

“Unconventional Artificial Lift Configurations and Deployment Methods”

SPE Applied Technology Workshop

13-14 March 2012

Amwaj Rotana Hotel, JBR Dubai, UAE



Heavy Oil Solutions Strategy



Aslan Mollaev



Heavy Oil Recovery Technologies

1. Thermal Methods

- SAGD
- Heat Resistant ESP
- Experience

2. Non-Thermal Methods

- PMM principles
- Low Speed PMM
- Drive to PC Pump

Thermal Methods

Challenges / Limitations:

1. High power demands for formation heating
2. High temperatures in down hole

200 °C

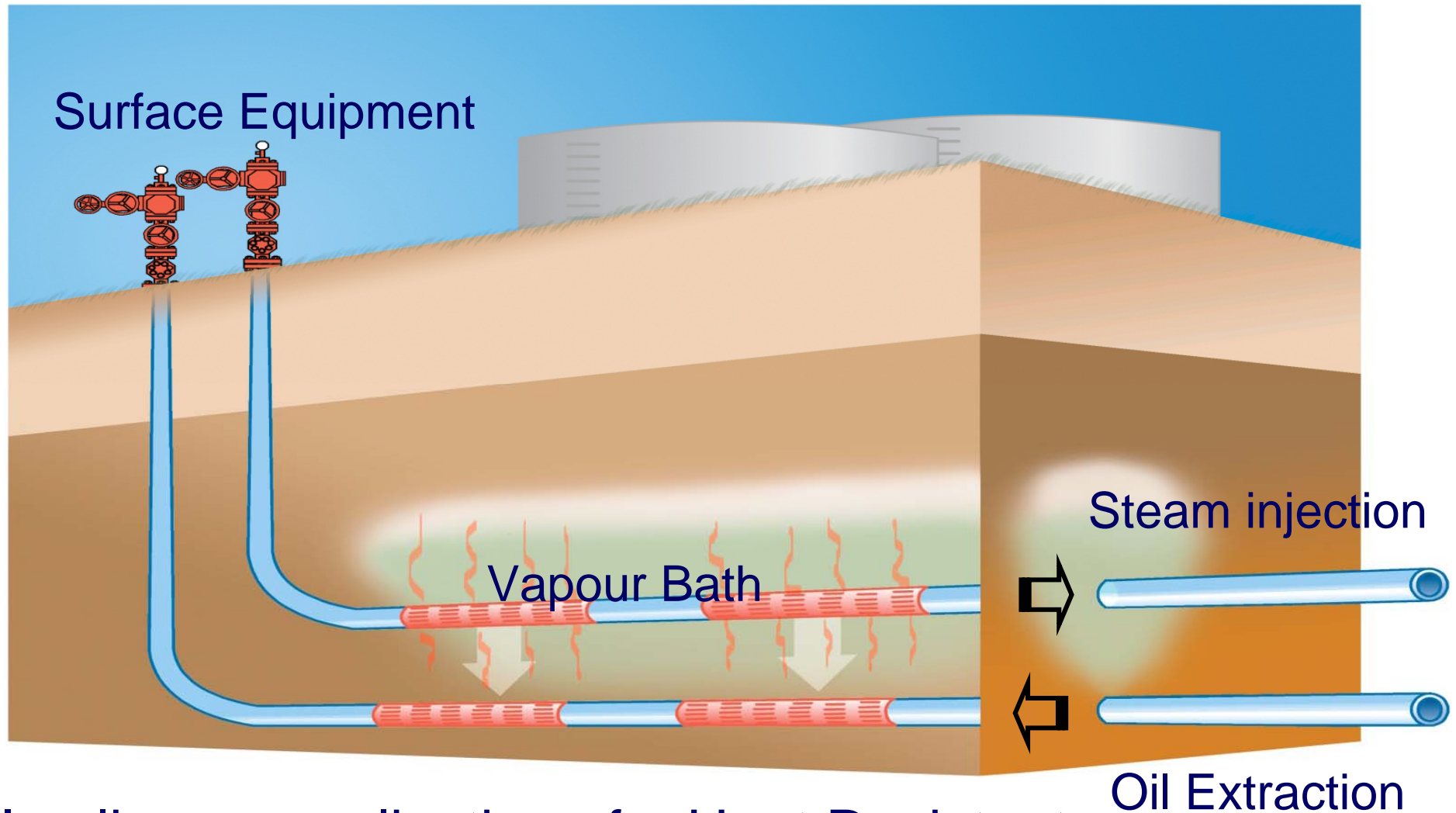
Non-thermal Methods

Challenges / Limitations:

Rod pumps:

- pump setting depth limit
- rods overloading
- limited production range
- low rotation speed
- rotor to stator clearance changes due to temperature

SAGD Technology



Implies an application of a Heat Resistant
Down Hole Equipment

Equipment Description



UHT Motor

- ❑ Compound encapsulated winding
- ❑ Special o-rings and gaskets
- ❑ Synthetic oil
- ❑ Special heat-resistant materials for current feed through shoe and thrust bearing

