Integrated Water Re-injection Plant for Enhanced Oil Recovery

(Onshore Oilfields)
Integrated Water Re-Injection Plant
Scope of Siemens Oil & Gas
Intelligent Water Re-injection Plant
Concept and Approach

Standardized components to provide customized but flexible solutions

Pre – engineered
- Solution Packages
- Skid mounted equipment and ready to use
- Connecting Pipes
- Electrical Wiring and Instrumentation
- Control Center
- Modules (for single, parallel or sequential arrangement)
Integrated Water Re-injection Plant
Plant Diagram

Produced Water from GOSP

Produced Water Surge Drum Skid

Oil & Solid Removal Skids
- 1 set L-S Hydrocyclone
- 1 set S-S Hydrocyclone
- 1 set DGF (Veirsep-PTM)
- 1 set Walnut Shell Filter
- 2 set Pump Skids

Processed Water Surge Drum Skid

Injection Pump Skid
- variable speed drive system
- high pressure
- including lube oil system

Make Up Water
- Sea Water
- Fresh Water
- River Water
- Ground Water

Water Conditioning
- Coarse Filters
- Fine Filters
- Deoxy Vacuum Tower

Make Up Water Balance Tank

WELL HEADS

Surge Drum Skid

Oil & Solid Removal Skids

Processed Water

Injection Pump Skid

Electric Power System

Automation & Control System

Piping & Layout

Telecommunication

Instrument Air System

Air Compression Station

Laboratory

Manned versus unmanned Operation

Make Up Water

Water Conditioning

Make Up Water Balance Tank

WELL HEADS

Electrical Power System

Automation & Control System

Piping & Layout

Telecommunication

Instrument Air System

Air Compression Station

Laboratory

Manned versus unmanned Operation

Make Up Water

Water Conditioning

Make Up Water Balance Tank

WELL HEADS

Electrical Power System

Automation & Control System

Piping & Layout

Telecommunication

Instrument Air System

Air Compression Station

Laboratory

Manned versus unmanned Operation

Make Up Water

Water Conditioning

Make Up Water Balance Tank

WELL HEADS
Integrated Water Re-injection Plant
Pre-engineered produced water reinjection

Siemens WRI solution to be perfectly balanced between meeting client requirements, product standardization and manufacturing time. Designed to plug’n play.

Requirement needed from Customer:
Water inlet and outlet specification

- Pre – Engineered Solution Packages water injection 20 … 40 … 80 k BWPD
- Injection pressure range 50 – 250 bar
- Oil and Solid Removal < 10 ppm
- Skid mounted equipment ready to use
- MW range up from 0,5 MW – 4,0 MW
- Ex Zone Classification 1 and 2
- Oil & Gas proven standardized components (API, ASME, EU)
- Delivery in ca. 12 -18 months, all from one source
- Plug ‘n play during commissioning
- Totally unmanned operation
- Full maintenance and operation service
Integrated Water Re-injection Plant
Environmental Conditions

- Plant design for -40° Grad Celsius
- Heating tracing system for complete plant
- Isolation according to client spec.
- Gost and RTN Certification
- Ready for train transport
- Bilingual documentation

- Plant design for up to 60° Grad Celsius
- Tropicalization of the electrical equipment and instrumentation
- Housing and shelter
- Ready for ship transportation

Arctic environment (Russia)

Desert environment (Libya)
Integrated Water Re-injection Plant
Lifecycle Management - Comprehensive View

**LIFE CYCLE MANAGEMENT**

**PLANT LIFE CYCLE**

**INSTALLATION PHASE**
- Preservation
- Mechanical Completion
- Clear punch list

**COMMISSIONING PHASE**
- Functional checks
- Testing & commissioning
- Putting to operation
- Training, SAT
- Completion, As built drawings, Training

**OPERATION PHASE**
- Startup support
- Warranty, On call service
- Preventative & Planned maintenance
- Repairs, Training
- Upgrading & Retrofitting

**FEED/EPC PHASE**
- Solutions, systems
- Feed stage, Documentations, Bid Management, Purchase order

**ENGINEERING/PROJECT PHASE**
- Engineering & Project Management
- Documentation
- Planning
- Procurement, FAT Delivery

**Solutions, systems, Feed stage, Documentations, Bid Management, Purchase order**

**For more information, visit:**
- Integrated Water Re-injection Plant Lifecycle Management - Comprehensive View

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• Plant is designed and engineered in a modular manor, e.g. skid mounted, standard equipment, etc.

