Reducing fresh-water in hydraulic fracturing: An analysis of fracturing fluids used in the Montney Formation in Alberta

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INTRODUCTION

Problem Statement: Large volumes of freshwater used during HF operations which becomes contaminated and is not returned to the water cycle.[1] The extraction of freshwater from their sources for these projects can impact the health of aquifers and of aquatic ecosystems.[2] In addition, local communities affected by such activities have expressed concerns that increased use of freshwater will negatively impact the quality and availability of potable water sources.[3]

As the demand for freshwater increases, alternative fluids that reduce the necessity for freshwater in HF must be pursued. In this study, we compared the amount of water usage as well as resulted BOE for different fracturing fluid systems in the Montney Formation.

HF - water-intensive method.[4]

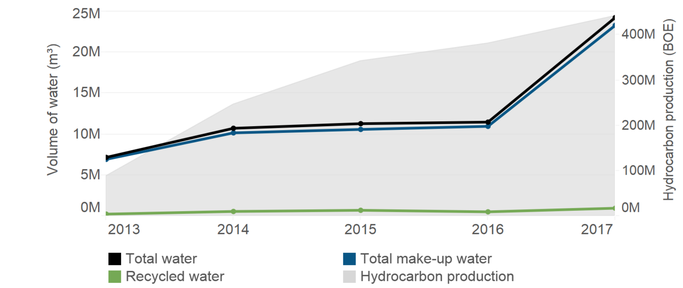

Fig. 1. Volumes of water used for hydrocarbon production in Alberta (2013-2017).

In 2017, 24 million m^3 of water were used in HF operations in the province;[4]

- On average it took 0.59 barrels of water to produce 1 BOE;[4]
- There has been an increase in HF projects in Alberta since 2013;
- The use of recycled water for HF operations has been minimal.

STUDY AREA

The Montney Formation is a low-permeability hydrocarbon-rich siltstone that stretches from NE British Columbia down into NW Alberta.[5]

The formation lies under towns such as Grand Prairie, Fox Creek, and Peace River (Fig 2). This area is also home to the traditional territories of the people of Treaty 8 and Treaty 6, several Indigenous Reserves, and is also home to the Metis Nation of Alberta Regions 4, 5 and 6.

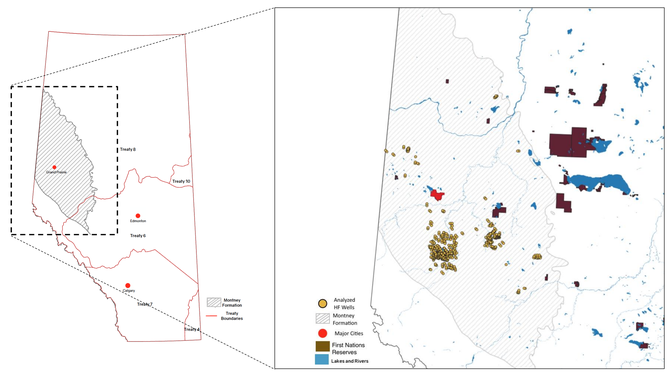

Fig. 2. Location of 598 analyzed stimulated wells in the Montney formation, AB.

METHODS

Data & workflow:

- Data on production start and end dates, as well as BOE produced were retrieved for the identified wells (geoSCOUT).
- Wells were filtered with last produced dates between 2013-2018.
- Data on total water volume, carrier fluids, energizing fluids and their % component by mass in the fracturing fluid was gathered from FracFocus.[6]
- Data from 598 wells was classified into 4 categories based on their HFF (Fig 3).
- Statistical analysis comparing water use to BOE production was conducted.

ADDITIONAL INFORMATION:

ASSUMPTIONS:

- Montney has uniform geologic properties in all the wells;
- HFF were categorized based on composition noted in FracFocus and literature definitions.

LIMITATIONS:

- Data limitations due to availability of public information;
  - Limited number of wells analyzed;
  - Specific cost information not available (proprietary information).

FLUID TYPE	PRIMARY CARRIER FLUID	CONCENTRATION IN HFF BY % MASS OF PRIMARY CARRIER FLUID	ENERGIZING FLUID	NUMBER OF WELLS
WATER-BASED	Water	along with proppant >99%	None	230
OIL-BASED	Crude Oil, Kerosene, Diesel, Liquid Petroleum Gas (LPG), Propane	>55%	None	110
ENERGIZED - CRYOGENIC	Water	26 - 65%	Liquefied Nitrogen or Carbon Dioxide	178
ENERGIZED - GAS	Water	27 - 57%	Nitrogen	80

Tab. 1. Fracturing fluid systems analyzed in this study.

RESULTS

- Energized-cryogenic fluids have highest normalized BOE production (20% more than water-based fluids) and consume significantly less water than water-based fluids (80%).
- Water-based HFF have a variation in BOE produced (however in average is the second efficient fluid type) and consume the most water.
- Energized-gas HFF use less water than energized-cryogenic, but result in the least BOE production.
- Oil-based HFF use no water, while have as the same BOE as Water-based.

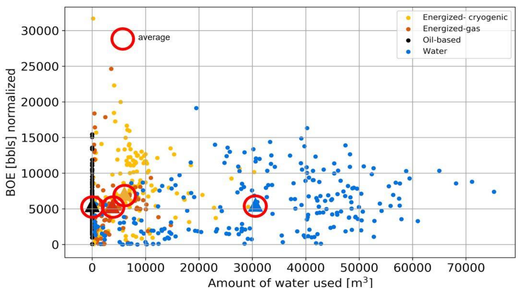

Fig. 3. Comparison of resulted BOE and amount of water used. Triangles represent average normalized BOE and water use. In this study only BOE production within first 12 months was analyzed.

- The use of alternative fluids has decreased in recent years, likely due to economic conditions.
- Until 2015, alternative fluids were the most widely used in HF operations.
- From 2017, more than 95% wells used water-based fluids for HF operations.

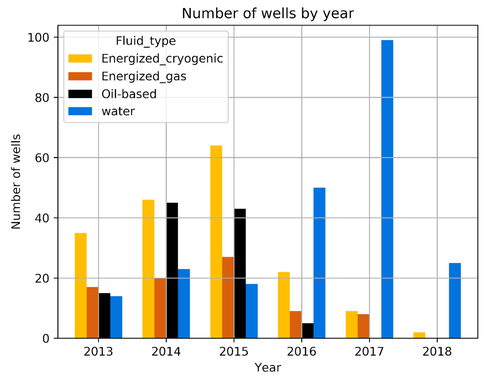

Fig. 4. Number of wells for fluid types by year.

CONCLUSIONS

Based on the results from statistical analysis and literature review:

- Alternative fluids showed higher production rate per stage within first 12 months of the production comparing to water-based wells.
- In general, water based HFF result in larger fractures and more complex fracture networks. Lower BOE production per stage comparing to alternative wells may indicate the limited proppant transportation capacity of water based fluids.
- Overall, energized-cryogenic HFF have proven the higher efficiency than water based HFF, however the number of "alternative" wells has decreased in the last few years, most likely due to higher cost of the fluid components and necessity of special infrastructure.
- Current alternative HFF are more expensive than water-based HFF, but higher production rates and reduced production time would encourage industry to start using alternatives.
- Reduced freshwater consumption would positively impact the natural environment and local communities.
- Incentives for alternative HFF should be explored, as well as research into alternate HFF, to help reduce freshwater consumption.

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