

Pollucite and cesium formate fluids in oilfield drilling - supply, processing & demand

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Sinomine Specialty Fluids

- Previously Cabot Specialty Fluids
- World's leading cesium formate fluids supplier to the oil & gas industry since 1999
- Fluid service company
- Headquartered in Aberdeen, Scotland
- Own and operate the Tanco mine in Manitoba, Canada
- Sales offices and stock points strategically located around the world
- Since June 2019 part of Sinomine (Hong Kong) Rare Metals Resources Co. Ltd, which is part of Sinomine Resource Group (public company).
- Access to additional reserves and mining expertise through Sinomine.
- 47 employees, including offshore engineers + 71 at mining site



The lifecycle of cesium formate



Pollucite ore

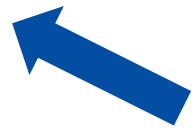


Cesium formate brine

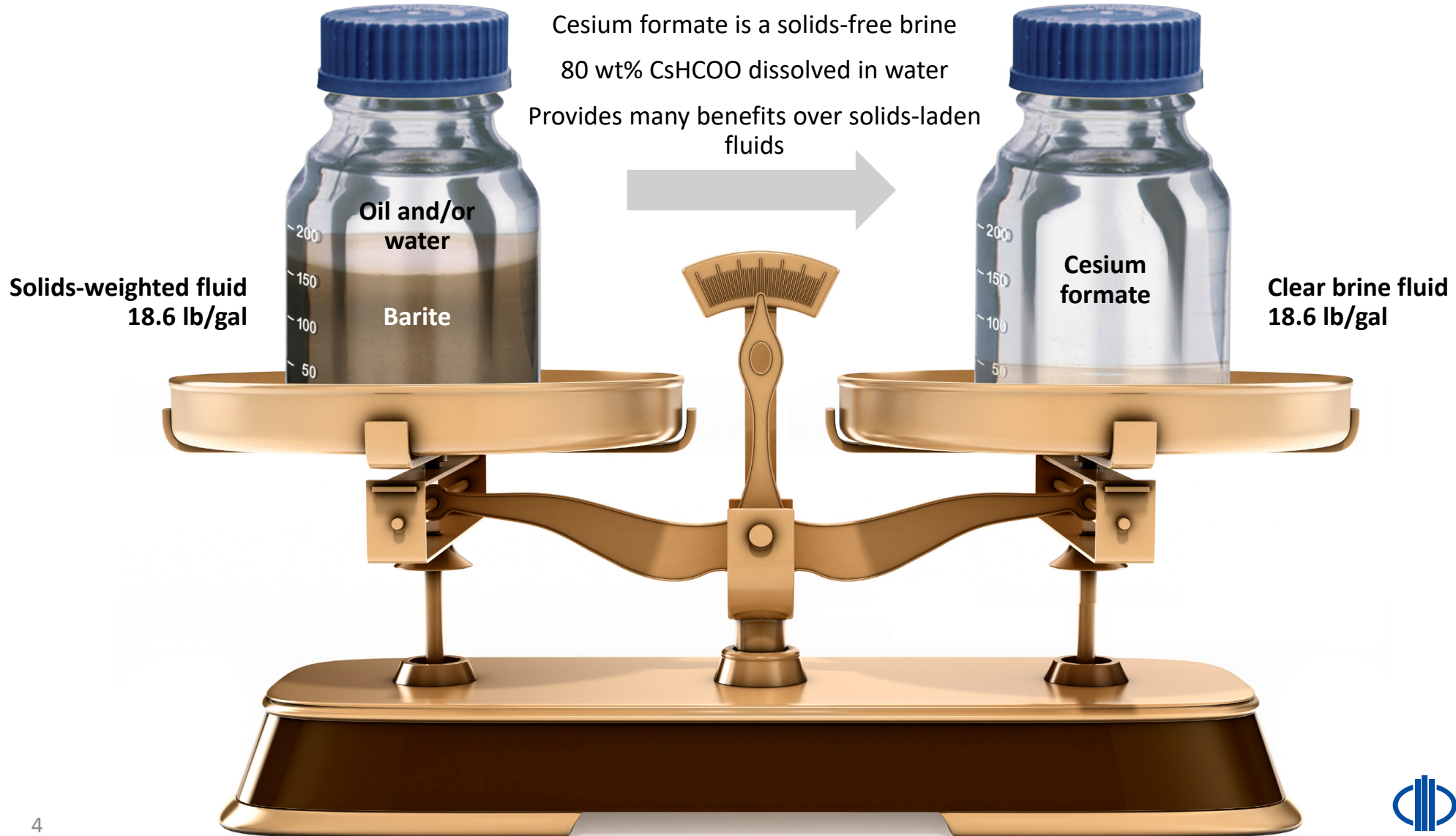


Reclamation

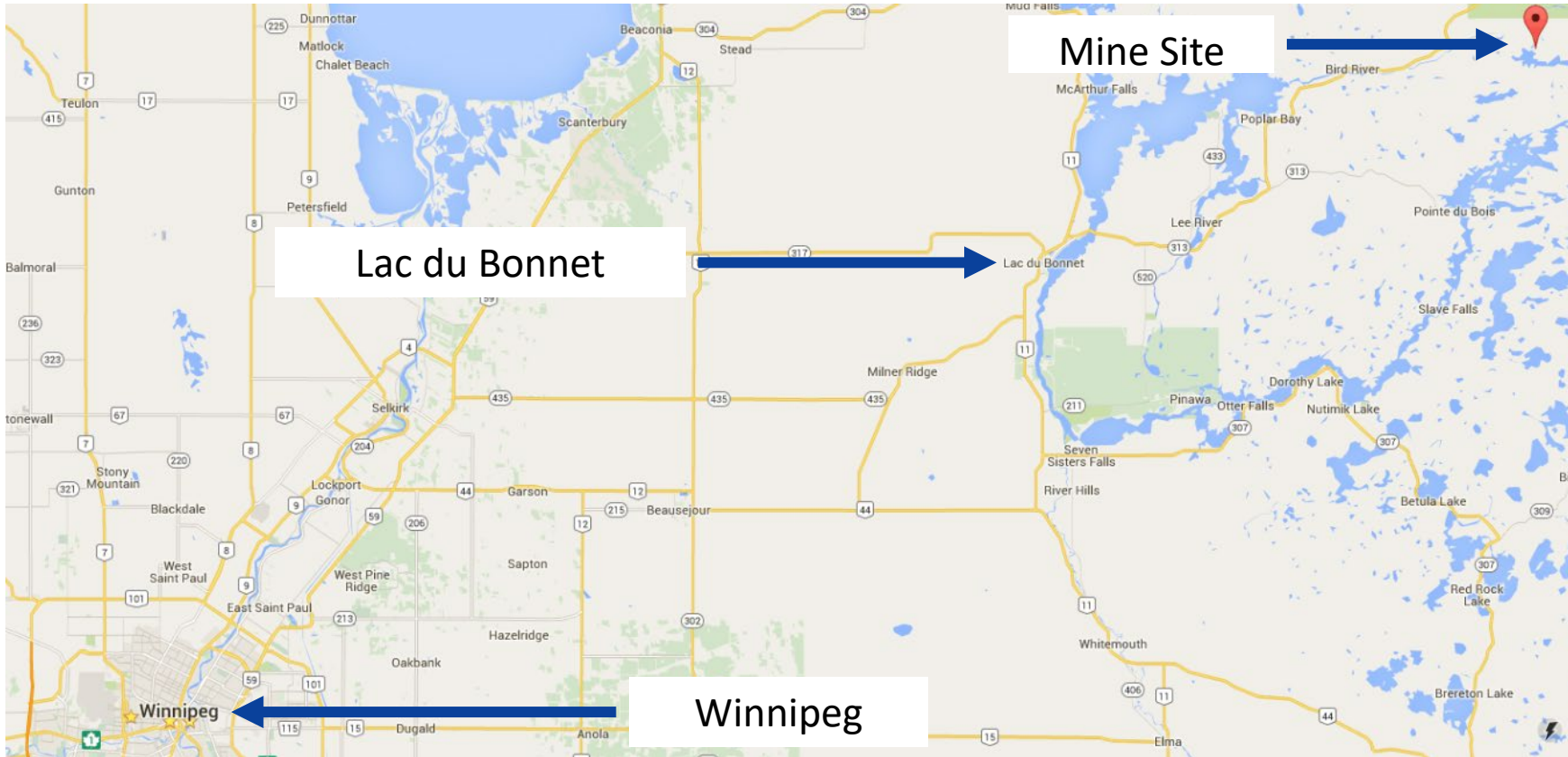
Chemical Leasing



What is cesium formate?



