

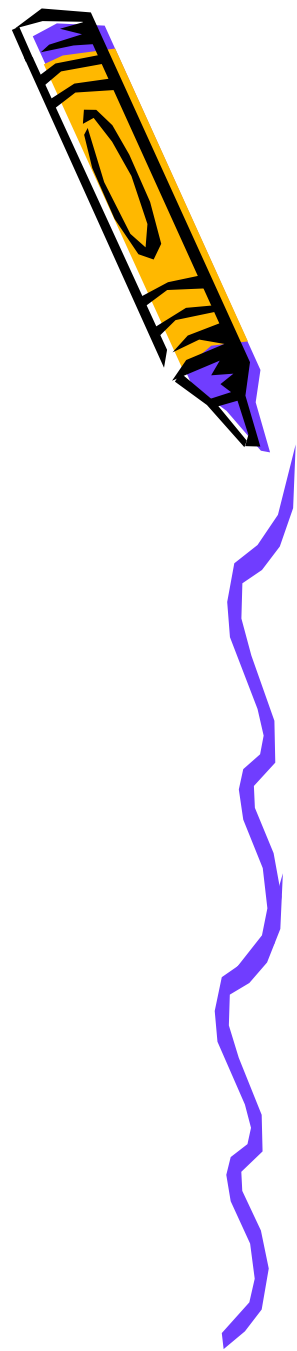


# Producing Difficult Fluids: Challenges and Solutions

M.Helmy Sayyoyh  
Cairo University

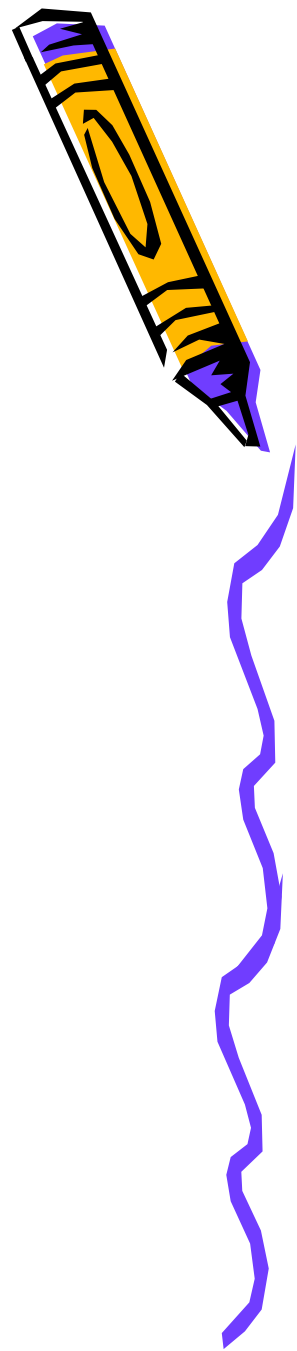
# What are Difficult Fluids?

- **Heavy crude (low API)**
- **High paraffin / asphaltene content**
- **High viscosity / heavy emulsion**
- **Sour (high H<sub>2</sub>S and high CO<sub>2</sub>)**
- **High scaling tendency**



# What are Difficult Fluids?

- **High GOR**
- **Crude oil in complex geologic structure**
- **Small accumulation in remote locations**
- **Offshore heavy oil fields in deep water**
- **Low economic margins**

