Bubble Benefits

* *Ed Godeauy and Jeff Grist*

Oil and gas producers face many operation related issues, and one major concern is water treatment. Companies are challenged to address water treatment issues, which can be especially difficult for all types of petroleum operations, where often times space requirements and a harsh operating environment require unique solutions. Ineffective treatment of wastewater streams can impact companies economically, and more importantly, negatively effect the environment. Oil and gas producers are looking for ways to effectively and responsibly treat waste streams from both onshore and offshore locations.

In order to meet ever increasing environmental demands, companies require technologies that remove solids and hydrocarbons, soluble and insoluble, from waste streams resulting from remediation/stimulation, completion and workover fluid activities (commonly called "flow backs"). In the Gulf of Mexico, companies must meet stringent discharge criteria before water can be discharged into the Gulf (Clean Water Act, Federal Register 40 CFR Part 435, Subpart A).

One aspect of water treatment that has developed in recent years is treatment processes surrounding these waste streams. Companies looked for ways to keep from interrupting production during completion, workover and acid Stimulation activities. Until recently, the technology had changed very little since first being introduced in the Gulf in 1996. Standard flow-back equipment has utilised either sparge tube or centrifuge technology. Both Systems have limitations due to separation efficiency, low flow rates and high consumable costs.

Flotation technology is one of the main Systems used for removing contaminates from these waters. Not only is there a need to increase the efficiency of these Systems; there is also a necessity to reduce the size of the equipment, and to handle the pitch and roll of deepwater production facilities.

Flotation Systems for Oily Waste Streams

Flotation Systems are used for a variety of applications through-out the world. The process floats solids, oils and other contaminates to the surface of liquids. Once on the surface, these contaminates are skimmed off and removed from the liquids. Oil and gas production facilities have used flotation systems to remove oil and solids from their produced and processed water for many years.

The keys to good separation are both gravity and the creation of millions of very small bubbles. Based on Stokes' Law, the size and density of the oil droplet will affect the rate of rise to the surface. The larger and lighter the droplet, the faster it will rise to the surface. By attaching a small gas bubble to an oil droplet, it will decrease the density of the droplet, which will increase the rate it will rise to the surface. Therefore, the smaller the gas bubbles created, the smaller the oil droplet floated to the surface. Efficient flotation Systems need to create as many small bubbles as possible. The method by which the bubbles are introduced into the water stream and retention time are also important factors.

There are a few different types of flotation systems.

- Dissolved air flotation (DAF) system. In this method, the air is compressed and dissolved into the water stream. These bubbles are very small and provide high quality results, but the system requires a compressor and a saturation tank. This may not be suited for offshore platforms due to space and maintenance requirements.

- Induced gas flotation (IGF) systems. These systems can be mechanical or hydraulic. The mechanical system uses a motor and paddle assembly to shear the gas out of the water. As the paddle spins in the water, it agitates the flotation cell with small bubbles. The motors, bearing and paddles require regular maintenance. The hydraulic system uses a recirculation pump to drive an eductor, which induces fine gas bubbles into the water. Each flotation cell is filled with many micro fine gas bubbles. The recirculation pump recycles 25 - 125% of its effluent, depending on the equipment design. Mechanical systems can be maintenance intensive and typically are not used for flow-back operations. In addition, gas bubble size generated by the eductor system is dictated by the orifice size and efficiency can be impacted by erosion or corrosion of the orifice nozzle.

- Sparging system. This system uses a porous stainless steel tube to introduce small gas bubbles into the water. The gas bubbles are very small and provide superior results. The sparging tubes, however, are prone to plugging with scale and/or hydrocarbons.

- Dissolved gas flotation (DGF). This system uses fine bubbles, which are predissolved in the produced water, to remove oil and solids. While normally more expensive than comparable IGF systems, the DGF systems offers increased treatment efficiency and reduce float volume. By reducing the fluid carryover, the DGF system decreases the fluid that needs to be reprocessed through the system. A new technology, the Monosep™ DGF pump technology, uses a hydraulic method for flotation without the need of auxiliary equipment such as an eductor. The recirculation pumps used in the system dissolves the gas bubbles within the pump and associated piping. The Monosep™ pump technology addresses the needs of oil and gas producers by increasing the efficiency of the flow-back system, while taking into account operational ease and long term flexibility.

Use of DGF Technology for Flowback Applications

A typical flowback waste fluid treatment system would include flotation technology, filtration, adsorption and final polishing. The Monosep dissolved gas flotation (DGF) pump, when included as part of the dissolved gas flotation System, has proven to be a cost effective solution for treating these types of waste fluids and is an integral component of the treatment process. Utilising Monosep DGF pump technology in flowback and pipeline applications routinely results in savings of at least 30% over traditional treatment methods by reducing consumables and disposal costs. The equipment is completely operational on fixed or floating platforms, dive support vessels, and can be semi automatic to accommodate personnel issues while reducing cost.
The first step in the flowback treatment process is the gas flotation unit (GFU) equipped with weirs, DGF patented pump and oleophilic coalescing media. Demulsifiers, coagulants and/or oxidisers can be introduced into this vessel to aid in the Separation of the phased organics or break frac gels from the aqueous phase. The water will then go through a series of weirs and compartments to allow sufficient separation of organics. Finally, the liquid will pass through oleophilic media, which will further aid in organic separation. Small droplets of oil, normally too small for gravity assisted separation, are

attracted to the fibres/media where they collect and coalesce. As the oil droplets merge, their increased buoyancy forces upward movement and separation. The media can remove oil particles down to 20 μm in size and produce an effluent quality of less than 10 ppm of free oil. Usually, the recovered oil will be collected in an oil weir system and sent to a wet oil tank.