Tantalum Mining Corporation of Canada - TANCO



The mine is at Bernice Lake, Manitoba, 180 km north-east of

Tantalum Mining Corporation of Canada - TANCO



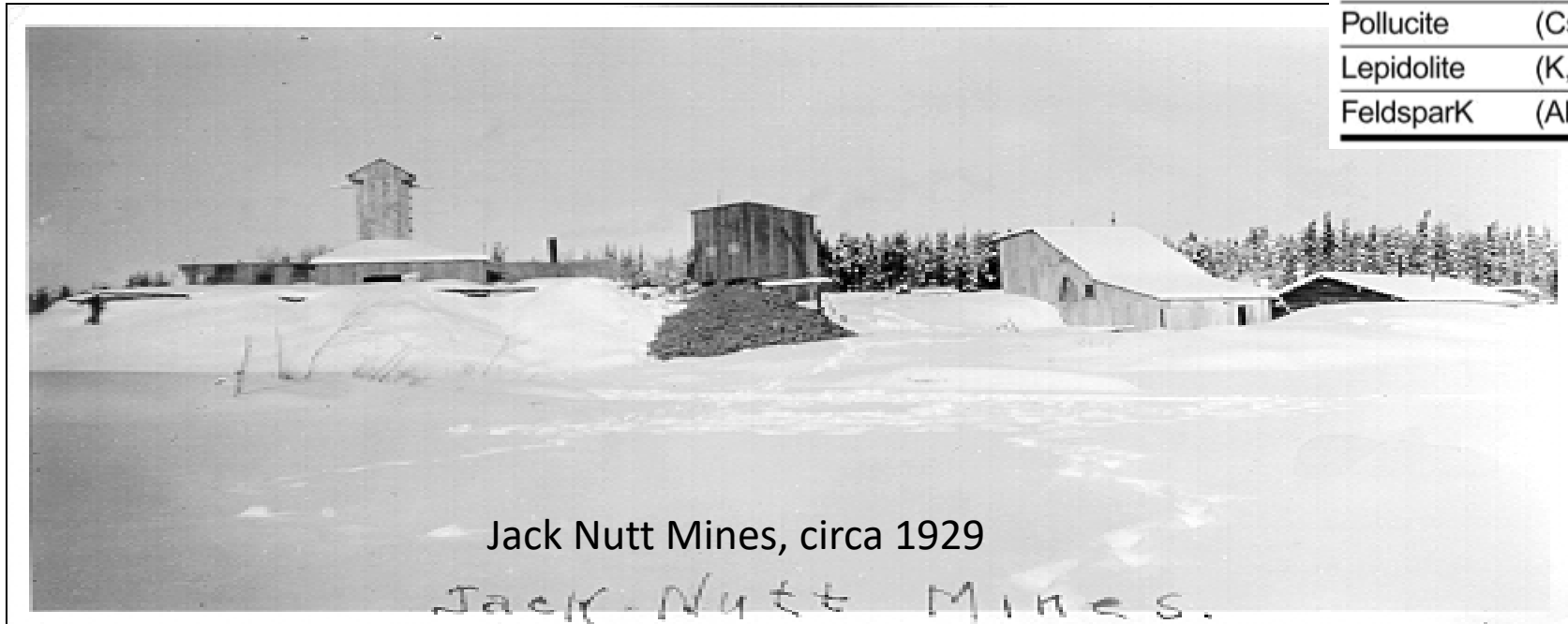
Mine in relation with surface



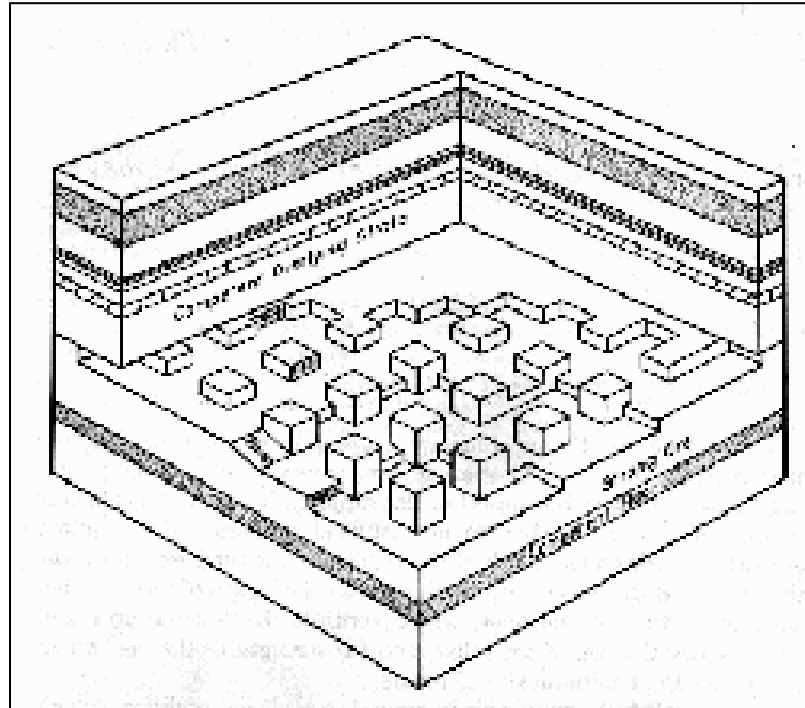
TANCO history

- 1914 Federal Surveyors Beresford and Nicole camped on the shores of the lake and name it Bernic Lake
- 1929 TANCO pegmatite was discovered during drilling operation exploring for tin
- 1957 Pollucite was identified (cesium)
- 1958 Mine opened
- 1967 Tantalum Mining Corporation of Canada Limited (TANCO) formed
- 1977 2.6 mill lb of tantalum oxide had been produced from 1.25 mil tons of ore

Mineral	Chemical Formula
Spodumene	$\text{Li Al (SiO}_6\text{)}$
Montebrasite	$\text{Li Al PO}_4 \text{ (F}_9\text{OH)}$
Wodgonite	$\text{Mn}_4(\text{Sn} > \text{Ta, Ti, Fe})_4 (\text{Ta} > \text{Nb})_8 \text{O}_{32}$
Microlite	$(\text{Na, Ca})_2 \text{Ta}_2 \text{O}_6 (\text{O, OH, F})$
Pollucite	$(\text{Cs, Na}) (\text{AlSiO}_6) \text{H}_2\text{O}$
Lepidolite	$(\text{K, Rb}) (\text{LiAl})_2 (\text{Al, Si})_4 \text{O}_{10} (\text{OH, F})_2$
FeldsparK	$(\text{AlSi}_3\text{O}_8)$



