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A Case Study of a New Emulsifier Used in a High Density Non-aqueous Drilling Fluid in Asia

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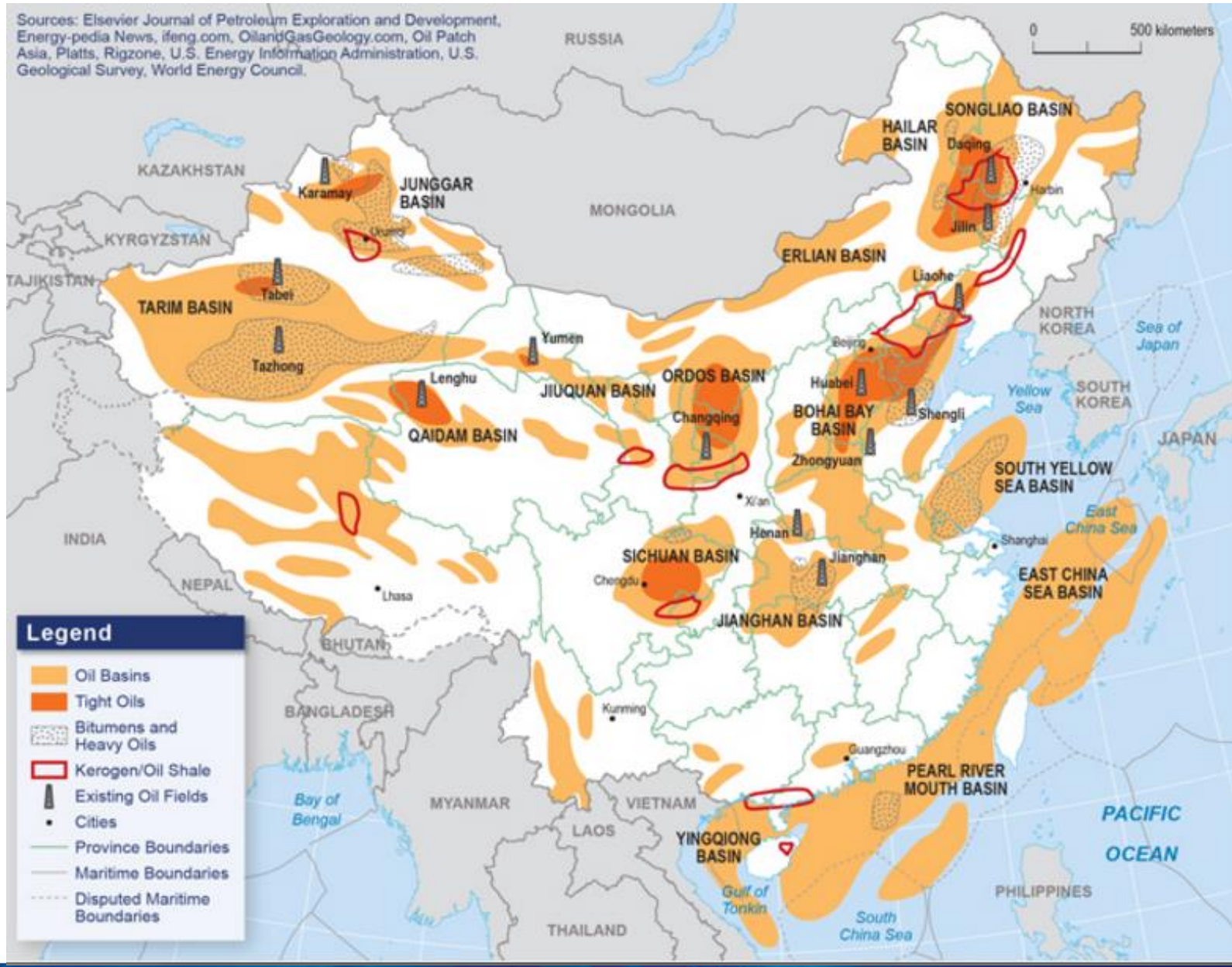
Outline

- Introduction
- Laboratory development of the emulsifier
- Field trial lab qualification of the emulsifier
- Field trial results
- Conclusion

HTHP Wells Locations

Tarim China


Sources: Elsevier Journal of Petroleum Exploration and Development, Energy-pedia News, ifeng.com, OilandGasGeology.com, Oil Patch Asia, Platts, Rigzone, U.S. Energy Information Administration, U.S. Geological Survey, World Energy Council.
0
500 kilometers
RUSSIA
KAZAKHSTAN
MONGOLIA
KYRGYZSTAN
TAJIKISTAN
INDIA
NEPAL
BHUTAN
BANGLADESH
MYANMAR
LAOS
VIETNAM
THAILAND
PHILIPPINES
NORTH KOREA
SOUTH KOREA
JAPAN
Sea of Japan
Yellow Sea
East China Sea
South China Sea
Gulf of Tonkin
Bay of Bengal
PACIFIC OCEAN
SONGLIAO BASIN
HAILAR BASIN
ERLIAN BASIN
JUNGGAR BASIN
TARIM BASIN
JIUQUAN BASIN
QAIDAM BASIN
ORDOS BASIN
BOHAI BAY BASIN
SOUTH YELLOW SEA BASIN
EAST CHINA SEA BASIN
SICHUAN BASIN
JIANGHAN BASIN
PEARL RIVER MOUTH BASIN
YINGQIONG BASIN
Karamay
Urumqi
Tabei
Tazhong
Yumen
Lenghu
Changqing
Daqing
Harbin
Jilin
Liaohe
Beijing
Huabei
Shengli
Zhongyuan
Xi'an
Henan
Shanghai
Jianghan
Chengdu
Lhasa
Kunming
Guangzhou
Legend
Oil Basins
Tight Oils
Bitumens and Heavy Oils
Kerogen/Oil Shale
Existing Oil Fields
Cities
Province Boundaries
Maritime Boundaries
Disputed Maritime Boundaries