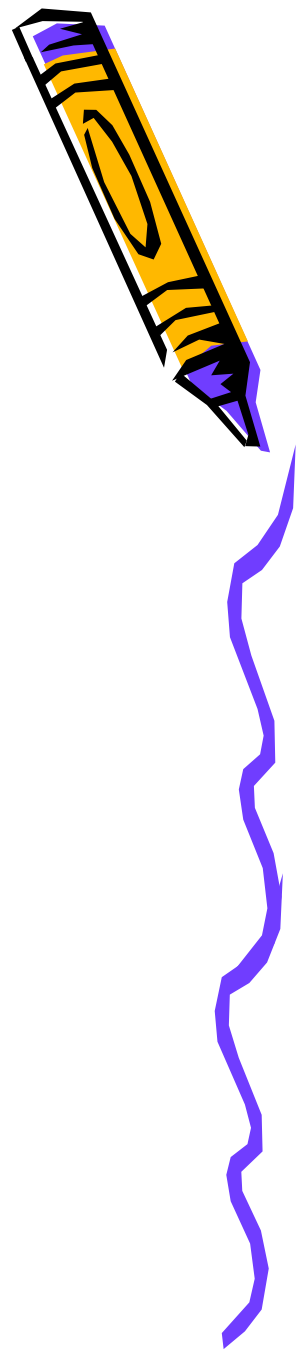


## Characteristics of Heavy Oil

**Low API Gravity (Less than 20)**

**High Viscosity (greater than 50 cp)**

**Low gas in solution (less than 50 scf/bbl)**



# Heavy Oil Development : Challenges

**.Drilling  
and  
completion  
cost**

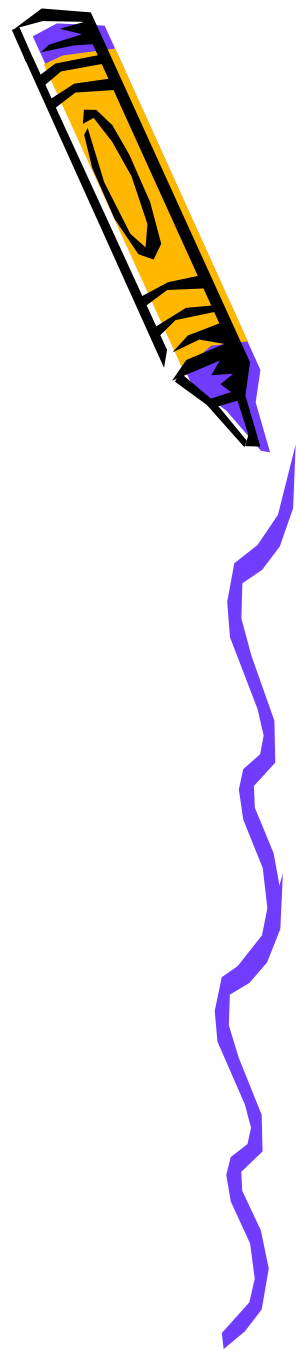
**.Facilities  
cost**

**.Low recovery factor**

**.Timing**

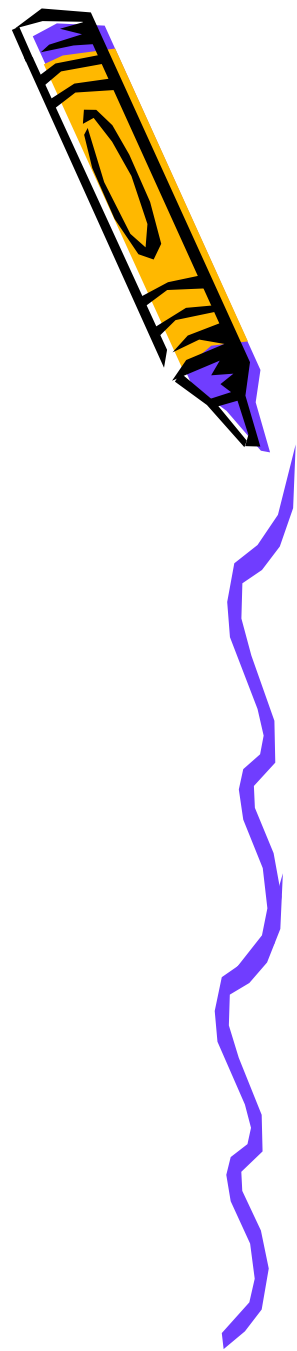
**.Low price**

**.Lifting**



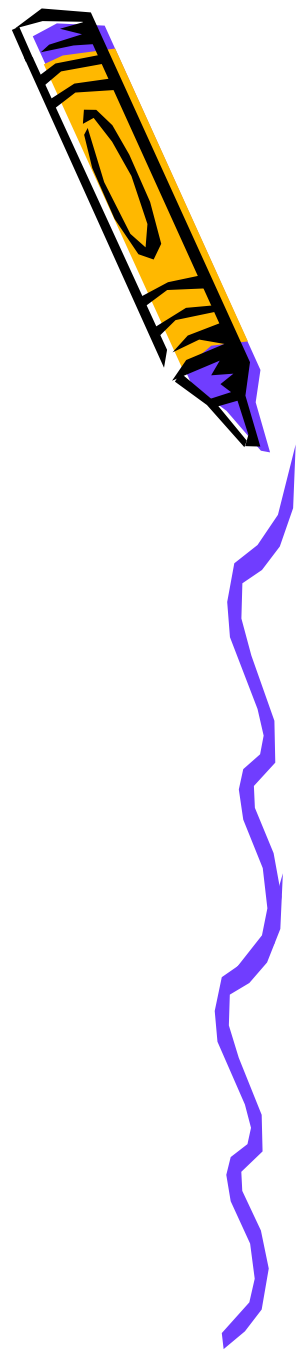
# Heavy Oil Development : Challenges

- **Sour (H<sub>2</sub>S, CO<sub>2</sub>, Water Prod)**
- **Commercial contractual terms**
- **Production Problems**  
**(Emulsion, Asphaltene, sand, wax)**



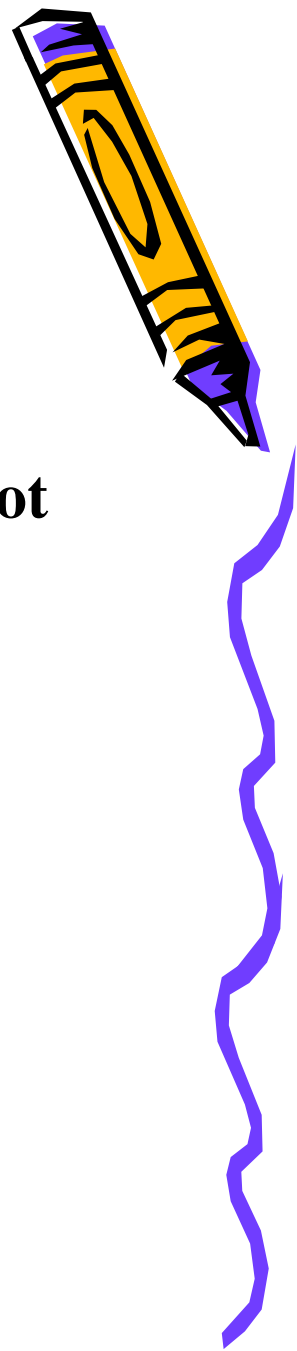
# Heavy Oil Development : Challenges

- **Expensive and difficult EOR**
- **Shortage of experts in EOR**
- **Low well Deliverability**