Room and pillar mining

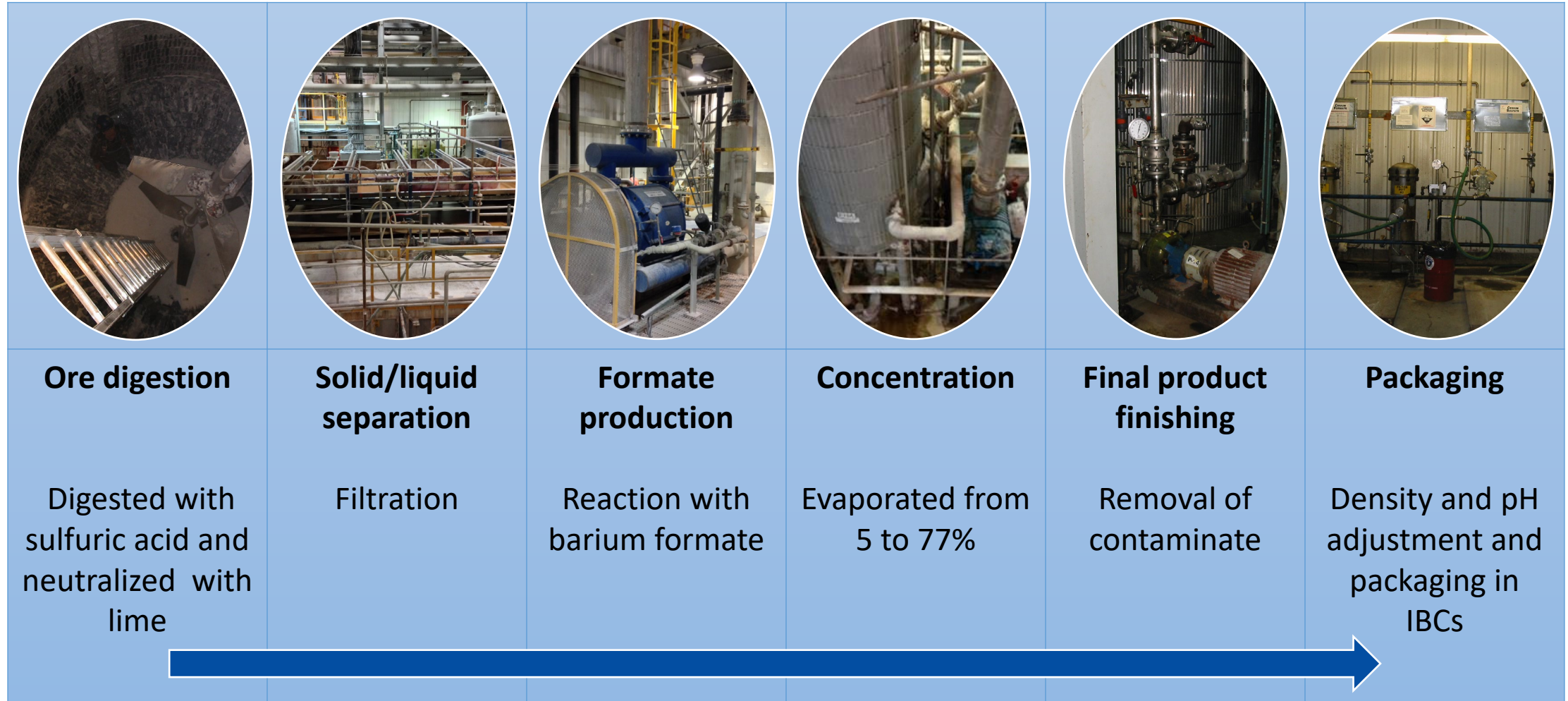


Ore to plant

- Pollucite ore mined and broken with rock breaker
- Ore is Hoisted in 3.5 MT double skip hoist and stored into 2x Coarse Ore Bins
- Crushed to <3" and stored on surface
- Ground in rotating ball mill to ~200 mesh (consistency of flour) and pneumatically transferred to Chemical Plant



Cesium formate production



Current capacity ~ 700 bbl/month

Cesium formate brines – in use since 1999

Applications are mainly deep HPHT gas well constructions, including:

- Reservoir drill-in
- Completion
 - Screen-running
 - Perforating
 - Gravel pack carrier fluid
 - Upper completions
- Workover & Interventions
- Packer and long-term well suspensions
- Low-solids OBM



