Autonomous Initiation Systems
Development Update and Field Trial Planning

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Special thanks to the R&D teams at Hunting Titan and Exxon Mobil
Agenda

- Advantages of Autonomous Technology
- Risks Associated with Downhole Conveyance
- Introduction into Autonomous Initiation Systems (AIS)
- Obstacles of AIS Development
- AIS Testing
- Field Trials
- Future Applications of AIS
Advantages

After deployment, autonomous technology can respond to real world conditions without human aid, improving on:

**Safety**
- Reduce or Eliminate Personnel

**Reliability**
- Eliminate human inconsistencies

**Efficiency**
- Faster and more consistent throughput

**Economics**
- Lower costs over time
Risks

Safety
- High pressures, explosive operations and other hazards

Reliability
- Inconsistencies in loading, arming, assembly, tool string lifting, winch control, pump control, etc.

Efficiency
- Wireline pump down speeds max out at ~600 ft/min

Economics
- Inefficient operations = frac wait time and/or rig NPT
- Fishing parted wireline could ruin economics of well completion
Introduction

Eliminate risks associated with downhole conveyance by implementing Autonomous Initiation Systems (AIS)

- AIS Tool consists of an electronics processing assembly, a CCL and the device which is to be initiated

- Programmed with pipe tally, marker depths and parameter file so that the algorithm can keep track of where it is, determine velocities and initiate on depth

- Features redundant mechanical and electrical safety measures to ensure power cannot be supplied to the initiation device until the proper depth is reached
Developmental Obstacles - Retrieval

- To eliminate conveyance, need for retrieval must be removed
- AIS tools can be left in the well for P&A applications
- Perforating guns used in horizontal well completions would need to “disappear” after initiation
Developmental Obstacles - Navigation

Counting Collars vs AIS

- Noise in the well was picked up as collars
- Difficulty distinguishing wellhead before “starting” collar count
- Limited speeds

AIS navigation data from horizontal loop
Autonomous Initiation Systems

Developmental Obstacles - Safety

Safety Features

- Lanyard pin must be pulled at launch to start tool
- 30 sec. timer from launch must expire
- Limited speeds

AIS navigation data from vertical well test data
Developmental Obstacles - Testing

1 mile long flow loop in Milford, TX USA
Navigation Testing

**Horizontal Testing in Flow Loop**

- Successful navigation of the 5200+ foot flow loop with depth accuracy within 3 feet at speeds up to 1000 ft/min
- Anomalies were placed on the outer diameter to ensure navigation system could distinguish noise from collars
- Future testing includes AIS flow loop navigation at speeds up to 3000 ft/min
Navigation Testing

**Vertical Well**
- Successful navigation in 140’ well with short joint

**Simulated Well**
- Use flow loop data to ensure accuracy within 10’ at speeds up to 3000 ft/min
- Introduce anomalies to ensure navigation algorithm performed correctly
Initiation Testing

Acoustic Testing

- Mimic detonator with sonic annunciator for non-destructive flow loop testing
- High speed DAQ used to detect precise location which the tool’s sonic annunciator “fired”
- Four microphones placed on flow loop spaced various lengths from the target

  **RED** - 6 ft. ahead of target  
  **YELLOW** - 1 ft. ahead of target  
  **GREEN** - 8 ft. after target  
  **BLUE** - 24 ft. after target
Initiation Testing

![Graph showing the progression of feet versus seconds for various tests and depths.](image-url)
Autonomous Perforating Tool (APT)
- August 2018
- Non-Frangible steel tool
- Vertical well with 8000 ft of 3.5” tubing
- Multiple deployments of 3 different 2.5” APT
- Initiate circulating charge(s) to punch 3.5” tubing
- Run caliper and fish after each run

Autonomous Cutting Tool (ACT)
- Late Q4 2018
- Non-Frangible steel tool
- 2.5” cutter to cut 3.5” tubing
- Ruggedized to survive trip
- Other cutter sizes in development
Future Applications

P&A Tools
- Non-frangible, non-retrievable
- Guns, plugs, severing tools and cutters
- Plug and Cut simultaneously

Perforating
- Frangible AIS guns for vertical and horizontal wells

“Plug and Perf”
- Frangible AIS for horizontal stage work
- Zonal isolation devices
- Selective Fire Perforating systems

Autonomous Cutter

2.5” O.D. Autonomous Cutter
Conclusion

- AIS will allow any initiated device to be deployed into the well without the need for conveyance
- AIS will reduce personnel, equipment and overall footprint
- Reliability will increase as human inconsistencies are removed from the equation
- AIS will take minutes rather than hours
QUESTIONS? THANK YOU

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