COMPLUS SYSTEMS GROUP

SEPARATION OF OIL AND WATER AND REGENERATION OF SEPARATED PRODUCED WATER

TECHNOLOGY INTRODUCTION

19/JULY/2021

WEST EUROPEAN BRANCH
Via Lavoratori Autobianchi 1
20832 Desio (MB) – Milan, Italy
Tel.: +39-02-87199397
Fax: +39-02-56563230
www.complusystems.it

COMPLUS SYSTEMS NORTH AMERICA, LLC
151 Katy Freeway, Suite 140, Houston Texas
77007 - USA
Tel.: +1 830.200.5119
www.complustrading.com

EAST EUROPEAN BRANCH
Vabaõhumuuseumi 2A-14
13522 Tallinn – Estonia
Tel.: +372-6027986
Fax: +372- 6667289
www.complusystems.ee

INDEX

1. INTRODUCTION 3
2. OFFERED TECHNOLOGIES – OIL, GAS AND WATER SEPARATION 3
3. OFFERED TECHNOLOGIES – MULTI-PHASE REACTOR 9
4. INFORMATION NEEDED FROM THE CLIENT 10

WEST EUROPEAN BRANCH
Via Lavoratori Autobianchi 1
20832 Desio (MB) – Milan, Italy
Tel.: +39-02-87199397
Fax: +39-02-56563230
www.complusystems.it

COMPLUS SYSTEMS NORTH AMERICA, LLC
151 Katy Freeway, Suite 140, Houston Texas
77007 - USA
Tel.: +1 830.200.5119
www.complustrading.com

EAST EUROPEAN BRANCH
Vabaõhumuuseumi 2A-14
13522 Tallinn – Estonia
Tel.: +372-6027986
Fax: +372- 6667289
www.complusystems.ee

1. INTRODUCTION

In this document, the technologies proposed by Complus Systems Group to separate Oil/Gas and Water, treatment of waste water coming from separation as well as desalinization are described. The scope of work are the following:

1- Separate Oil/Gas/Water from mixture pumped out from wells after stimulating process.
2- Treatment of produced water to be then reused for next stimulating process.
3- Desalinization of sea water.

2. OFFERED TECHNOLOGIES – OIL, GAS AND WATER SEPARATION

After stimulation process of a well and/or bulk of wells, the liquid that is pumped out from wells is a mixture of Oil, Gas and Water. So it is necessary to use proper technologies to separate Oil, Gas and Water. For that purpose, Complus System Group offers proper three stage vessel named Heater-Treater.

Heater-Treater

These are three-phase vessels that are usually larger than separators while operating at around the same pressure of about 50 pounds. They're also usually more expensive, as the larger size requires thicker walls to hold the same pressure. The heater-treater is usually the second vessel in the tank battery, just after the separator. If you use a higher pressure separator, it's possible to use a lower pressure heater-treater and save a little on its cost.

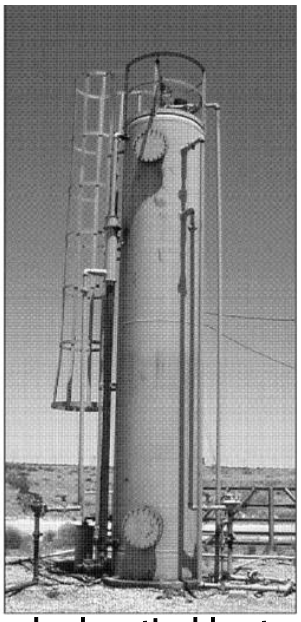

Figure 1. An example of a standard vertical heater-heater. The firebox and site gauges are on the far side.

How A Heater-Treater Works

As the name implies, the heater-treater uses heat as part of the separation process. In many cases, particularly during warm summers, the heat from the sun warming the tank is enough to do the job. You can just add chemicals, and it will work without any additional expense. This effectively makes it a three stage separator. You can light the firebox if the weather turns cold, though that will use natural gas as fuel which could otherwise be sold. Cost effective use of a heater-treater depends on balancing the efficiency of using natural gas as fuel vs. selling it as an additional source of income.