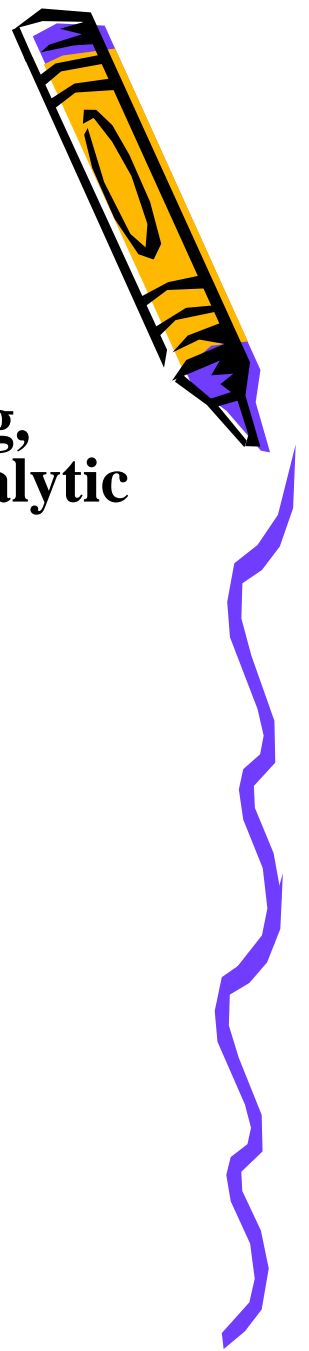
# Producing Difficult Fluids : Solutions

- **Innovative techniques for Enhanced Oil Recovery (EOR) including Steam flooding, CO<sub>2</sub> flooding & Hot water injection**
- **Horizontal Completions**
- **Effective stimulation techniques with efficient placement control**





# Producing Difficult Fluids : Solutions

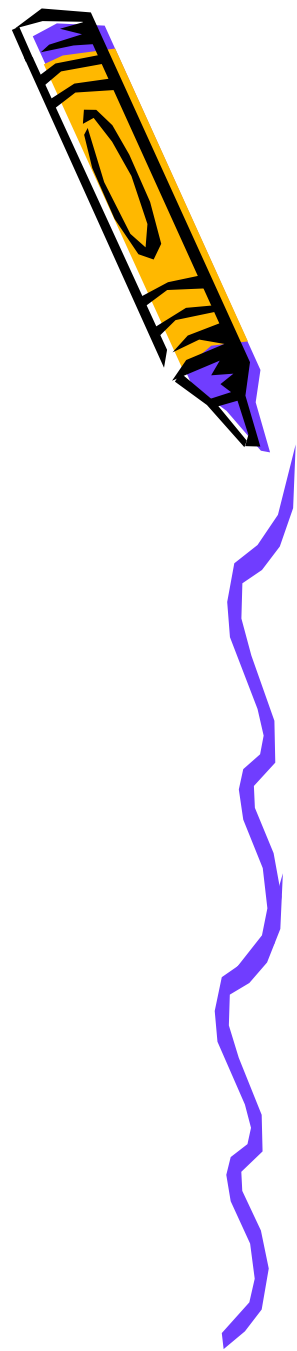


- **Innovative technologies for heavy crude upgrading, e.g. the Aquaconversion technology (Thermal Catalytic Steam Conversion Process)**
- **Chemical Treatment systems**
- **Utilization of evolving technology in processing facilities**
- **Reservoir Management**



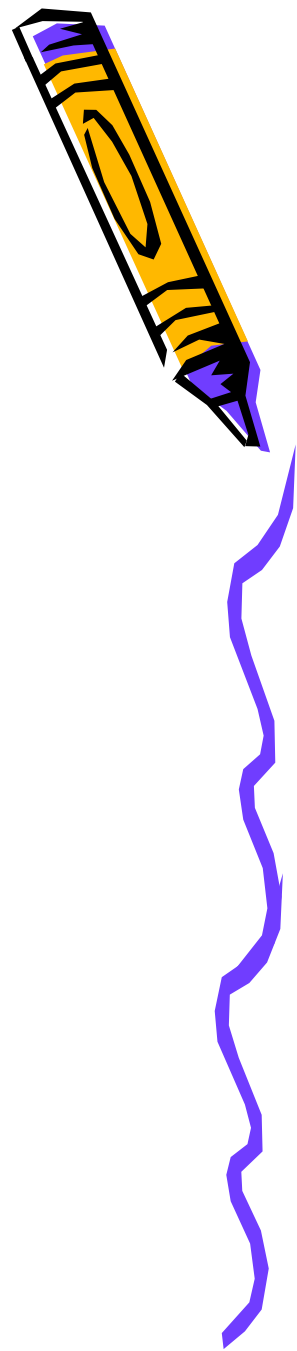
# High Paraffin & Ashphalene Crude's

- **Chemical Treatments, Subsurface and Surface**
- **Solvents**
- **Dispersants**
- **Inhibitors**
- **Electromagnetic Treatments**