HP = 176
HT = 177
HPHT = 121
Ultra HPHT = 29

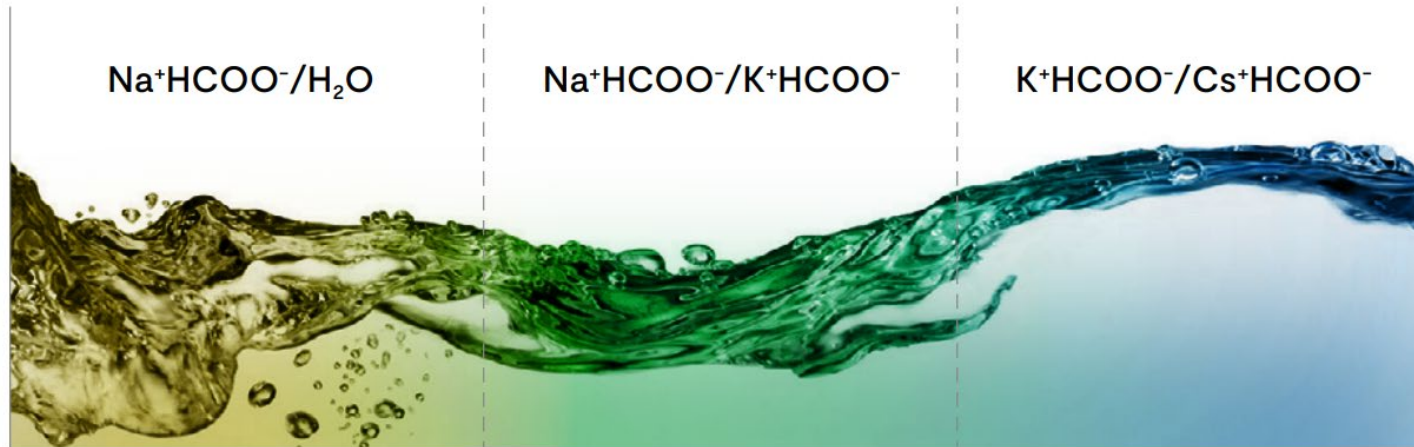
The formate brine family

H₂O
1.00 g/cm³
8.3 lb/gal

Na⁺HCOO⁻
1.30 g/cm³
10.8 lb/gal

K⁺HCOO⁻
1.57 g/cm³
13.1 lb/gal

Cs⁺HCOO⁻
2.30 g/cm³
19.2 lb/gal



Covers the whole density range from water to 19.2 lb/gal



Performance through SIMPLICITY

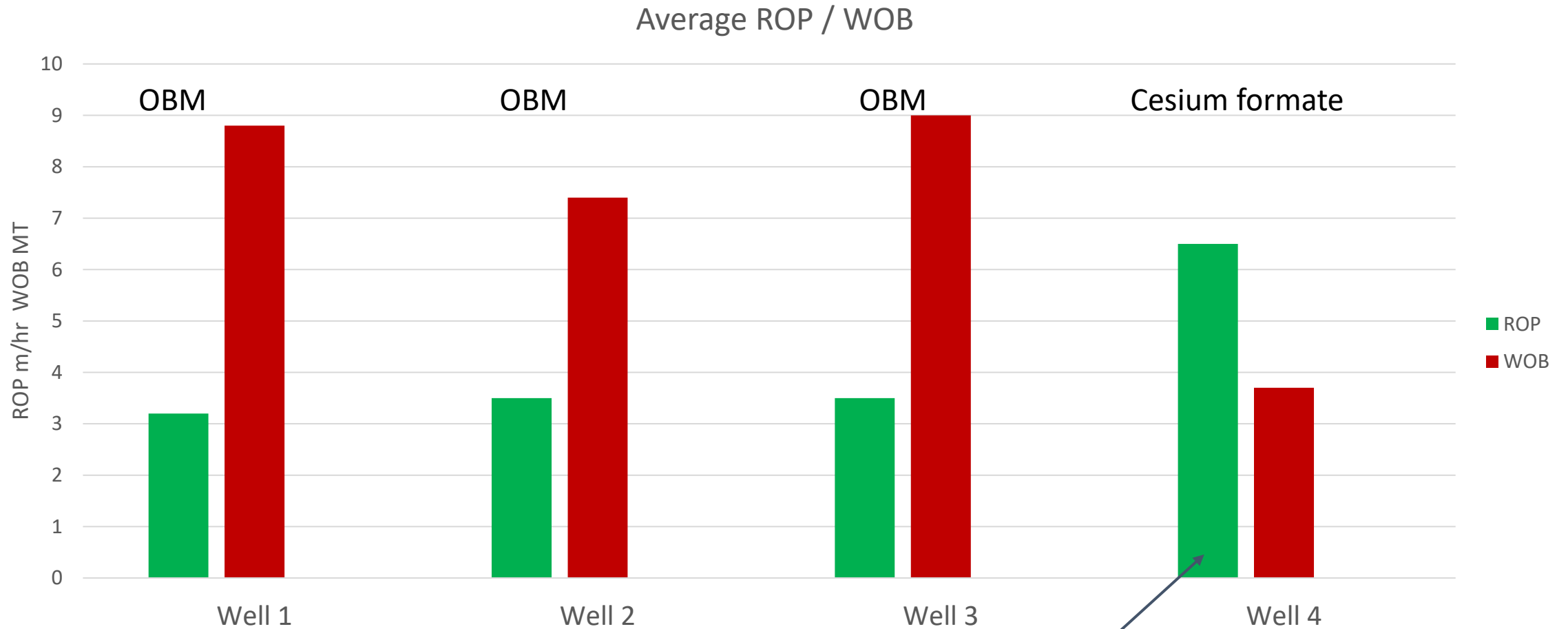


A combination of unique **inherent** fluid properties gives excellent fluid performance

- Well control
 - Sag-free
 - Early kick-detection
- Drilling performance
 - High ROP
 - Low ECD
 - Improved hole cleaning
 - No differential sticking
- Reduced formation and completion damage
 - Compatible with reservoir
 - No screen-plugging

