Enigma: A Case Study in ASP Implementation


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Enigma Field Porosity vs Permeability

Porosity (%) vs Permeability (md)
ASP Design Considerations

The foremost consideration is **water**, both quality and quantity!

a. Produced water not feasible for mixing ASP.
   i. Must soften to prevent precipitation in presence of alkalinity.
   ii. To soften, cannot have oil in water (fouls resin bed of softener).
   iii. To remove oil from water, water processing facilities probably will exceed cost of ASP mixing facility.
   iv. If oil not removed, operating costs exhorbitant (frequent replacement of resin beds), and will jeopardize quality of ASP (surfactant interacting with entrained oil, inconsistent gel quality).

*Enigma field relative close to City of Worland municipal supply (Madison), able to reach agreement with city to purchase water.*

b. Since produced water not used, must have outlet for the volume of produced water replaced by ASP.
   i. Truck to off-site disposal (expensive).
   ii. In-field SWD (good).
   iii. Surface discharge (best).

*Enigma field permitted for surface discharge.*

City Supply Water → Charge Pump → 20 micron Filter →

Three Storage Tanks → Charge Pump →

1 micron filter bank →

Suction Tanks →

Mixer for soda ash → Circulating Loop for soda ash water (mix and circulate soda ash)

Tiorco Pumping Skid

Alkaline filtered water → Charge Pump →

Polymer Mixer (concentrated mix) 1 hr residence time →

Surfactant Tank and Proportioning Pumps → Static Mixer → Triplex Pump → Madeleine 8 WIW

25 micron filter bank
Pilot injection

Intent: Determine if ASP had tendency to plug sandface.

Actual learnings: No plugging evident, but discovered that surfactant required modification to initial plant design.

Viscosity of surfactant:
- 104°F – 284,000 cP
- 158°F – 11,730 cP
- 212°F – 6400 cP

However, begin losing water phase of surfactant at 180°F. Thus incorporated design for heat and stirring of surfactant storage tank, plus gear pump to inject into ASP steam.
Enigma ASP: Generalized Plant Flow Schematic
Enigma ASP: Final Plant Design
As-built water transfer line from Air Vac #13 to Enigma Battery, generalized schematic.

Revision 1-15-01
Not to scale.
Air Vac #13
SW/SW Sec 28-T49N-R91W
Big Horn Co., WY

System additions (details below).

Worland’s existing system.

24” line existing
Valve

Bypass for repairs to meter. Sealed valve in bypass line.

Isolation valves

Double Check Valve

Straightening Tube

Meter

± 3.5 miles poly pipe
6” SDR-9
200 psi rating

Components upstream of line A (left of A) existed prior to line construction by Citation Oil and Gas.

Section A-B: above ground, enclosed in locked and heated hut, steel pipe transitioned to poly pipe at B. Bypass line to be used only during repair to meter. Bypass line will have a sealed valve for monitoring bypass of meter. Use of bypass line will be documented.
Meter: 3” Neptune turbine meter with ProRead system, 24” long 3” diameter straightening tube upstream and downstream of meter.
Double Check: 3”, minimum pressure rating of 175 psi, USC-FCC approved.

Section B-C: buried 6” SDR-9 poly pipe (PE 3408), 200 psi service rating with air relief valves at high spots of terrain.

Downstream of C: riser and inlet to storage tank at Enigma Battery.
Tank inflow: modulating throttle valve to maintain relatively constant flow; valve closes at desired high tank level.
Bypass installed around valve for repair/replacement if necessary.
Tank: atmospheric (vacuum breaker) with appropriate air gap.

Line completed November 30, 2000. Line was static tested to existing pressure of Worland City line (+145 psi) for 14 hours, no leaks.
Line placed in service December 1, 2000.
Throttle control, inlet of city water tank
Soda ash day bin

Vibrator

Air fluffer

Auger
Bad Things ‘bout Soda Ash

Mechanical degradation causes clumping; smaller particle size increases surface area - particles have natural tendency to adhere together.

Therefore:
- Pneumatic transfer rate must be minimized.
- Vibration may exacerbate clumping.
- Radius of sweeps in transfer line must be maximized.
- Auger conveyance should not exceed 30° slope.
- Belt conveyor better than auger – reduces mechanical grinding of particles.
Injection Considerations

1. Filter at wellhead.

2. Do not use chokes to adjust injection pressure – polymer will shear thin.
   a. If injection pressures for each well are not approximately equal, use segregated pumps for groups of wells of similar pressure, or
   b. Use friction loops to reduce pressure at wellhead.

3. Install pressure-capable sample chambers to collect samples at wellhead (to avoid shear-thinning when collecting wellhead samples).
PLC Functions and Advantages

1. Provides reliable automation thus providing reliable quality control of ASP injection.

2. Reduces manpower requirements.

3. Programmable functions:
   a. Polymer concentration primary focus. All other functions (surfactant and alkali mix rates slaved to polymer concentration and rate). Injection pump controlled with VSD, also slaved to polymer mix rate.

4. Provides versatility through scalable functions to make adjustments during the course of the project.
Conclusions

1. Quality and quantity of mix water is critical to successful implementation of any ASP flood.
2. Disposal of produced water is critical to successful implementation of any ASP flood.
3. Operationally, soda ash is not as desirable as sodium hydroxide though may be necessary for attaining target chemical properties of ASP.
4. Pilot injection is beneficial to discover unforeseen problems.
5. Dollars spent on automation are worthwhile if quality counts.
6. Keep a bottle of good bourbon within reach at all times.