Drilling Fluid Challenges in Tarim Basin

- High formation pressure with deep salt layer ---Calls for Ultra-high density drilling fluids (over MW 2.4 (20ppg), killing fluid density up to 2.8 (23ppg))
- Gypsum formation with mudstone and even potential salt-water bed---Calls for NADF
- Encounter borehole stability, stuck pipe, high pressure brine influx and downhole losses

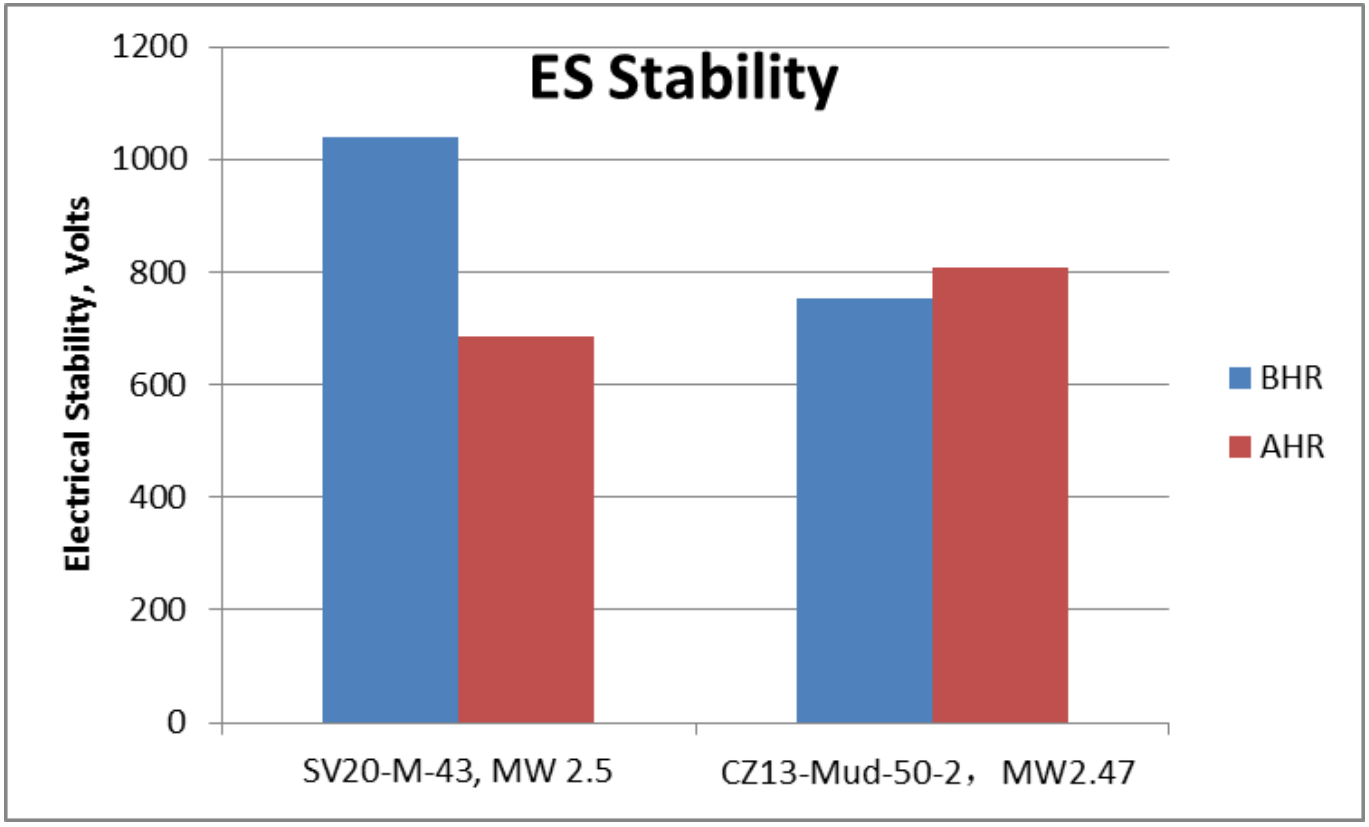
Emulsifier Development

- Project Target
  - ✓Emulsifier for NADF, 220-250^{o}C
  - ✓MW up to 2.4 S.G.
  - ✓ES over 600V