Total Martin Linge - 4-well comparison

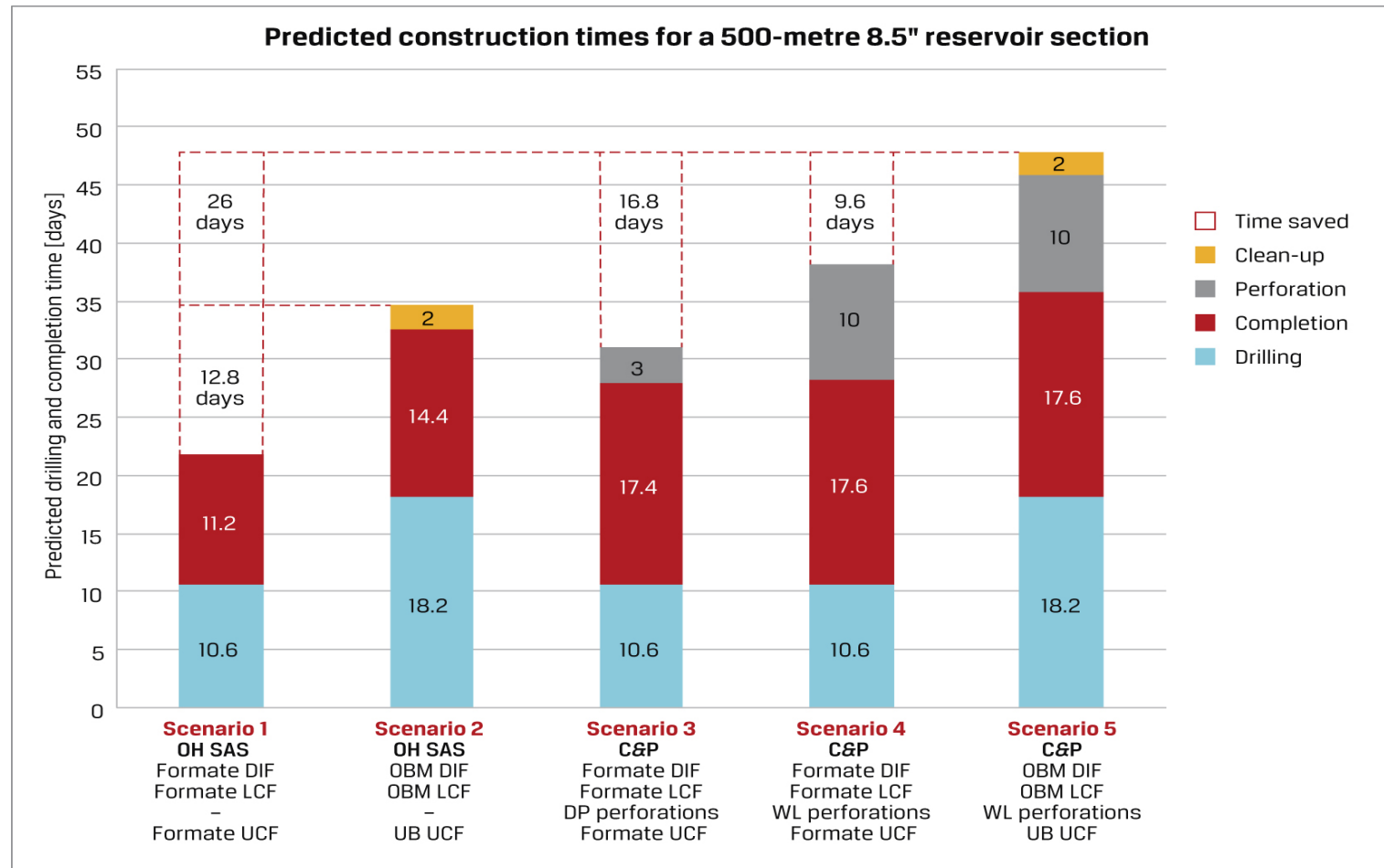
SPE-189550-MS



Regulated to ~ 15 m/hr in shale sections and ~ 5 m/hr in pay-zones and coal beds

Drilling & completion – formate time benefit

A benchmarking study by Ridge on North Sea rig time



DIF = Drill-in fluid, LCF = Lower completion fluid, UCF = Upper completion fluid, UB = Under-balanced

