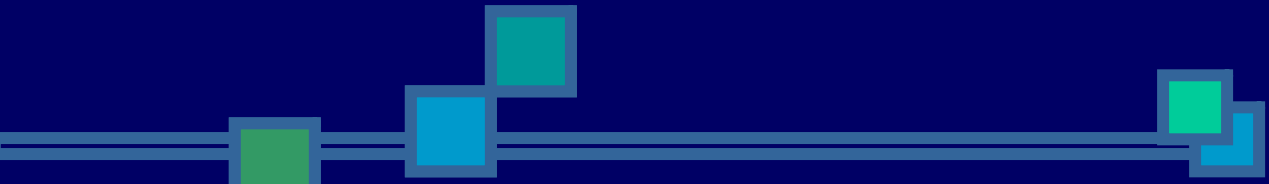


Dealing with wastewater from shale gas
fracking

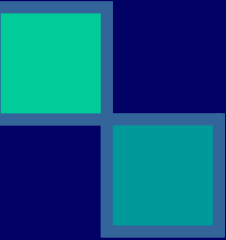



Fracking operation

- Well is drilled vertically, then turned horizontally in shale deposit
 - “Necklace” of shaped-explosive charges inserted, detonated to make holes
 - Chemicals and proppant (sand) mixed with water
 - Injected into well with high pressure
 - Fractures in shale forced open and propped
 - Pressure released, methane comes up with flowback
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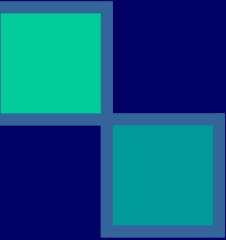



Wastewater from fracking comprises “flowback” and “produced water”

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- Flowback is the fracturing fluid that returns to the surface when drilling pressure is released
 - Produced water is the wastewater emerging from the well after production begins
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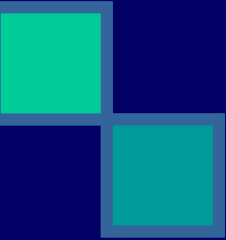




Composition of flowback

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- Dissolved and suspended solids
 - Heavy metal salts
 - Petroleum compounds
 - Friction reducers
 - Proppant (sand)
 - Radioactivity
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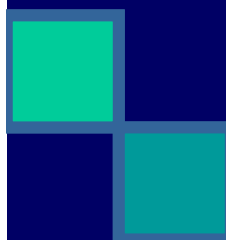



Composition of produced water

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- Metal salts, chromium, mercury
 - Dissolved hydrocarbons, methane, ethane, propane and carcinogens
 - Halogenated hydrocarbons
 - High levels of total dissolved solids
 - Barium, calcium, iron, magnesium
 - Radioactive materials (NORM)
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Re-use of flowback and produced water on site

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- Reduction of dissolved solids needed
 - Trailer-mounted treatment plants deployed
 - High TDS will rule out reverse osmosis
 - MVC is an alternative treatment
 - Separate double-walled tank(s) required for solute (concentrate flow)
 - Disposal of solute is still problematic
 - Solvent (cleaned flow) mixed with new water for re-use
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Wastewater treatment

- Concentrate flow has increased TDS
- Existing sewage and industrial treatment works unable to accept high TDS
- Toxicity and radioactivity concentrated in sludge
- Dedicated process line needed to avoid scale
- Deep well injection of untreated wastewater only satisfactory disposal method prohibited
- Seismic survey needed to locate deep porous rock
- Insufficient wells to cater for total wastewater

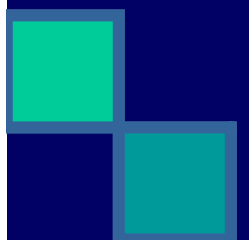


Wastewater in the US

- Deep injection wells are classified
 - Class II wells for fracking wastewater
 - Not all shale areas have wells
 - Injection wells have been main source of earthquakes
 - Methane in wastewater for injection caused major explosion
 - Leakage cannot be 100% prevented
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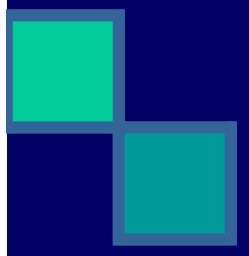




Reverse osmosis

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- Commonly used for desalination
 - High pressure pump overcomes osmotic pressure
 - Maximum TDS handled 50,000 ppm
 - Fracking waste water can be up to 250,000 ppm
 - Energy input high




Mechanical Vapour Compression

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- MVC does not need a heat sink
 - Most likely technology on site for re-use
 - Concentrate needs drying, crystallisation and/or disposal
 - Energy input, scaling and concentrate disposal problematic
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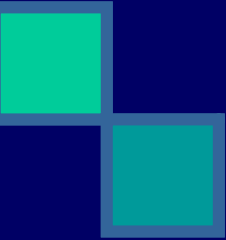



Treatment of wastewater too problematic

- The TDS in the raw wastewater is problematic enough
 - Concentrates cannot be discharged into water courses
 - Toxic landfill for sludge is expensive
 - Low level radioactive dump unpopular and restricted
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What about fracking in the US?

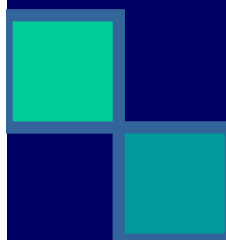

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- There are three classes of wells with “dry” and “wet” gas and “tight” oil
 - In the US the drillers have moved to “wet” gas with NGLs (ethane, propane, butane, pentanes) and to the oil rich shales (Bakken and Eagle Ford)
 - Water resources are contaminated by wastewater plus health problems from vapours from open pits
 - See www.marcellus-shale.us aerial views and data
 - In the UK proper regulation will make fracking for gas uneconomic and the prospectors are looking for oil
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Wastewater policy in the UK?

- Before a fracking operation there needs to be a system in place for handling of the wastewater
- UK rejects open pits which yield health problems from release of dissolved petroleum vapours
- Closed, double-skinned tanks for wastewater need connecting to flare stacks
- There needs to be an adequate separation of the methane and other hydrocarbons from the wastewater
- Injection of untreated wastewater into deep injection wells prohibited in the UK

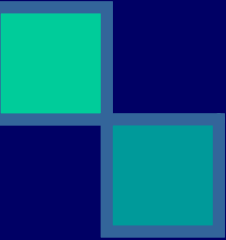



Re-use and treatment

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- Re-use of cleaned wastewater concentrates the suspended and dissolved solids in the “dirty” solute
 - Salinity increased and toxins and NORM concentrated in residual wastewater
 - Treatment problems “irresolvable”
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Environmental loads

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- Heavy truck traffic, noise, smells and flaring together with road-building and pipe swathes through forests lead to protests
 - Wastewater is an intractable problem for fracking
 - The “Halliburton Loophole” was an indispensable factor in US fracking surge
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My Conclusion

- Water use too high
 - Wastewater a barrier to fracking
 - That fracking can be successfully regulated is an illusion
 - Thousands of wells needed will attract thousands of protests
 - Government intervention will worsen protests
 - Fracking is an unlikely pursuit in the UK
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