Emulsifier Development

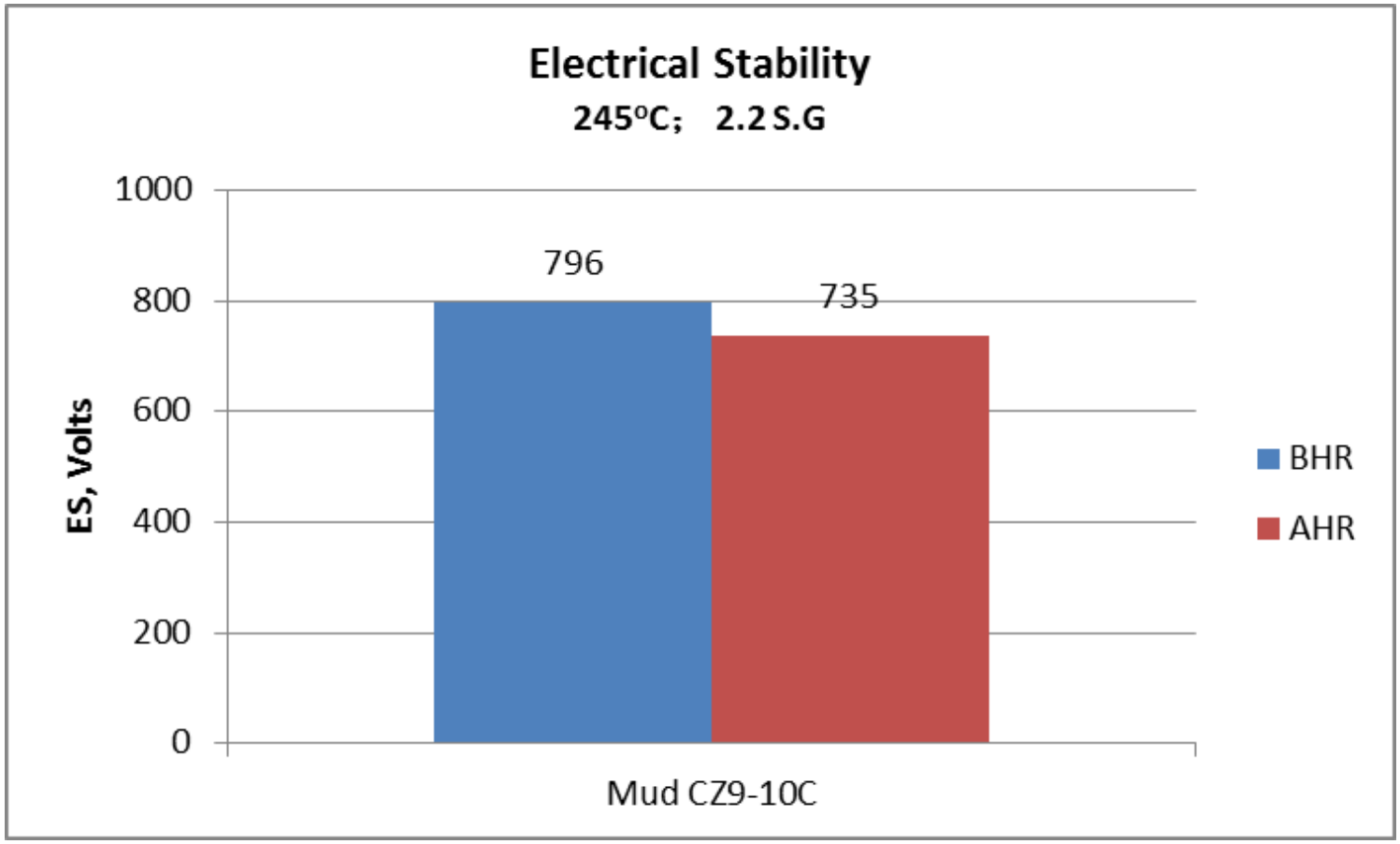
- uHT emulsifiers are patent pending products.
- Selectively crosslinking structures contribute the temperature stability.
- Main raw materials are organic food grade vegetable oils, such as corn oil, soybean oil, and Castor oil, etc.