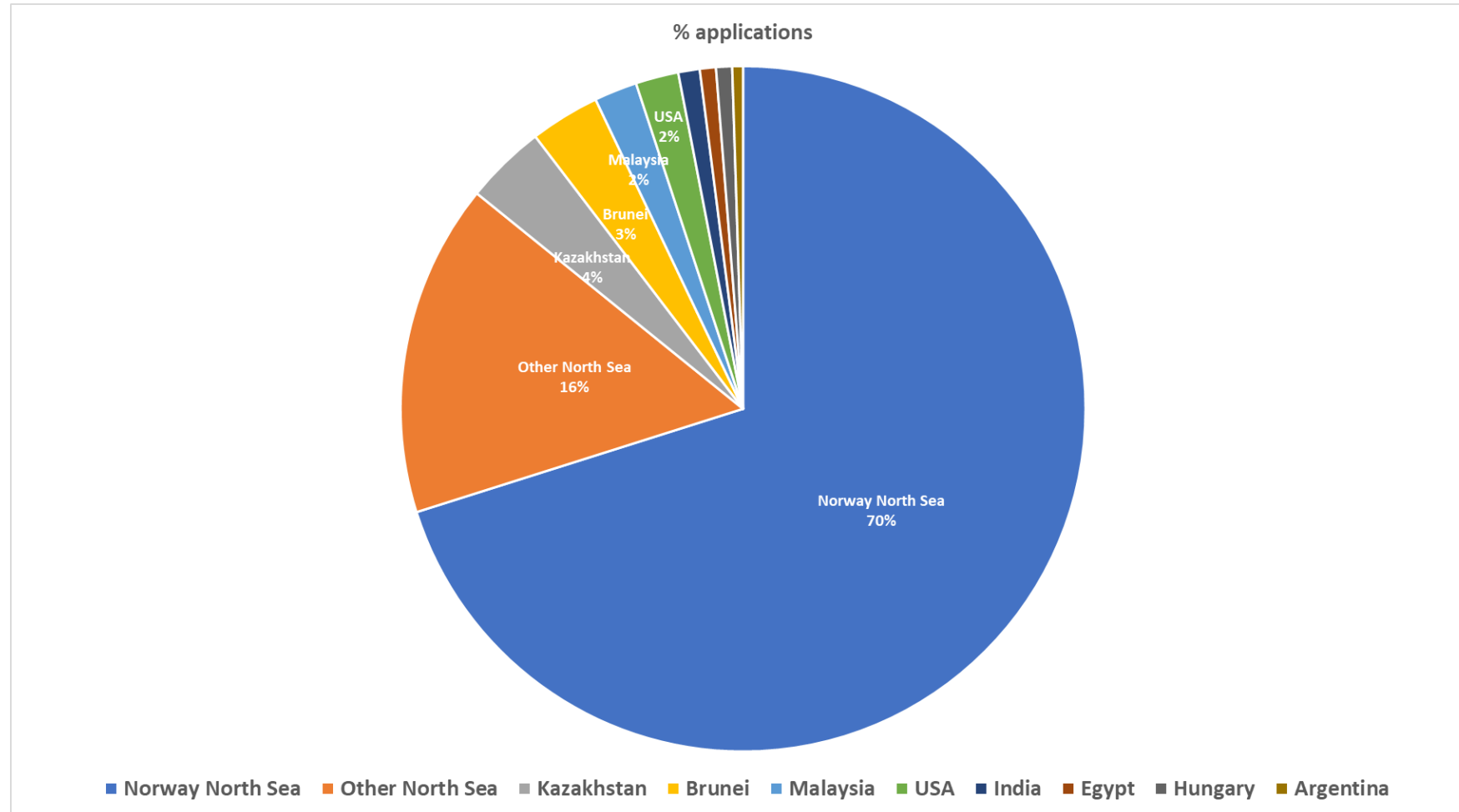
Cesium formate vs zinc bromide - HSE



- Cesium formate does not cause burns
- Formate ion degrades in water
- Cesium does not bioaccumulate
- Biocides not required
- Low environmental toxicity
- Alkaline pH
- Cesium formate is not on EPA's list of priority pollutants



Cs formate applications per geographical area



UNIDO chemical leasing award 2010

- Winner of the UNIDO (United Nations Industrial Development Organization) Global Chemical Leasing Award
- Sinomine is the world's largest chemical leasing company
- 8,000 MT cesium formate fluid on lease every year