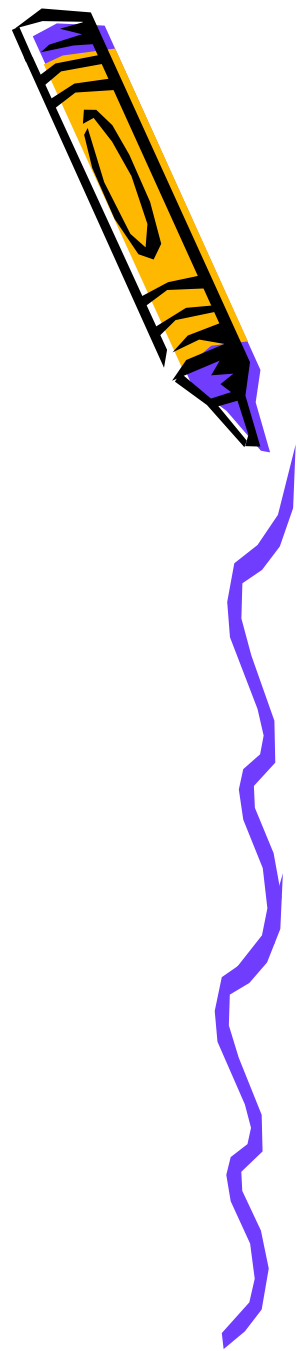
# High Viscosity/Heavy Emulsion Crude's

- **Chemical Treatments, Subsurface and Surface**
- **Emulsifiers**
- **Surfactants**
- **Thermal Treatments**
- **Electromagnetic Treatments**



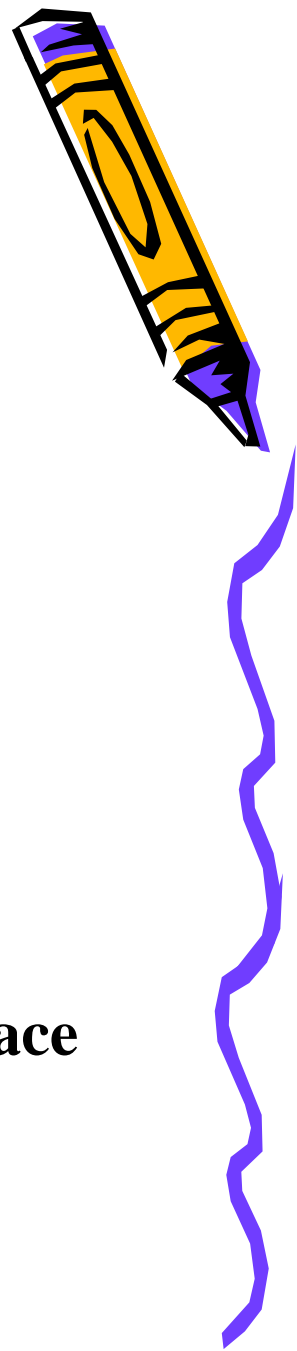
## Sour Fluids

- **Chemical Treatments, Subsurface and Surface**
- **Inhibitors**
- **Scavengers**
- **Downhole Completion Metallurgy**
- **Combination**

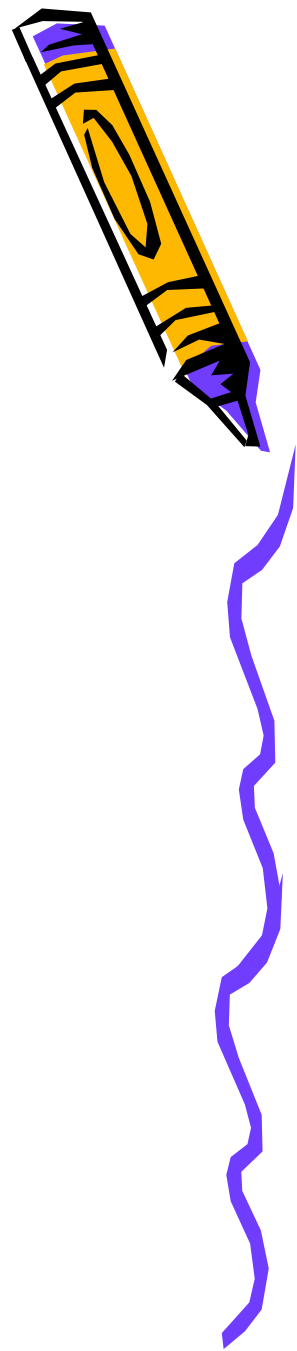


# High Scaling Tendency Fluids

- **Chemical Treatments, Subsurface and Surface**
- **Inhibitors**
- **Solvents**
- **Mechanical**
- **Electromagnetic Technology, Subsurface and Surface**



## High GOR: Challenges

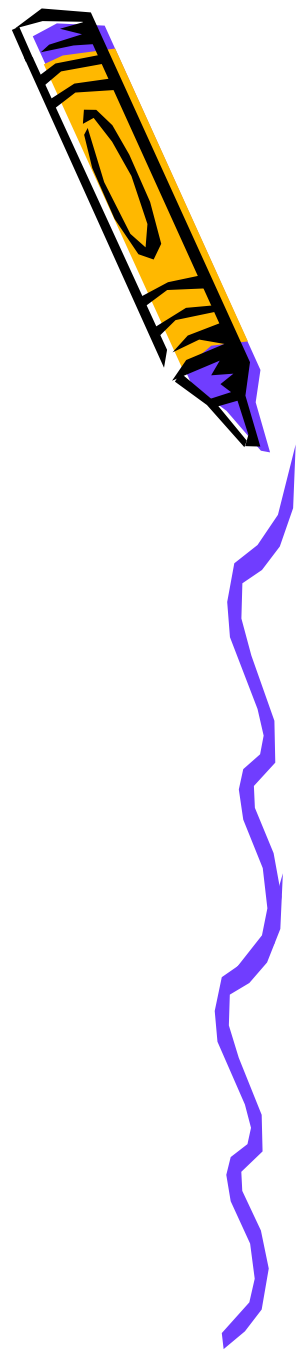


- **High GOR will result in Low Oil rate.**
- **Reduce Reservoir Energy**
- **Gas coning in Gas Cap Reservoirs will impact recovery and sweep.**
- **Saturated reservoirs GOR are related to free gas.**