Emulsifier Development

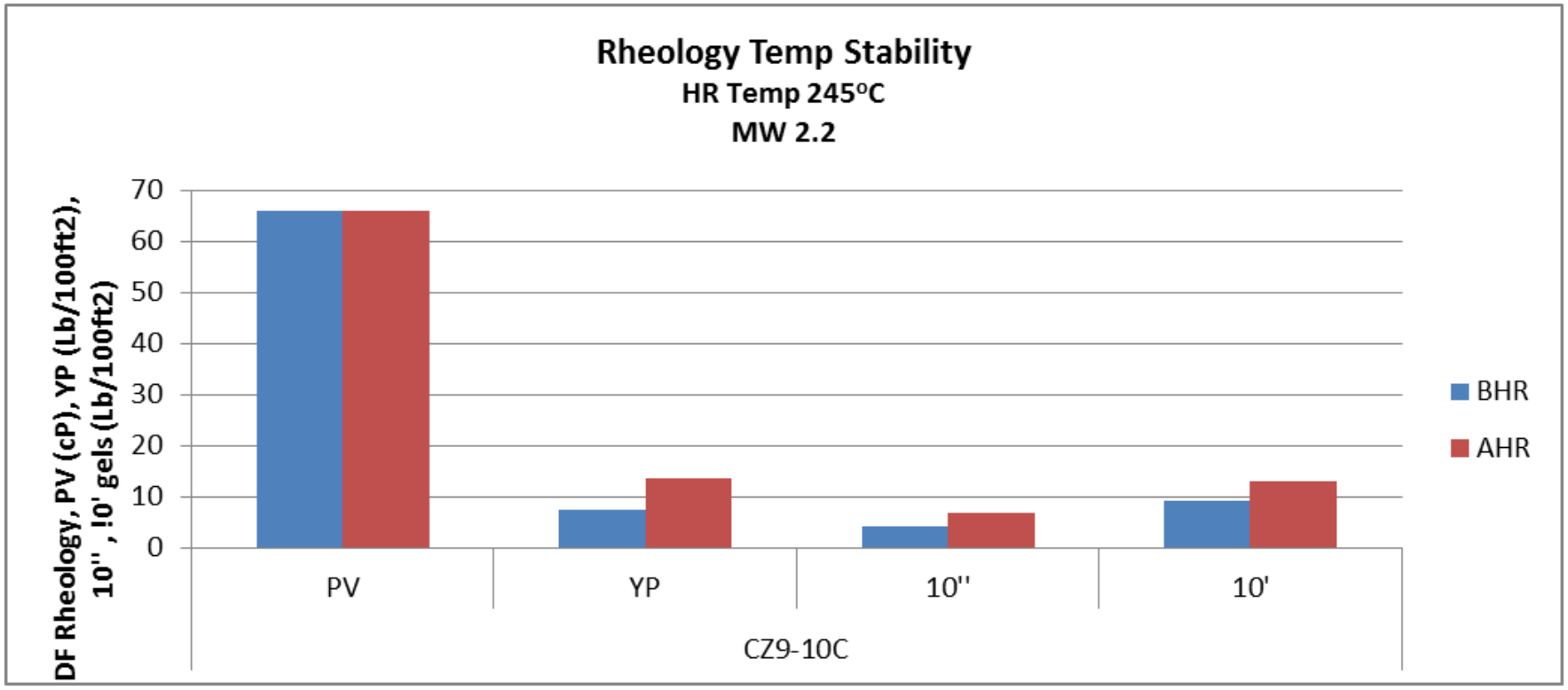


- ✓ **MW over 2.4**
- ✓ **ES over 600V**
- ✓ **HR temp: 225°C**

Emulsifier Development



Emulsifier Development



Field Trial Parameters

Well section	Typical properties						
	Density, g/cm3	PV, mPa.S	ES, V	HTHP, F.L. mL	HTHP F.L Cake, mm	10'' gel	10' gel
Salt Layer	2.20-2.40	45-85	>=400	<=15	<=12	1~4	5~12
Production Layer	1.82-1.95	45-85	>=400	<=10	<=10	1~3	4~10

Field Trial, Tarim Field Lab

Mud	Density, g/cm3	PV, mPa.S	ES, V	HTHP, F.L. mL	HTHP F.L Cake, mm	10'' gel	10' gel
20160628	2.41	90	1115	3	6	2	5
20160628C	1.9	53	910	2.8	5.5	3	4.5

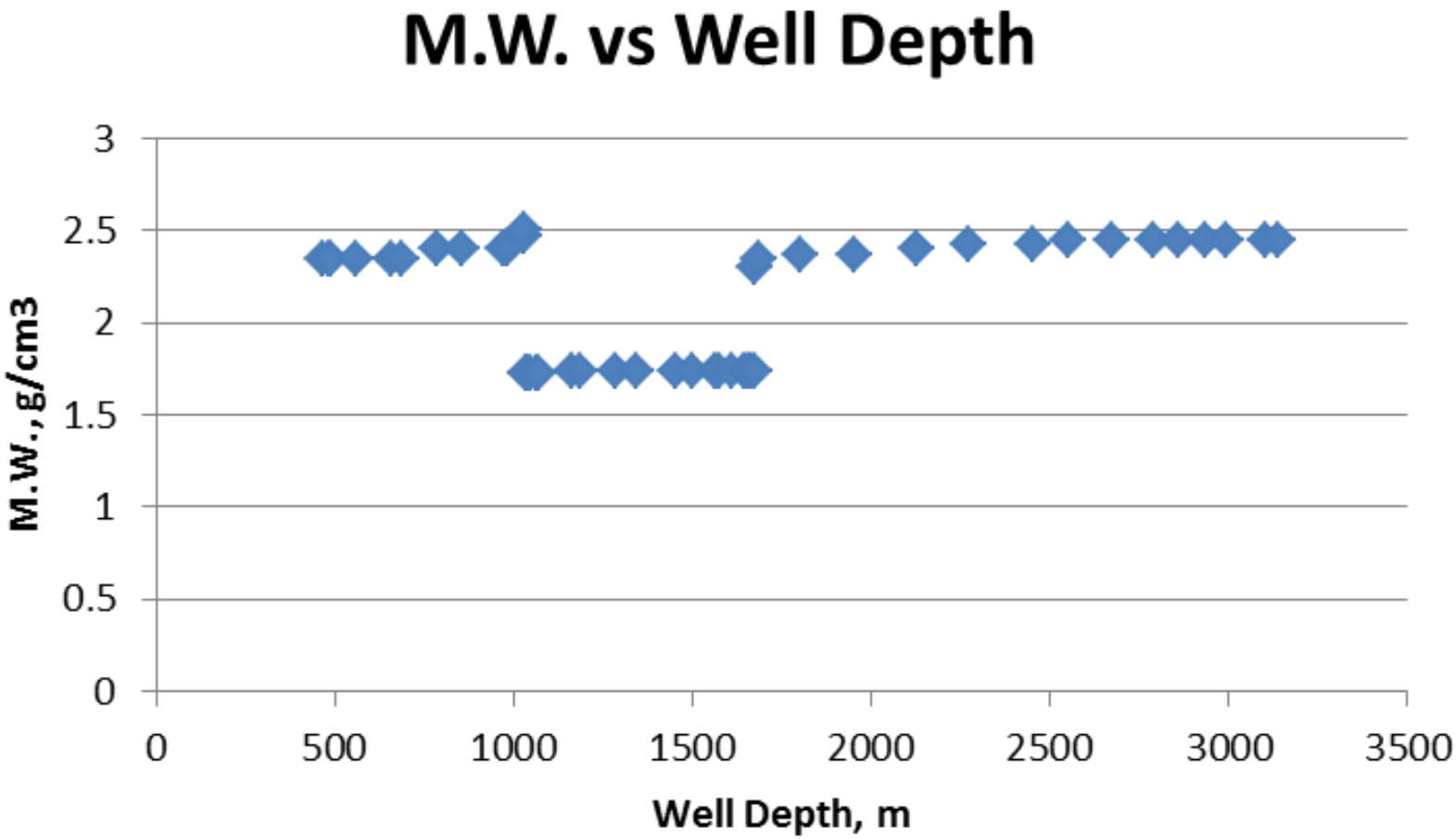
Mud	Density, g/cm3	PV, mPa.S	ES, V	HTHP, F.L. mL	HTHP F.L Cake, mm	10'' gel	10' gel
20160701-1	2.4	75	1087	3.8	5	4	5.5
20160701-2	1.8	33	837	5.4	4	3	4.5