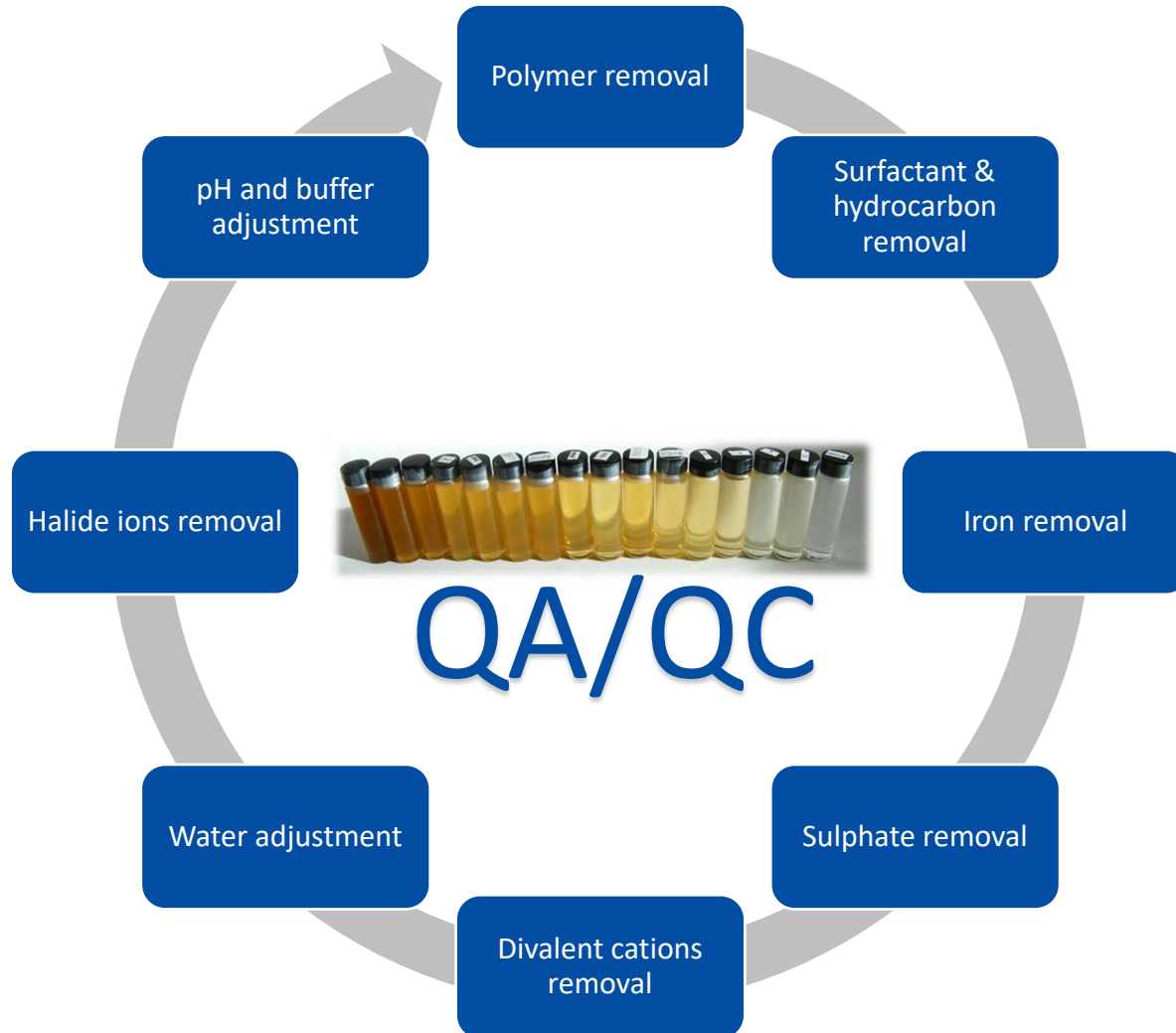
The leasing model

- Cesium is a limited resource → cesium formate fluids rare and costly
- Fluid supplied according to a leasing model to:
 - minimize chemical losses
 - preserve the inventory
 - make this very beneficial fluid affordable to the end users
- Leasing model:
 - \$ per bbl/day
 - Reduced cost for lost fluid
- Sinomine always retains ownership and stewardship of the fluid.
- The leasing contracts are **win-win**, rewarding Sinomine and its clients for minimizing waste and losses of cesium formate brine.
- After use on the drilling rig, the fluid is recovered and recycled