Equipment Description

Series:

319 - **744**

Temperature ratings:

Rated for:

Reservoir – up to **395 °F** (200 °C)

Winding – up to **430 °F** (220 °C)

Operation Experience

Yagera field, Northern Russia

Wells	5GS and 3GS
Production	566 bpd and 786 bpd
Water Cut	80%
Bubble Point	66.85 PSI (4,7 bar)
GOR	56 scf/bbl (10 m³/m³)

Operation Experience

Yagera field, Northern Russia

Dynamic Viscosity

14000 cP

At formation temperature

Operation Experience

Yagera field, Northern Russia

Dynamic Viscosity

3600 cP

At 20 °C temperature

Operation Experience

Yagera field, Northern Russia

Dynamic Viscosity

1 cP

At 140-160 °C temperature

Operation Experience

Motor N460AM35, 840V, SGL, CR2, UHT

Series	460
Power	35 HP
voltage	840 V
Current	25,5 A
Heat resistance	Compounding (operating temp up to 200 °C (395 F°))

Operation Experience

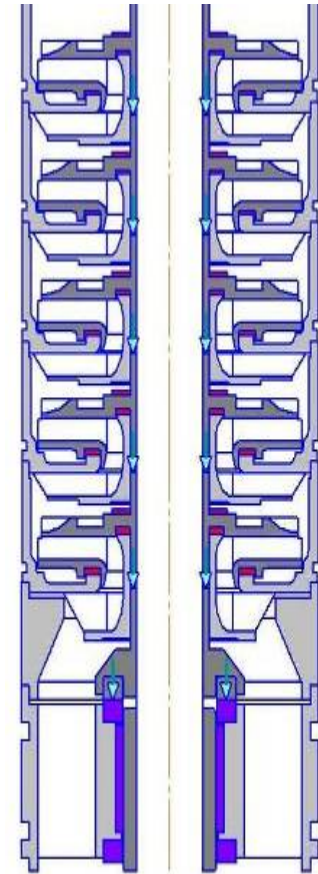
Motor Seal N362P, LsBsL, CR2, HT, STL

Series	362
Configuration	LsBsL
Rubber technical parts	Aflas
Heat resistance	170 °C

Operation Experience

Pump NFV600,SCMP,AR2,CR2,95stg

Series	362
Production rate	680 BPD
Head	1805 ft
Amount of stages	95
Type	Semi-compression design
Corrosion resistance	Stainless steel