Field Trial

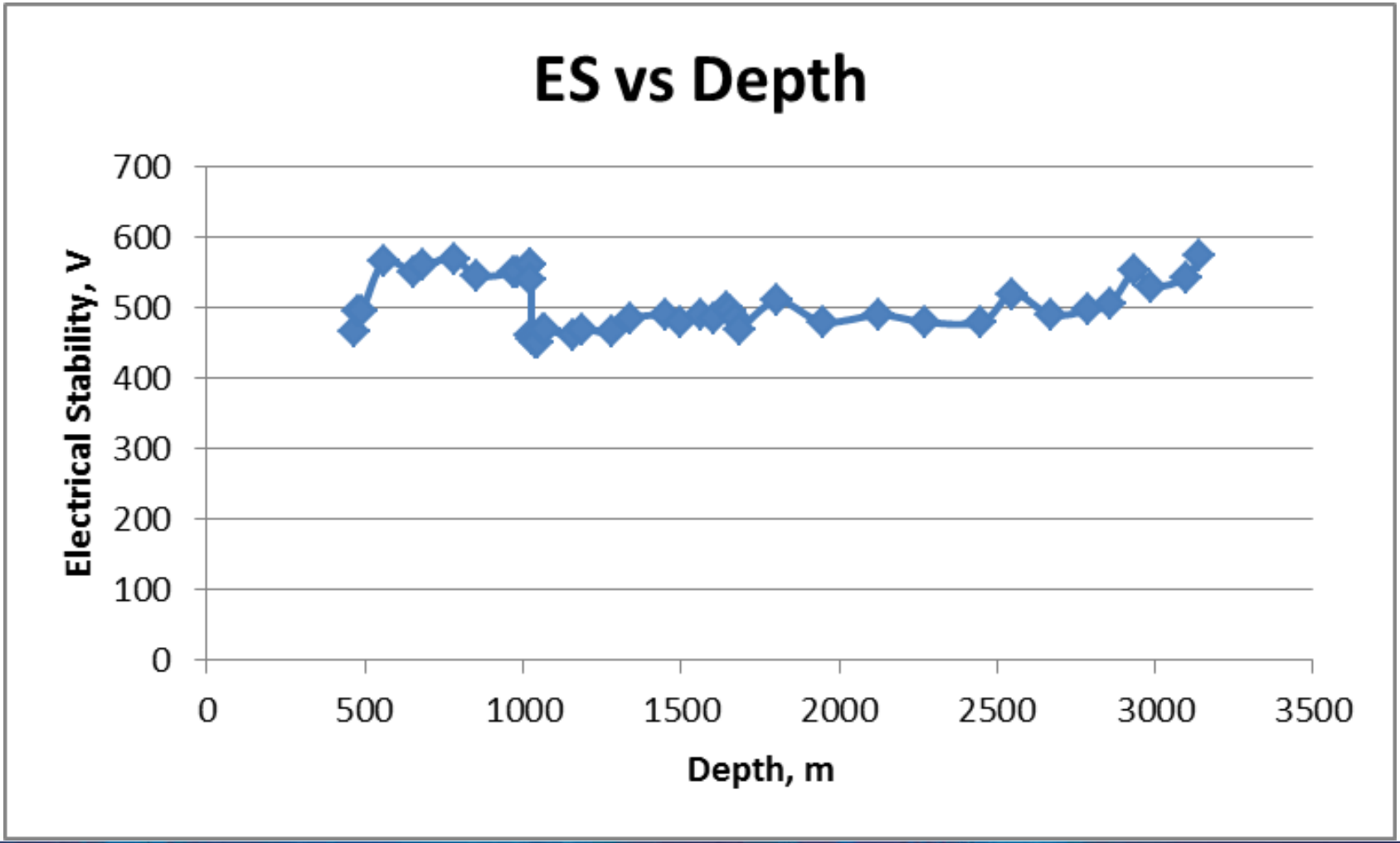
- Trial section DF requirement

Depth (m)	Density (g/cm^3)	OWR	ES (V)	HTHP FL (mL)	YP (Pa)	Gel (10s/10m), Pa	LD Solid %	Ex. Lime (kg/m^3)
412～3002	2.40 ～ 2.50	80:20～90:10	≥ 400	≤ 5	5～20	3 ～ 8 /5 ～ 16	≤ 9	≥ 5