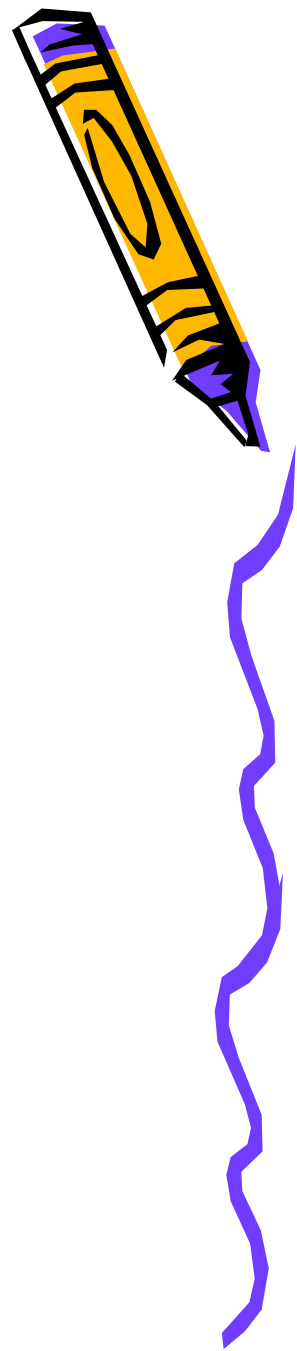
## High GOR: Solutions

- **Long Horizontal well**
- **Cycling wells**
- **Intelligent/Smart Wells**
- **Natural Gas Lift**



## High GOR: Solutions

- **Low overbalance pressure while drilling**
- **Optimize well placement**
- **Downhole Separation**
- **Slug Flow valves**





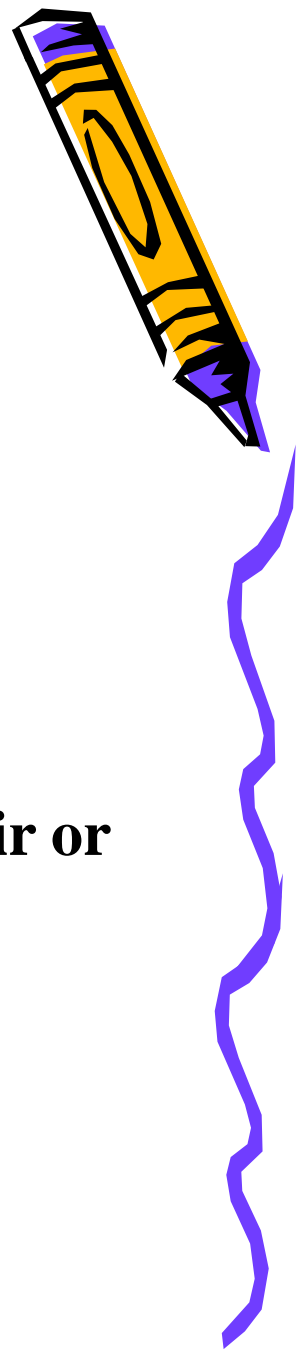
## Sour Fluids



- Oil and gas that has H<sub>2</sub>S and or Co<sub>2</sub> That need special treatment to produce safely and reduce reservoir & facilities damage.
- What is the limit between sour and sweet fluid?
- What is the source of sour fluid?



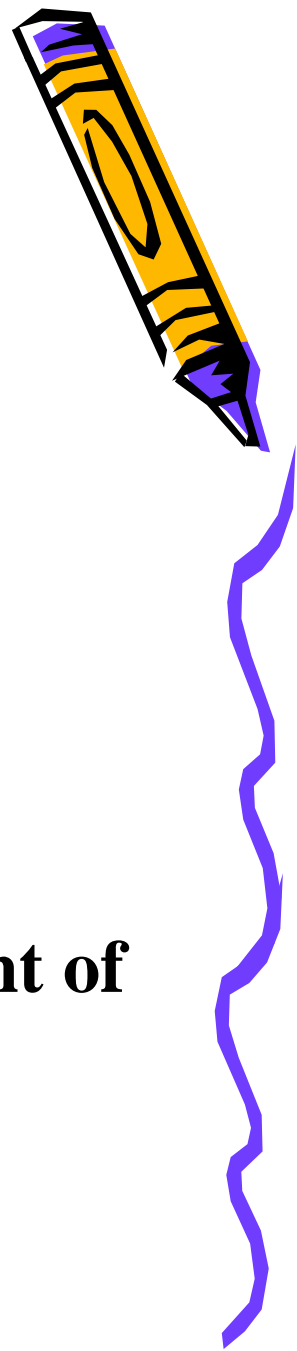
## Sour Fluids: Challenges



- **Identify the possible mechanism of sour fluid generation:**
  - **Water injection may turn sweet to sour fluid**
  - **Pressure depletion**
- **Where should be treat the sour fluid? in reservoir or at surface?**
- **How to predict H<sub>2</sub>S concentration?**



