Preliminary Study on Dewatering Gas Production with Ultrasonic Cavitation

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Outline

● **Background**
  - Dewatering gas production
  - Dewatering procedures
  - Schematic diagram of a patent method
  - Theoretical feasibility I-- Ultrasonic cavitation
  - Theoretical feasibility II-- Hydrodynamics

● **Simulation Device**
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    - Flow chart of simulation
    - Cell experiments
    - CAD—Plots of cell experimental data
  - Model experimental equipment

● **Simulation Experiments and Result Analysis**

● **Conclusion and Future Work**
Dewatering Gas Production

• **What?**
  
  *To remove water* build-up from production gas wells.

• **Why?**
  
  When natural gas flows to the surface in a producing gas well, the gas carries liquids to the surface if the velocity of the gas is high enough.

  As the gas velocity in the production tubing drops with time, the velocity of the liquids carried by the gas declines even faster. Flow patterns of liquids on the walls of the conduit cause liquid to accumulate in the bottom of the well, which can either slow or stop gas production altogether.

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Dewatering Procedures

• **How?**
  ✓ Velocity string
  ✓ Foamers injecting capillary string
  ✓ Pump

➢ All the existing procedures cannot properly solve the problem in the gas wells with low bottom pressure and small bottom water.

◆ Thinking of new methods...
One patent brings forward the use of ultrasound.
Theoretical Feasibility I
--Ultrasonic Cavitation

- **Ultrasound** is sound with a frequency greater than the upper limit of human hearing—20kHz.

- **Ultrasonic Cavitation** is the process where a bubble in a fluid is forced to oscillate in size or shape due to an acoustic field, then the bubble rapidly collapses, producing a shock wave and causes high speed impinging liquid jets.

  ➢ In the dewatering case, liquid jets effect is the key concern.
Liquid Jets in Ultrasonic Cavitation

\[ d = \alpha \left( \frac{8\pi T}{\rho L f^2} \right)^{1/3} \]

- \( d \) - diameter of the jetted drop
- \( \alpha \) - coefficient
- \( T \) - temperature of the liquid
- \( \rho \) - density of the liquid
- \( L \) - frequency of the ultrasound (f) which generated the cavitation

Diameter of the jetted drop is decided by the frequency of the ultrasound which generated the cavitation. Moreover, the drops are finely dispersed to form a mist flow pattern.
Theoretical Feasibility II
--Hydrodynamics

\[ V_g = \left[ \frac{4gd(\rho_L - \rho_g)}{1.32\rho_g} \right]^{0.5} \]

- Gas velocity needed to carry out the liquid drop is in direct proportion to the diameter of the liquid drop.
- That is to say the smaller the diameter of the liquid drop, the lower the velocity of gas is needed.
- If the drop with the largest diameter could be brought to the ground, there will be less or no bottom water.
- By decreasing the diameter of the liquid drop, gas velocity needed thereby could be reduced.

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Flow Chart of Simulation

- Cell Experiments
- Experimental Data
- Computer Aided Parameter Design
- Bases for Structure Design
- Simulation
- Experimental Equipment
- Bases for Parameter Design
Cell Experiments
Plots of Cell Experimental Data
Model Experimental Device
How They Work

- Water conduction and collection scheme
- Mist generation
- Gas velocity adjust and display

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Thanks!

Questions and Comments

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