• Plant units are configurable and scalable, e.g. by means of modular concept

• Plant is designed and engineered for unmanned operation, if applicable

• Plant is supplied “turnkey”. This includes design, engineering, procurement, installation, commissioning, and maintenance services, as well as Siemens Project Management expertise, if applicable

• Siemens equipment and systems are included in design and engineering as thoroughly as possible
• All actuators for control equipment shall electrically operated and compliant to e.g. ATEX specification, SIL requirements, etc.

• Remote I/Os are installed per Unit / Skid and e.g. skid mounted. For instance, there shall be one cabinet on skid containing power supplies and I/O modules

• DCS and SIS integrated

• All process pumps are driven by VSDS in order to increase energy efficiencies and to minimize CAPEX and OPEX

• Plant is designed and engineered for Remote Service e.g. in order to optimize Plant availability and spare part warehousing with respect to OPEX
Integrated Water Reinjection Plant
Our Value Proposition

Fast ROI
- Standardization

Risk Reduction
- “one-throat-to-choke”
- World-class products
- Project management and execution

Short Project Execution Time
- Pre-engineered packages

Flexibility
- Modular design
- Transportable modules
- Leasing model available
- Support testing and analysis of reservoirs
Hypothetical example for WRI Plant
20,000 bpd, 150 bar, approx. 1.1 MW

<table>
<thead>
<tr>
<th>Step</th>
<th>Equipment</th>
<th>Siemens</th>
<th>Siemens</th>
<th>Siemens</th>
<th>Siemens/external</th>
<th>Siemens/external</th>
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</thead>
<tbody>
<tr>
<td>Hydrocyclone</td>
<td></td>
<td>LxBxH: 6mx2,5mx2,5m</td>
<td>6 months</td>
<td>1 Skid</td>
<td></td>
<td></td>
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<tr>
<td>Flotation</td>
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<td>LxBxH: 10mx3mx2,1m</td>
<td>10 months</td>
<td>1 Skid</td>
<td></td>
<td></td>
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<tr>
<td>Walnutshell Filter</td>
<td></td>
<td>DxH: 3,3mx7m</td>
<td>8 months</td>
<td>1 Skid</td>
<td></td>
<td></td>
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</tbody>
</table>
| Water Surge Drum           |                            | DxH: 12mx3mx3m     | 6 months | 2 Skids  |                  | 2 process pump skids, 1 injection pump skid
| Pump Skid                  |                            | LxBxH: 10mx2,5mx3m | 12 months|         |                  |                  |
### Hypothetical example for WRI Plant

**20,000 bpd, 150 bar, approx. 1,1 MW**

<table>
<thead>
<tr>
<th>Component</th>
<th>Siemens</th>
<th>External</th>
<th>Siemens</th>
<th>Siemens</th>
<th>Siemens</th>
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</thead>
<tbody>
<tr>
<td>LxBxH:</td>
<td>6mx2,5mx2,5m</td>
<td>6mx2,5mx2,5m</td>
<td>6mx2,5mx2,5m</td>
<td>n.a.</td>
<td>Foot print 250 m²</td>
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<tr>
<td>12 months</td>
<td>12 months</td>
<td>12 months</td>
<td>4 months</td>
<td>6 months</td>
<td>12 m. of delivery after PO + 2 m. inst./comm.</td>
</tr>
<tr>
<td>1 Skid</td>
<td>1 Skid</td>
<td>1-2 Skids</td>
<td>1-2 Skids</td>
<td>n.a.</td>
<td>11-12 Skids</td>
</tr>
</tbody>
</table>

**Siemens** 75% Siemens 25% External
Actual Project

End User: ZADCO (ADNOC)

Overview:

- 400,000 BWPD ~ 2650 m³/hr
- 5 trains with around 100,000 BWPD Plants
- 4 trains in operation and 1 train in stand by
- Increasing of the injection water over 25 years up tp 1.2 mio. BWPD

Important for the Customer:

- Less capex
- flexibility during the lifetime
- easy to integrated a additional train in the existing plant (instrument, electrical, control and automation system)
Contact

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We are happy to answer your questions!
**Water Re-injection Plant**