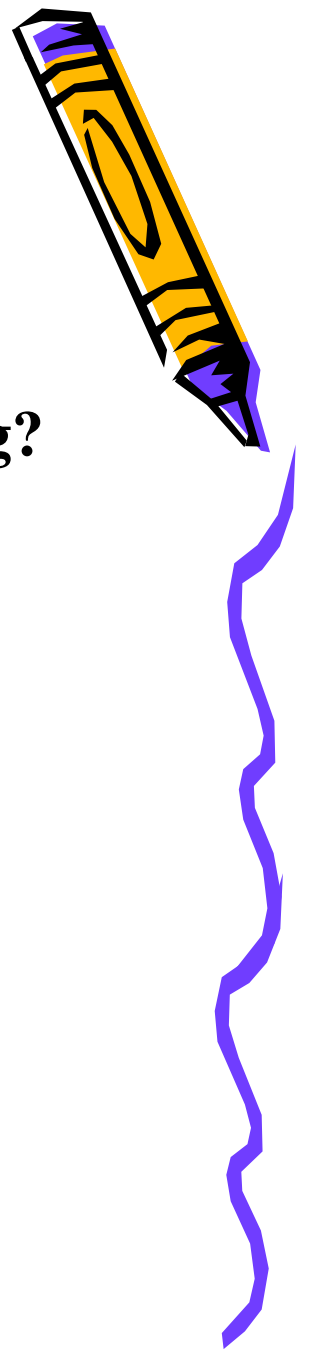
## Sour Fluids: Challenges



- **How to handle it?**
  - **Environmental impact,**
  - **Cost impact. (Operation problems, logging)**
  - **Reservoir damage**
- **How to control the cost of the development of this reservoir?**



# Sour Fluids: Challenges

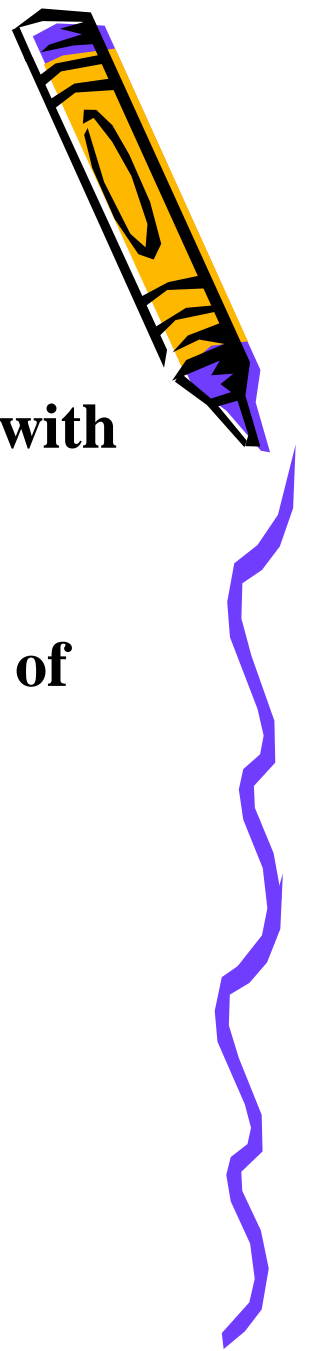


- **Adding difficulties in understanding & modeling?**
- **How to get benefit from sour fluid?**
  - **Improve sweep efficiency**
  - **As fluid tracer**



# Difficult Fluids: Solutions

## Artificial Lift Methods



- **All artificial lift system can be used for difficult oil with some limitations for each type.**
- **More work is required to overcome the limitations of artificial lifting difficult Oil.**
- **Generally Rod and PCP are used for Heavy oils .**



## Difficult Fluids: Solutions

### Artificial Lift Methods

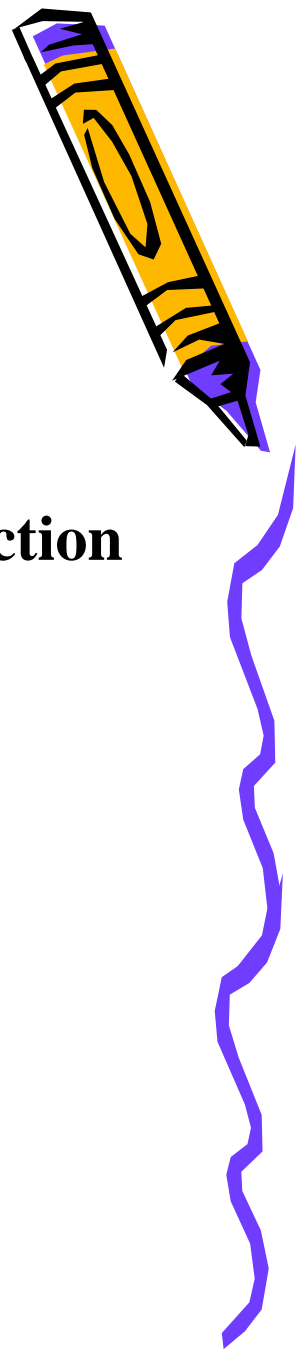


- **ESP has a limitation with highly paraffanic crude especially at low rates.**
- **In case of high water production rate ESP is the most applicable technique.**
- **It is recommended, in sour condition, to minimize using systems with more moving parts (jet pump. Gas lift. ..).**