Operation Experience

Operation Results

Not a single case of NOVOMET
equipment failure recorded

Average Runlife

350 days

in **High Sandy** conditions

Operation Experience

Well 5GS

Current Runlife

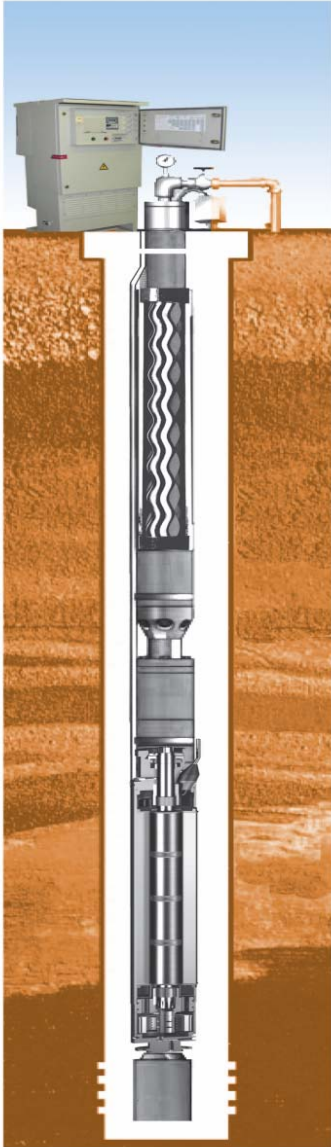
516 days

still in operation

Down hole Temperature

160 °C

Non-Thermal Approach



LOW SPEED PERMANENT
MAGNET MOTOR AS A BH
DRIVE FOR PCP

Low Speed PMM Features

100-1000 rpm

High torque at Low speed

88-89 %

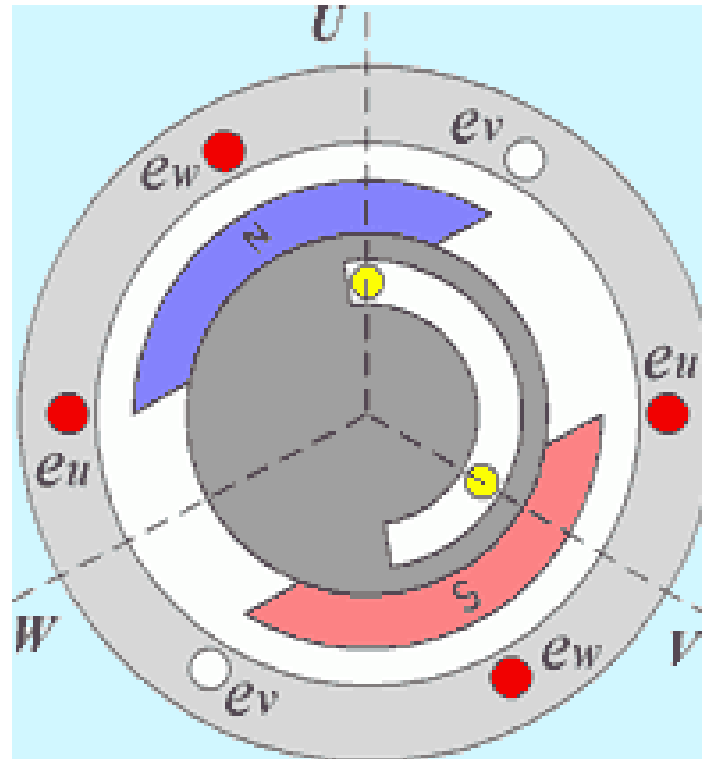
Low Speed PMM Features

395 F

Cooling fluid velocity - twice as little

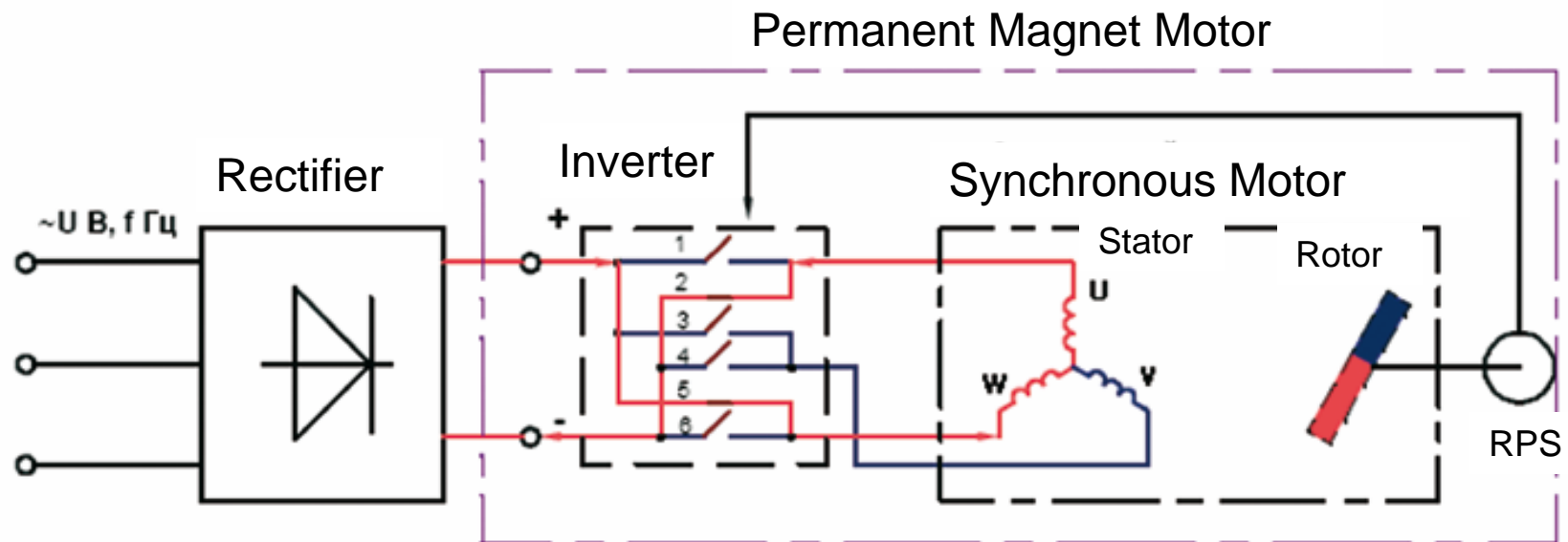
Low Speed PMM Features

How does it work?



Low Speed PMM Features

How is it controlled?



Low Speed PMM as a drive for PCP

PCP

operates at low rotating speeds 100-500 rpm.



Surface



depth **limit**



Down hole AM



Reduction Gear
Significant Length
LOW Efficiency

Low Speed PMM as a drive for PCP

Efficiency

PM Motor **89%** AM Motor **26%**

$L_{PMM} = 29 \text{ ft.}$ $L_{AM} = 85.5 \text{ ft.}$

Solution: application of low rpm PM Motor as a
PCP drive

Overview

1. High Temperature ESP for Steam Flooding (**200 C**)
2. Successful Experience in **160 C. 516** days still in operation
3. PMM is a High Efficiency option for down hole drive of PCP
4. No Gear Box required
5. Has significantly higher Torque at low speeds due to Permanent Magnets
6. Can be run at any depth, set at perforations level and below
7. Up to ambient temperature of 395 F