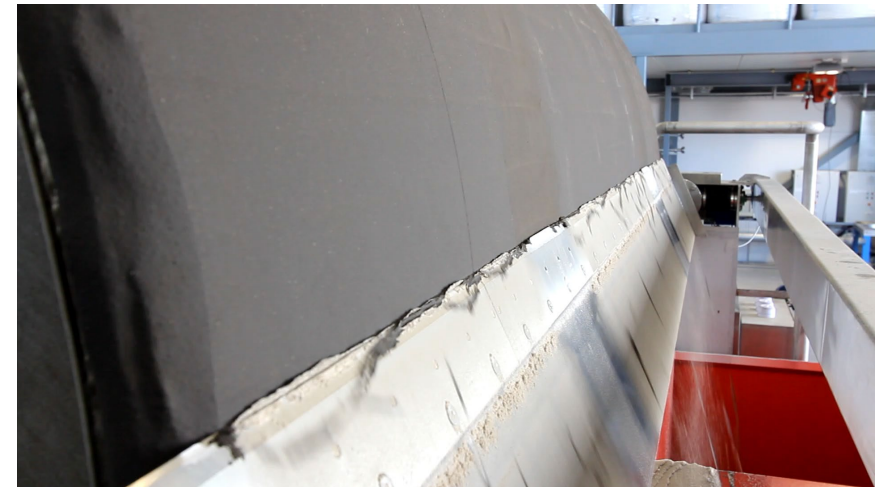


The Chemical Leasing Sustainability Criteria

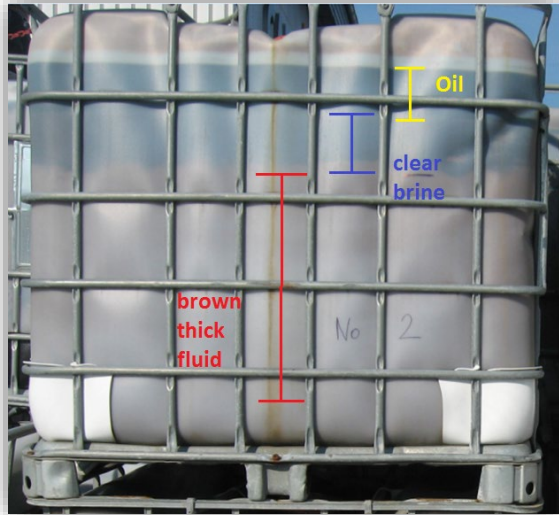
Cesium formate reclamation



Rotational vacuum filter (RVF)



Formate brine reclamation – 2015 challenge

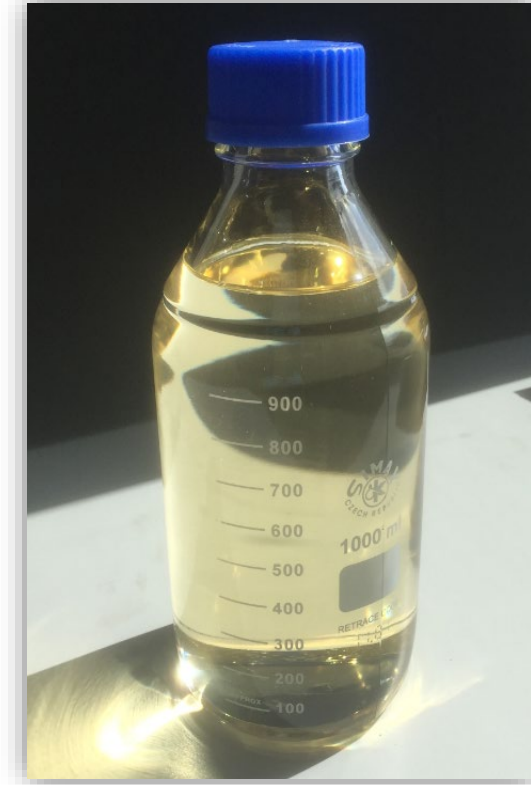


136 IBCs with used
'fluid' stored in Norway

- solids
- unwanted cations
- surfactants
- sulphate
- Hydrocarbons (20 vol%)
- polymers



'Fluid' sampled from the
bottom/middle of an IBC



Reclaimed brine

LSOBM reclamation challenge

- LSOBM (low solids oil-oil based mud) contains about 50% cesium formate brine as internal phase in an oil emulsion
- Used for running sand-screens to prevent screen-plugging when oil-based fluid desired
- Reclaiming Cs formate brine from LSOBM had been a challenge for many years



Conclusions

- **Cesium** is rare and expensive – limited resource
- **Cesium formate** has unique properties that enable challenging applications, especially in HPHT and ultra-HPHT environments
- **Cesium formate** use:
 - Unique properties realized in drilling and OH completion applications
 - Completely displaced zinc bromide as clear brine completion fluid in the North Sea
 - Limited use in the GOM
- **Chemical leasing** makes it a sustainable business and affordable for the end-user
- **Efficient reclamation** is essential for reducing brine losses



Thank you!