The DGF pump technology allows for greater removal of oil and grease using hydraulic separation. This technology has proven to yield tremendous savings by extending the life of the downstream media, which also results in reduced disposal cost. The DGF pump technology works by using a dual sided impeller that pulls both water and gas (blanket gas). The gas is dissolved into the water, creating very fine bubbles. As the gas/water matrix flows across a globe valve, it experiences a pressure drop, causing the dissolved gas to break out of solution. The discharge of the system is piped into the GFU so that the fine gas bubbles attach to the oil droplets. As the gas bubble attaches to the oil droplet, the droplet floats to the surface at an accelerated rate.

The DGF pump technology allows ultimate flexibility during flowbacks due to its ease of adjustments. Changes in water chemistry regularly occur during the completion of flowback activities. The water chemistry varies due to many factors, including shifting concentrations of completion fluids, completion additives, water/oil ratios, and a host of other factors. When this occurs, operators can adapt to these changes by adjusting the backpressure on externally mounted globe valves. In general, as the back pressure on the DGF pump is increased the lifting efficiency of the DGF technology increases, assuming the oil droplet size is in the submicron range. Service personnel can collect and analyse influent and effluent samples entering and exiting the GFU to determine the ultimate setting of the DGF technology, which correlates to the greatest removal efficiency setting. As water chemistry changes during the flowback operation, service technicians simply make adjustments in the back pressure, which instantaneously changes the removal efficiency. This technology allows companies to realise significant savings in consumable cost.

The aqueous phase from the flotation unit is then filtered further. This step will remove any solids such as calcium carbonate and/or oil wet solids that may have carried over from the GFU.

The filtered fluids then go through two stages of treatment, adsorption media and polishing, where any remaining residual organics will be removed to ensure that all discharges are within environmental guidelines. The treated water is discharged overboard.

MONOSEP DGF Pump Technology

DGF is a proven process that hydraulically lifts or floats solids, oils and other contaminants to the surface of the liquid phase. With the Monosep DGF pump technology, fine bubbles are introduced into the vessel. The gas bubbles attach to the oil droplets and float to the surface at an accelerated rate. When the contaminants reach the surface, they are skimmed off or removed from the liquids. DGF pump technology can produce bubbles that range from 1 µm and greater.

A unique benefit of this technology is the ability to alter bubble size to optimise the efficiency of the flotation unit, which is especially critical in produced water and flowback application where water chemistry changes quickly.

The pump uses a dual sided impeller that pulls both water and gas into the pump. A 'sub atmospheric' zone pulls vapour from the blanket gas source and allows mixing with the incoming fluid. As this occurs, the vapour is dissolved into the water, creating micro fine bubbles that break out of the solution once a pressure drop is experienced. The pressure drop occurs once the fluids and dissolved gas flow across a globe valve before it enters the flotation vessel. Due to the DGF pump's design, the vapour is sheared into micro fine bubbles, allowing greater attachment to the oil droplets. As the gas bubble attaches to the oil droplet, it floats to the surface at an accelerated rate. The bubbles with the oil droplets attached are then skimmed or removed from the liquids. DGF pump technology allows the operator to instantly change the bubble size in the flotation unit by adjusting the backpressure on the external globe valve. This results in more efficient oil and grease removal rates, lower chemical costs, no confined space entry and minimised corrosion impact.

The DGF pump's efficiency reduces the amount of water treating Chemicals required while still achieving discharge contaminant concentrations of less than 20 ppm oil and grease. Most Systems consistently achieve discharge concentrations of less than 10 ppm oil and grease.

Case Study

Challenged with meeting water treatment needs and meeting environmental standards. Anadarko Petroleum Corporation looked to Siemens Water Technologies to provide flowback technology and Services for its Marco Polo platform.

Siemens .provided temporary flowback equipment, including its Monosep™ DGF technology, and Services to treat residual completion fluids resulting from initial unloading activities at the company's Marco Polo project located in the Gulf of Mexico. Six wells were completed on the platform without any safety or environmental issues. The DGF technology's separation efficiency allowed Siemens to offer Anadarko a fixed cost/well based on certain completion parameters, providing limited protection against cost overruns during completion/flowback operations.

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Outline the benefits of DGF Technology in the treatment of waste streams.

Published "Hydrocarbon Engineering", Farnham, Surrey, UK
Issue June, 2006

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