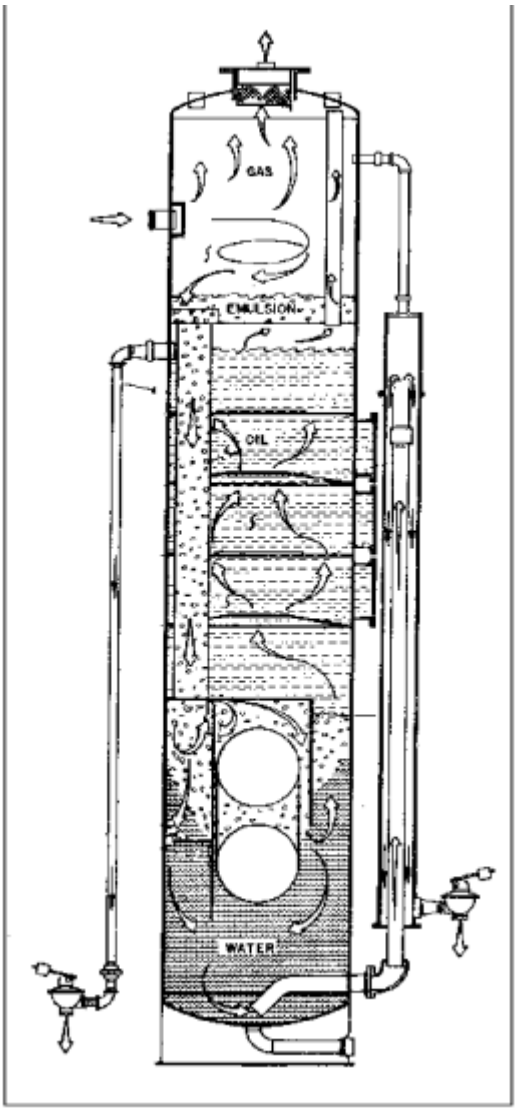

Figure 2. Inside a heater-treater.

A heater-treater is a three phase vessel, so it has three primary outlets. There is a gas line at the top of the heater-treater that collects natural gas. Somewhat below the top of tank is the oil outlet. This is also the level of total fluid in the heater-treater. There is also a water outlet for disposing of waste water.

The inlet leads to a smaller compartment at the top of the tank where any gas that was not removed in the separator is piped out through the gas line. The water and oil flow down through a tube to the bottom of the heater treater. Water flows out through the water leg, while oil continues up to the oil outlet. Controlling the height of the water column in the heater-treater is an important aspect of using the heater treater. The level of water should be about one foot above the fire tube. In other words, water fills the space from the bottom of the tank to one foot above the fire tube, with oil above that. As oil flows from the inlet tube and up, it will flow past and around the fire tube.

The water stays at the bottom of the tank and stays relatively cool. The oil absorbs most of the heat as it rises and leaves through the oil outlet. The inside of this part of the heater-treater has several horizontal plates with offset openings. Any water hits the plates and falls back to the bottom, while the heated oil continues upward. Any remaining gas is also separated at this point, through a tube at the top of the tank. This tube also helps maintain the pressure, and thus the water level, of the water in the water leg.

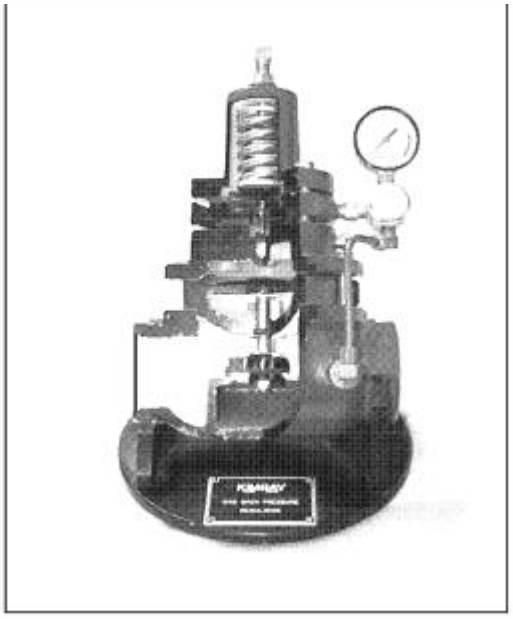

Figure 3. A back pressure valve that uses a diaphragm.

Separated oil flows out through the oil outlet and into the oil line. Likewise, water flows through the water leg and out. Both the oil line and water disposal line should use back pressure valves, which only open when a certain amount of pressure is applied from the upstream side. As the oil line fills up above the valve, pressure grows until the valve opens. That usually happens when four or five feet of fluid has collected above the valve. Once the collected column of fluid has passed through the valve the pressure drops and the valve closes once more. Treater valves, like that shown in Figure 11 are good choices for these valve.

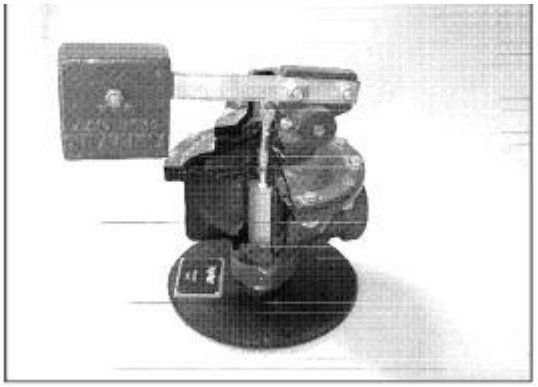

Figure 4. Examples of treater valves.