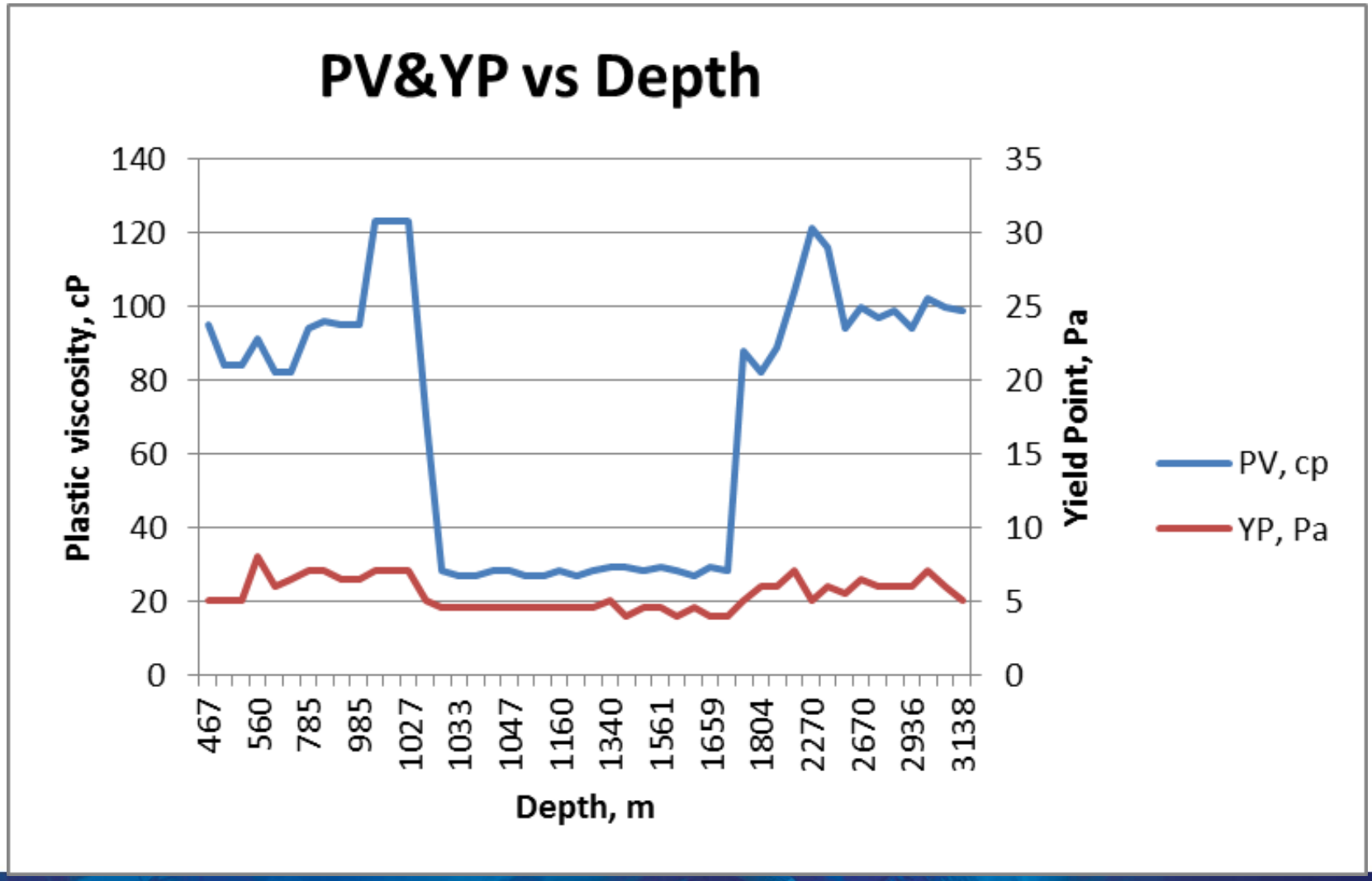
Field Trial


M.W. vs Well Depth
M.W., g/cm3
3
2.5
2
1.5
1
0.5
0
0
500
1000
1500
2000
2500
3000
3500
Well Depth, m