**Product Sheet – Injection Pump Skid**

**Water Injection Pump**
- Flow up to 20.00 – 60.000 BPD
- Heads up to 2500m
- Discharge pressure up to 250 bar
- Temperature up to 450°C
- Speeds up to 6000 RPM
- Variable Drive System

**Pumps:** WCC
**API 610 code:** BB5
Optional WCC Shearing Design

- Quicker dismantle
- Easy maintenance
- Full cartridge design
- Applicable technology
- Suitable for Water Injection
Water Re-injection Plant
Product Sheet – Hydrocyclone Skid

- Liquid/liquid, solid/liquid designs
- Maximum separation in a small footprint
- Low weight, important in offshore applications
- Hydrocyclone bundles recently patented
- Used primarily to remove concentrations of oil (200 to 2,000 ppm) from Produced Water as an initial separation step prior to polishing by flotation systems
Water Re-injection Plant
Product Sheet – Flotation Skid

- Liquid and solid removal from produced water
- Maximum separation in a small footprint
- Low weight,
- Solid and oil removal up 20 ppm
- Low maintenance cost and long life time
- Air or gas flotation system
- Operated under pressure or atmospheric conditions
Water Re-injection Plant
Product Sheet – Walnut Shell Filter Skid

Tertiary Produced Water Separation
- Walnut Shell Filters
- Media Filters
- Cartridge Filters
- Activated Carbon Filters

Advanced Treatment
- Biological Treatment

Solids Handling
- Gravity Thickeners
- Filter Press
- Belt Filter Press
- Sand Jetting Systems

Oil and Waste Recovery
## Power Supply

<table>
<thead>
<tr>
<th>Gas Turbine Nominal Rating At ISO, Gas Fuel</th>
<th>Generator Set MW(e)</th>
<th>Combined Cycle Output MW</th>
<th>Mechanical Drive KW</th>
<th>BHP</th>
<th>SPEED (RPM)</th>
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</thead>
<tbody>
<tr>
<td>SGT - 100</td>
<td>4,35/4,70 5,05/5,25</td>
<td>4,922</td>
<td>6,600</td>
<td>13,000</td>
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<tr>
<td>SGT - 200</td>
<td>6,75</td>
<td>7,680</td>
<td>10,300</td>
<td>10,950</td>
<td></td>
</tr>
<tr>
<td>SGT - 300</td>
<td>7,90</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGT - 400</td>
<td>12,9</td>
<td>17,2</td>
<td>13,400</td>
<td>18,000</td>
<td>9,500</td>
</tr>
</tbody>
</table>


Oil & Gas Production
Produced Water Treatment Process Map


Discharge or Reinjection for Water Flood

To Discharge, Reinjection or Reuse

To Disposal

Chemical Feed

VOC Control

Auxiliary Equipment

Solids Handling

Advanced Treatment
### Oil & Gas Production

**Water Injection/Reinjection – Case Study**

- **End User:** Saudi Aramco Company
- **Application:** Oil Field Water Floods.
- **Location:** Qurrayah Seawater Filtration Plant, Saudi Arabia
- **Scope:** Sea Water Media Filters (20 and 36) and Electrochlorination Systems
- **Flowrate:** 2.5 million bbl/day and 4.0 million bbl/day
- **Year:** 2004 and 2006
- **Order Value:** $10,500,000.00
Power Generation Set – SGT 100
Integrated Water Re-injection Plant
P&I Diagram Produced Water Surge Drum
Integrated Water Re-injection Plant
P&I Diagram Walnut Shell Filter Skid
Integrated Water Re-injection Plant
P&I Diagram Injection Pump Skid
Integrated Water Re-injection Plant
Single Line Diagram
Integrated Water Re-injection Plant
System Architecture Diagram
Integrated Water Re-injection Plant
Plant Layout Drawing
Integrated Water Re-injection Plant

Benefits for Customers

Conventional WRI

- Feed
- Contracting
- Engineering
- Manufacturing/Delivery
- Inst./Comm.

Siemens modularized WRI

12 month time savings

Value of time savings

Example:
- Production flow rate 100,000 bbl/d
- Water cut 20%
- Oil Production 80,000 bbl/d
- Productivity increase WRI 10%
- Oil production upon WRI 88,000 bbl/d
- Production increase 8,000 bbl/d
- Oil price 35 $/bbl
- Turn over increase \(102,2\) mill. $