# Difficult Fluids: Solutions

## Artificial Lift Methods



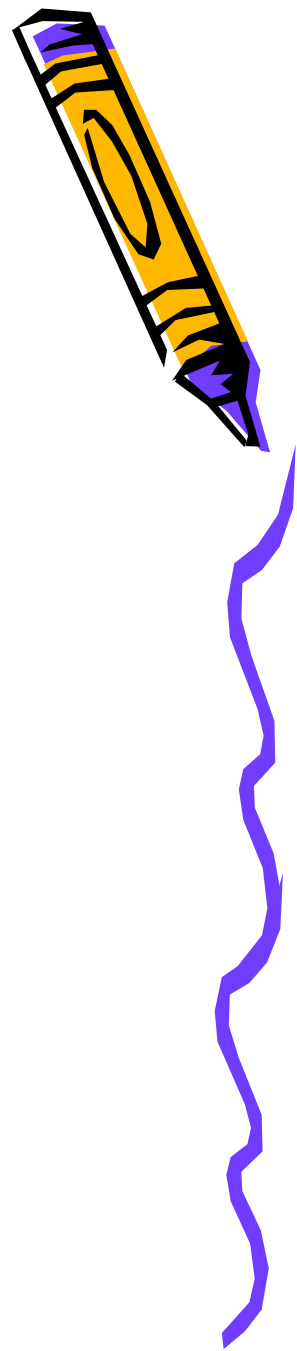
- **Available facilities and power will control the selection of AL System.**
- **Economic is the main criteria that have to be considered in designing a system**



# Difficult Fluids: Solutions

## Thermal Methods

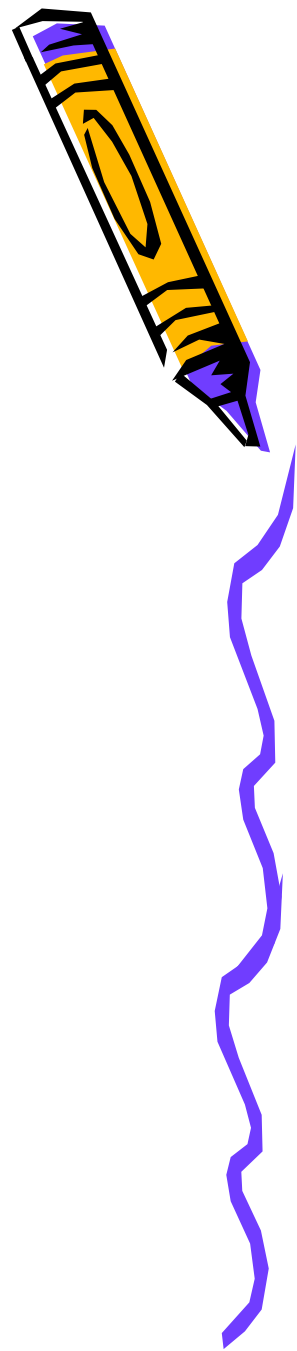
- **Steam Injection**
- **In situ combustion**





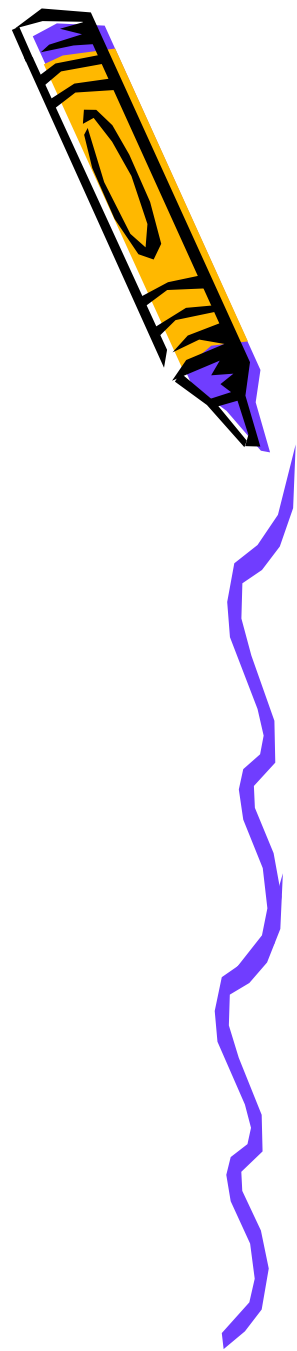
## Challenges with Steam EOR

- **Availability of fresh water for steam generator**
- **Large amount of fuel for steam generator**
- **Large number of producers to be drilled**
- **Has been successful in elastic formations .**
- **Is it successful in carbonates?**
- **Disposal of produced water.**



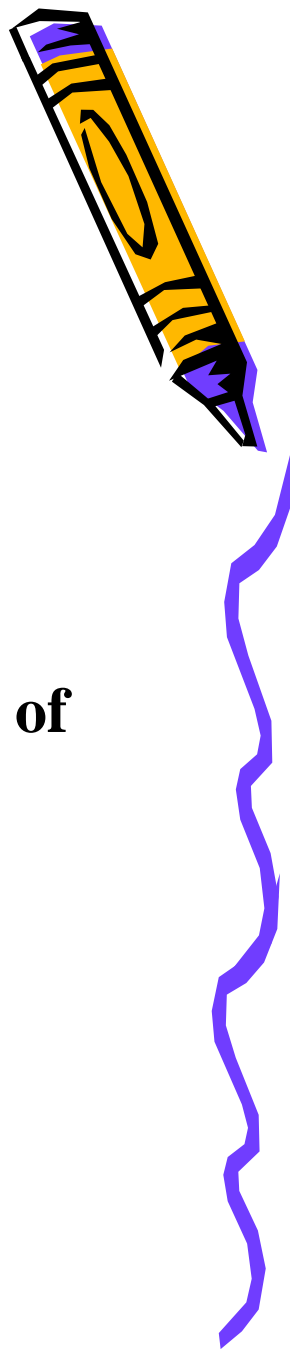
## Steps for applications

- **Study past experience**
- **Screening to identify candidate field:**
  - **OIP**
  - **Viscosity**
  - **Depth**
  - **Rock**
  - **Well Mechanics**
- **Lab experiments**