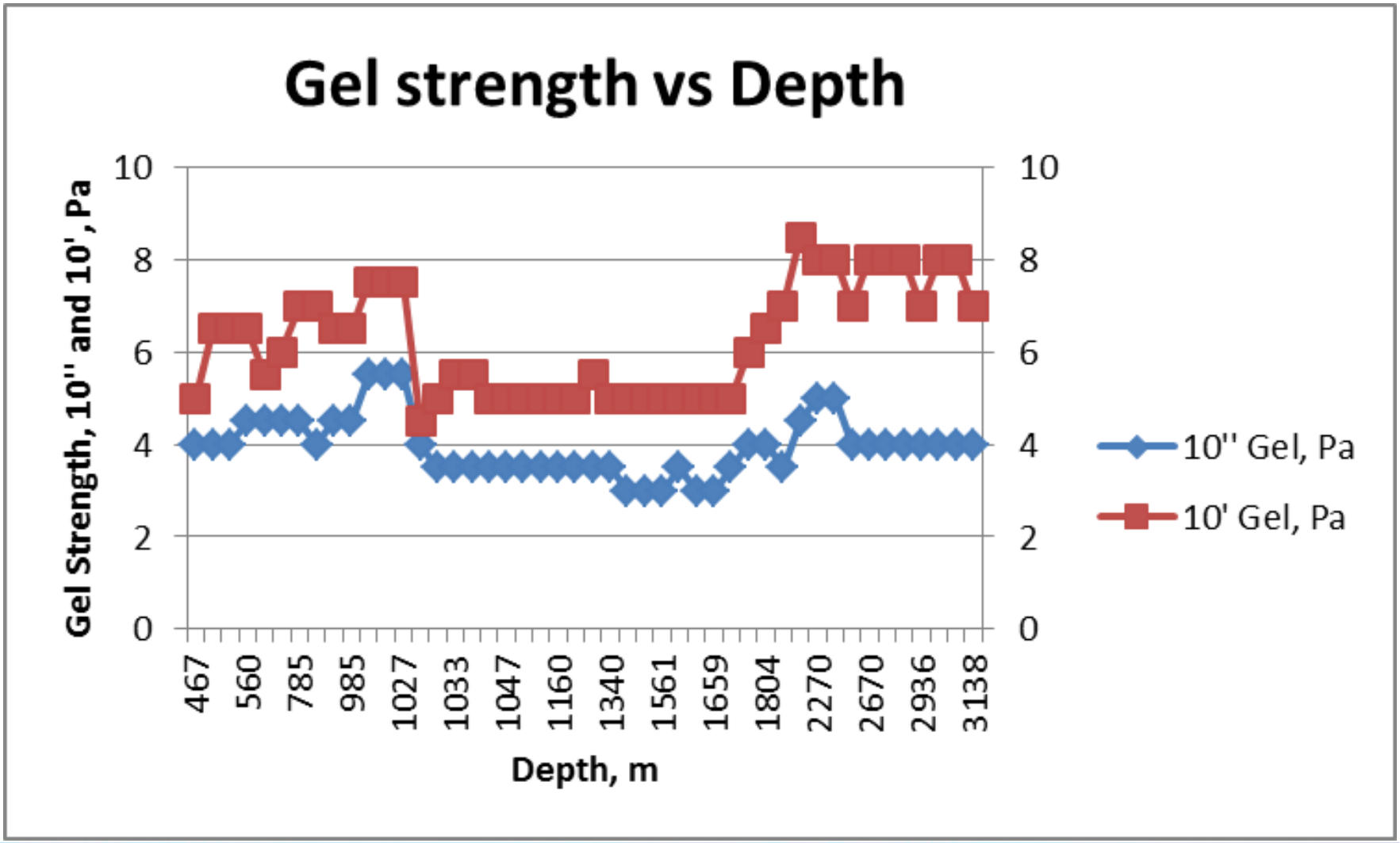
Field Trial


ES vs Depth
Electrical Stability, V
700
600
500
400
300
200
100
0
0
500
1000
1500
2000
2500
3000
3500
Depth, m