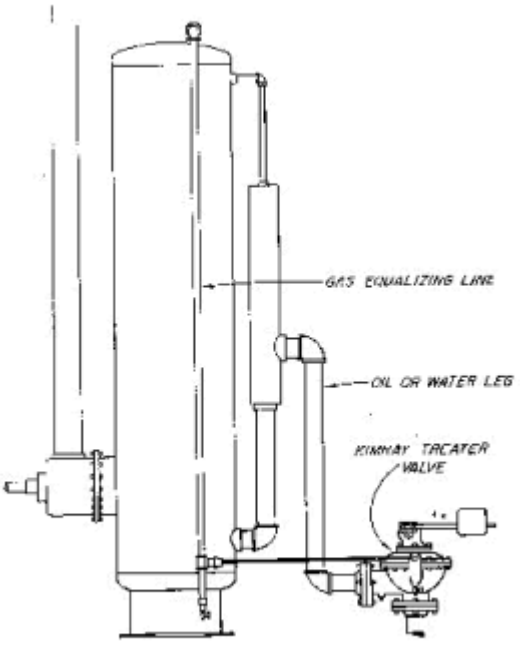

Figure 5. An outline of the system for using a treater valve

The dump valve in Figure 6 is float controlled, and of a type that is popular with lease pumpers for its reliability and versatility. The pressure exerted below the valve seat is transferred to its top, which helps with the ease and reliability of the valve's operation. It can also be turned to operate in the opposite direction.

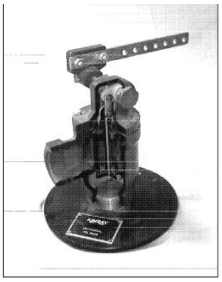

Figure 6. A dump valve that is float controlled.

Controlling Water Height

The water leg is a name applied to the secondary tube on the right side of Figure 6. Rather than using floats and arms to open valves, the heater treater simply uses line height and gravity flow for operation. As the fluid enters from the highest opening in the tank, it continues to flow throughout the system to the slightly lower oil outlet. The height of water in the water leg will equal the height of the total column of oil and water in the heater-treater.

Water flows from the bottom of the heater-treater and up the interior tube of the water leg. It flows over the top of the inside tube and the collects in the outer tube until the pressure is enough to open the valve. The amount of water in the heater-treater can be controlled by raising or lowering the side boot on the water leg.

Heater-Treater
Customer: Obax
End User: Sapetro (Nigeria)
Length: 32' 4" – Diameter: 10' 0" – Capacity: 8,800 BPD
This is a three phase separator manufactured for this early Production facility. Large enough to handle the production volume while keeping the skid small enough to fit the transportation vessel to Nigeria.
SUPPLIED BY COMPLUS SYSTEMS GROUP.

Heater Treater
Customer: Obax
End User: Sapetro (Nigeria)
Length: 30' – Diameter: 96" – Capacity: 4,400 BPD
This is another large vessel manufactured for this project playing with capacity and size.
SUPPLIED BY COMPLUS SYSTEMS GROUP.

3. OFFERED TECHNOLOGIES – MULTI-PHASE REACTOR

Once the separation is terminated, the flow of water, separated from the Oil, needs to be treated in order to reach acceptable level of industrial water to be re-used in the next stimulation process. For that purpose, Complus Systems Group proposes its MULTI-PHASE REACTOR technology, based on cavitation principle.

Complus Systems Group Multi Phase Reactor is an Advanced Oxidation process that generates a suite of highly reactive Oxidizing radicals from the waste water stream without additional of chemicals or pre-cursor oxidizers.

Bio solids suspended in the wastewater stream undergo substantial particle size reduction by means of lysing of cellular matter and then subsequent oxidation of the reduced particles. This process is capable of achieving full sterilization of the water by this process alone. This will result in accelerated bio-reactivity of the solids entering the digestor, decreasing time for digestion.

Dissolved solids such as metal ions are reduced to oxidized state, where the metallic ion is tied to Oxygen rendering it insoluble. The insoluble material forms a solid precipitate that is removed via conventional filtration. Chlorides that were previously ionically bonded to the metal ions form Chlorine Dioxide and free Chlorine.

The same technology is suitable for the desalinization of water, offering a cost effective solution if compared with more traditional technologies (i.e.: Inverse Osmosis). Thus the MPR can be also used by our prospective Customers for the desalinization of sea water.

For a detailed description of proposed MPR technology, please refer to full presentation in Annex 1.