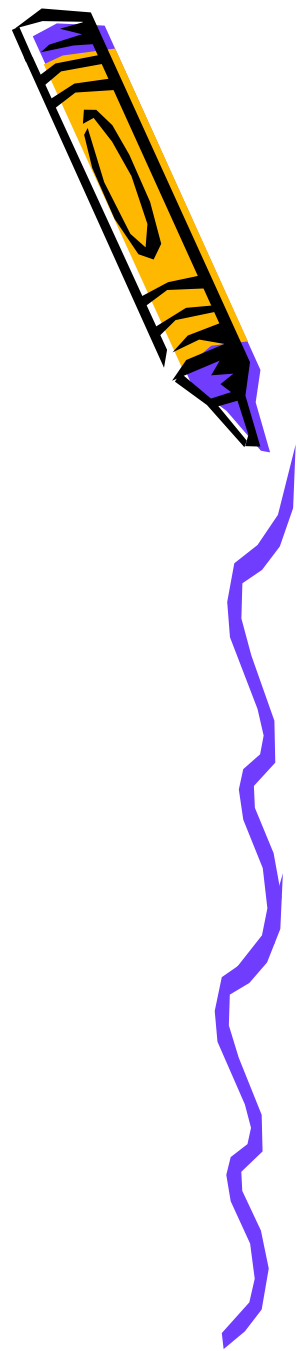
## Steps for applications

- **Modeling**
- **Pilot**
- **Full field scale application**
- **Urge oil industry to support research in the area of EOR**



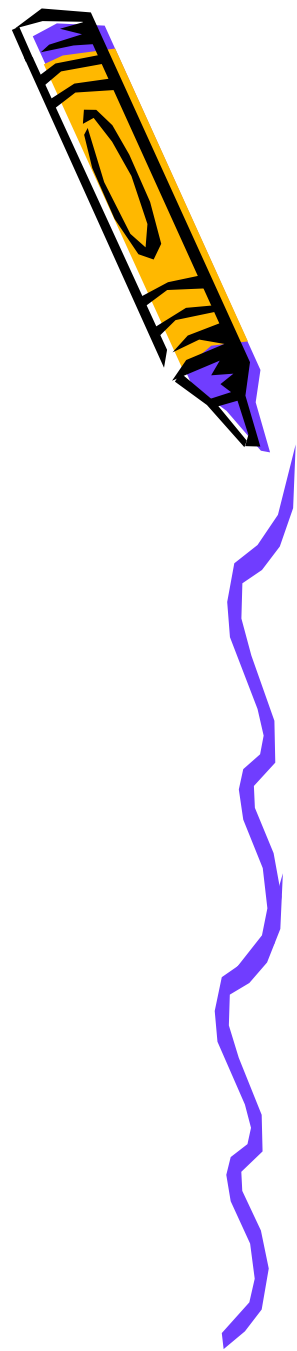
## Surface Facilities

- **Utilize gas steam generator**
- **Utilize existing nearby facilities**
- **Fresh water availability**
- **Boilers, lines and other equipment's**

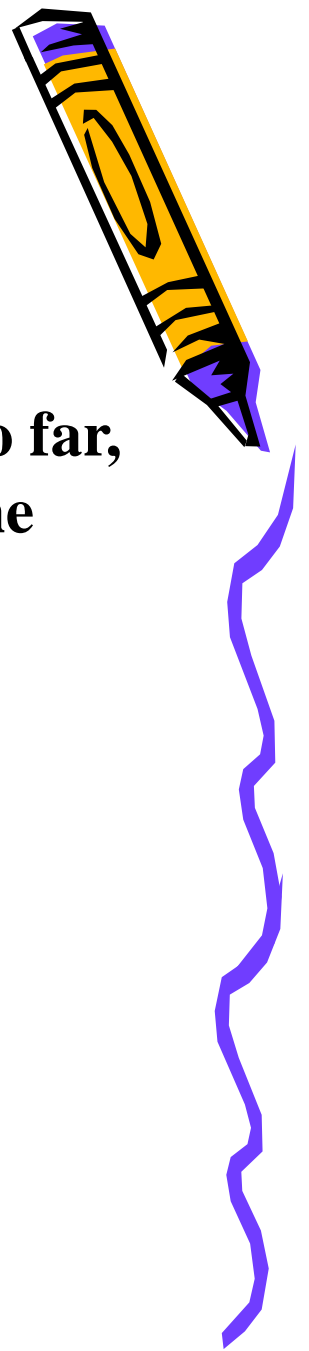


# Economics

- **Government Incentives (Taxes, government agreement terms)**
- **Optimize use of waste products**



# Economics



- **Thermal (steam injection) is the most used EOR so far, so we should start by applying it to benefit from the accumulated experience**



## Conclusion

- *Are we going to wait for an increase in oil price to start application of thermal methods?*