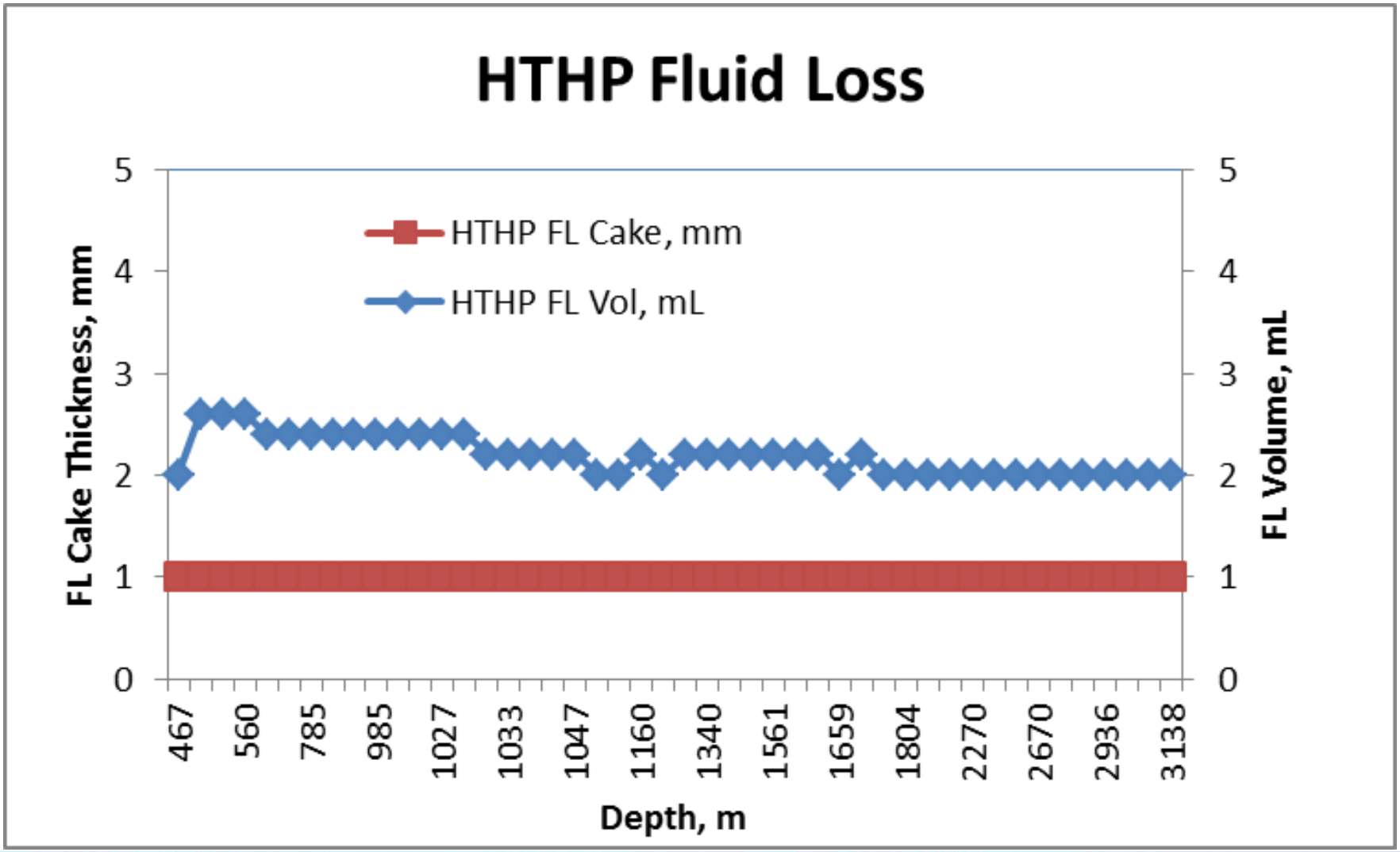
Field Trial


PV&YP vs Depth
Plastic viscosity, cP
Yield Point, Pa
Depth, m
PV, cp
YP, Pa
140
120
100
80
60
40
20
0
35
30
25
20
15
10
5
0
467
560
785
985
1027
1033
1047
1160
1340
1561
1659
1804
2270
2670
2936
3138

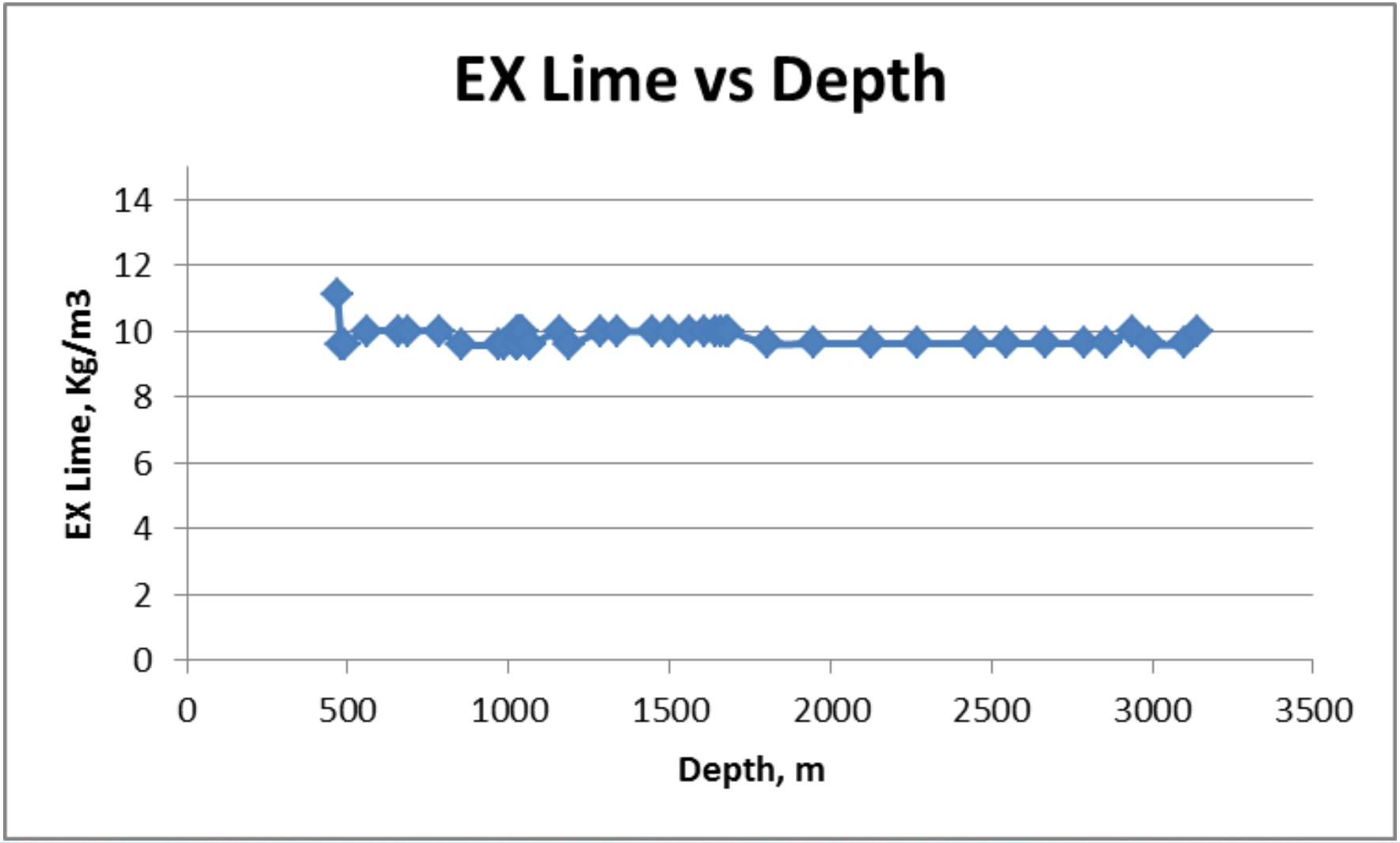
Field Trial


Gel strength vs Depth
Gel Strength, 10'' and 10', Pa
10
8
6
4
2
0
467
560
785
985
1027
1033
1047
1160
1340
1561
1659
1804
2270
2670
2936
3138
Depth, m
10'' Gel, Pa
10' Gel, Pa

Field Trial


HTHP Fluid Loss
HTHP FL Cake, mm
HTHP FL Vol, mL
FL Cake Thickness, mm
FL Volume, mL
0
1
2
3
4
5
467
560
785
985
1027
1033
1047
1160
1340
1561
1659
1804
2270
2670
2936
3138
Depth, m

Field Trial


EX Lime vs Depth
EX Lime, Kg/m3
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
3500
Depth, m

Conclusion

- High performance emulsifiers were successfully used (467 to 3118 meters)

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