4. INFORMATION NEEDED FROM THE CLIENT

In order to properly propose a fully customized solution, we do need the following information from the client:

OIL/GAS/WATER SEPARATION AND WATER TREATMENT

1- hydrocarbons composition
2- gas chromatography
3- crude oil assay
4- water data with pressure, temps, and volumes
5- desired levels of salinity and polluting substances in the treated water

SEA WATER DESALINIZATION

1- full lab analysis of sea water. Inclusive of salinity level
2- desired levels of salinity and polluting substances in the treated water
3- volumes of water to be treated daily

WEST EUROPEAN BRANCH
Via Lavoratori Autobianchi 1
20832 Desio (MB) – Milan, Italy
Tel.: +39-02-87199397
Fax: +39-02-56563230
www.complusystems.it

COMPLUS SYSTEMS NORTH AMERICA, LLC
151 Katy Freeway, Suite 140, Houston Texas
77007 - USA
Tel.: +1 830.200.5119
www.complustrading.com

EAST EUROPEAN BRANCH
Vabaõhumuuseumi 2A-14
13522 Tallinn – Estonia
Tel.: +372-6027986
Fax: +372- 6667289
www.complusystems.ee

ANNEX-1 MULTI-PHASE REACTOR PRESENTATION

Complus Trading
North America

ShockWater Systems

technology evaluation

Technical Evaluation

ShockWater has made commercial/industrial installation at a major O&G surface storage facility 20 minutes outside of Midland, TX.

The O&G Production company is constructing nine 1.2 Million barrel ponds to store treated produced water for recycle.

- They are transitioning to use 100% ShockWater treated produced water for their fracturing operations
  - Meeting following specifications:
    - H_2S 0.0
    - Turbidity < 10
    - Iron <2
    - ATP < 8
    - ORP > 300 or Free Chlorine > 1 ppm

ShockWater Solution

- A chemical free process that generates free Chlorine from salt in the produced water
  - A 2-stage process
    - RotoCavitator™ Reactor to generate OH and H_2O_2 radicals
    - Electro-Chemical Oxide Reactor – an electro-chemical cell that generates free Chlorine from the OH and H_2O_2 radicals and their binding to metal (Sodium and Iron) ions.
  - Generates in excess of 20 ppm Free Chlorine and Chlorine Dioxide
    - Greater than 0.8 ppm is sufficient for sterilizing water against microbes
    - Chlorine production is based upon an electrical current in the though the Electro-Chemical Oxide Reactor
  - Free Iron and Hydrogen Sulfide reduced to 0
    - Iron is precipitated out as a solid - Iron salt (FeClO) acts as a flocculant for water clarification – Achieve Turbidity < 10
    - Hydrogen Sulfide is consumed.

6,000 bpd trailer

15,000 bpd CONNEX

Industrial Process

- The current ShockWater process is modular, processing 6,000 – 20,000 barrels per day.
- Processing volume scalable to customer demand. 100,000+ bpd
- Exceeding all the client specifications
- Proving to be robust and tolerant to a wide range of influent water quality

Advanced Oxidation Reactor

- Water enters from bottom and flows out through the top.
- This generates the OH and H_2O_2 radicals and conditions the dirty water for the Electro-Chemical Oxide Reactor.
- The unit consists of two motors and rotors, one on each side of the reactor.
- At a 4,000 BPD process rate, the motors are operating at 40% power.

Water Clarification

- Discharge from the trailers are held in 5 frac tanks for final oxidation, and solid settling.
  - Anticipate needing to remove solids 1x per year.
  - Solids are non-Hazardous and are simply buried with other solid disposal.
- Final clarification is through these 40,000 BPD capacity 6-layer media filters. These filters are backwashed once per day to the inlet, dirty water frac tanks.

Clear Water After Media Filter

Chlorine and H_2S Testing

Zero out

Collect H_20 after Oxidizer Cell

Test for ClO_2

ClO_2 > 20 ppm

Free Cl > 20 ppm

Total Cl > 25 ppm

0 ppm H_2S

Chlorine Dioxide and Free Chlorine generated from dissolved solids in the water.

It Works

- Moving from left to right:
  - Dirty Water at inlet to trailer
  - Water exiting Electro-Chemical Oxide Reactor
    - Iron is seen as sediment at bottom of middle jar
    - Water clarity is not yet obtained.
    - Oxidation process continues in the final weir settling tanks and final clarifier
  - Water discharged at the holding pond after Media filtration

Generation II Reactor

- Integration of Multi-Physics into a single package
  - Advanced Oxidation reaction intensified in the reaction zone
  - High flow rate capability – 75k BPD in a single CONNEX containers
  - Wide Spectrum of Applications
    - Wastewater
    - Oil & Gas
    - Food & Beverage
    - Pharmaceuticals
    - Etc