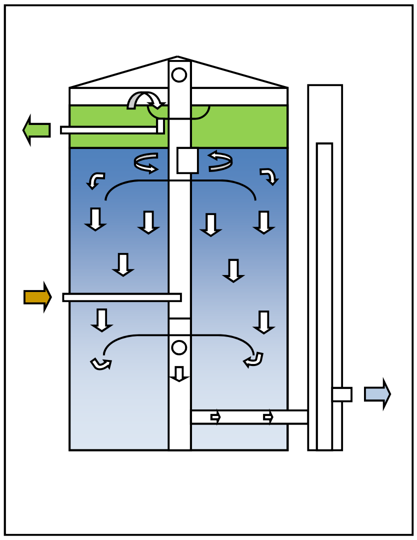
The HWSB™ Skim Tank (aka Gunbarrel)

The 2014 How, Why, and What of this Technology ™

INTRODUCTION

The HWSB™ is a replacement for conventional API gunbarrels. API gunbarrels are designed to remove small amounts of water from large amounts of oil production. The HWSB™ is designed to separate smaller amounts of oil from larger amounts of water production, typical of high water cut oilfield operations. The HWSB™ will separate virtually all oil from water, usually down to below 50 ppm, and will dehydrate the separated crude to pipeline quality in most cases.



THE HWSB™ SEPARATION SYSTEM

The HWSB™ design is more complex than an API Gunbarrel. Each component is actually engineered, a distinction the API Gunbarrel does not share with the HWSB™. By viewing this YouTube link, (please click on …

http://www.youtube.com/watch?v=jOv-eT7iQNM

… you can see that it's what's inside that really separates the HWSB™ from all other forms of oil-water separation facilities!

When the incoming fluid contains gas the HWSB™ has a top mounted degassing boot designed with an internal centrifugal diverter to assure the inlet liquid stream spreads out into a thin layer inside the degassing chamber, allowing all free gas to separate. This avoids the mixing that would occur in the separation section of the HWSB™ if the gas were allowed to enter with the liquids.

Once the gas free liquids enter the HWSB™ they are distributed just below the oil-water interface through a series of inlet diverters. These diverters impart a centrifugal force on the liquids, spinning them outward from the center of the tank in an increasing radius spiral. This slows the velocity of the inlet fluid and increases its effective separation time in the primary separation zone just below the oil-water interface. As the inlet fluid stream slows, smaller and smaller droplets of oil separate and rise the short distance to the oil layer. Some oil droplets accumulate on the top of the upper large area flow diverting baffle, which serves also as a huge surface area coalescer. As the fluid stream spirals outward away from the center of the tanks it encounters the inside surface area of the tank wall, another large area coalescer. Any droplets of oil attaching themselves to these surfaces are obviously now no longer in the water. They are permanently separated. As these surfaces become totally coated with oil the oil wicks upward, eventually entering the oil layer above, adding to the volume of oil collected.

The oil layer is designed to provide adequate time for all accumulating oil to completely dehydrate to typical pipeline specifications, or better. Uniform oil collection is critical to this function, so a very large oil collector in the center of the tank at the top of the oil liquid layer assures all oil rises uniformly through the entire oil layer, and is collected from 360° of that layer. The large collector is designed with a very large spillover weir. This weir is nearly 16' long. Its length secures a minimum level deviation even during periods of very high slug rates. The level differential between the oil outlet and the downstream tank assures that large flow rates of oil can flow out of the HWSB™ oil collector and oil outlet piping during slug flow conditions. Because of this it is nearly impossible to overflow oil from the HWSB™.

Once the bulk oil has separated from the main flow of inlet water, the water must turn 90° downward to flow down between the upper large area flow diverting baffle and the tank wall. This causes a small measure of acceleration. As the downward flowing water reaches the lower edge of the baffle it enters a quadrant of the HWSB™ which is open to full diameter flow. The acceleration velocity creates a mild eddy current that pulls a portion of the water in and under the baffle. At this point all fluid flow changes to vertically downward throughout the entire cross sectional area of the HWSB™. Velocity is now at is slowest, allowing the smallest of oil droplets to counter flow upward. These droplets coat the underside of the upper baffle. Once coated, the oil can migrate directly into the oil layer above through a pipe extended from the underside of the baffle up and into the oil layer, preventing any and all re-entrainment. This adds even more to the volume of oil collected and the separation efficiency of the HWSB™.

As the clarified water nears the bottom of the tank it encounters a second large area diverting baffle. As the water impinges on this baffle oil droplets accumulate on its surface, further enhancing separation. Additionally, this lower baffle forces the flow stream to change directions from vertically downward to nearly horizontal again.

Now the water is flow in straight toward the ID of the tank again. As it contacts the vessel wall some of the smallest oil droplets impinge on the wall and wick up into the oil layer above. Once again, separation efficiency is enhanced.

But to exit the HWWSB™ the water must turn downward again to flow between the outer edge of the lower baffle and the tank wall. Since this area is a fraction of the tank cross section the water must again increase in velocity as it turn downward. Any solids in the water at this point are now aimed directly at, and are being propelled directly at, the tank bottom.

As the water reaches the lower edge of the lower baffle it must now turn upward more than 90° and flow upward under the underside of the lower baffle. Solids, being heavier than water, are unable to change directions and settle to the bottom of the tank. The water flows along the underside of the lower baffle where the tiniest droplets of oil have one last chance to coalesce and attach to this very large surface. Oil accumulating on the underside of this baffle is allowed to exit through oil-dedicated weep holes. It exits to the area under the upper baffle and flows through the oil piping directly into the oil layer.

The water now reaches the center of the tank again and enters the large diameter center pipe, turns downward, and flows down to enter a horizontal pipe leading it out of the HWSB™ and into its water leg.

THE WATER LEG

The water leg is a pipe within a pipe. The clarified water enters through the outer pipe and turns to flow upward between the outer pipe and the inner pipe, in the annular space separating them. The inner pipe is sized for its circumference. The circumference of the outer pipe forms a spillover weir for the water. The height of this weir (the top of the inner pipe) sets the oil-water interface inside the HWSB™, so its *height is critical. It is always adjustable, either by removing the upper removable center pipe nipple, or via an externally adjustment assembly that slides the upper pipe up or down to change its spillover elevation.*

MAKING IT WORK RIGHT

When a new HWBS™ is first put in service it may take a while for it to accumulate enough oil to begin to put oil into the sales oil tank. Once it does, the lease operator should color cut the tank to determine the thickness of the oil layer. It is always shown on HTC's drawing, and is typically 4-6 feet depending on the oil gravity (heavier oil = thicker oil layer).

The oil layer should be maintained at the designed elevation. If it deviates more than 12" from the elevation shown on HTC's drawing the water leg must be adjusted to bring it into normal tolerances. In SWD Plant applications the trucked–in water may vary in its weight (specific gravity). In these instances, the water leg may need to be adjusted daily to optimize oil recovery. If this is the case, and the HWSB™ was delivered with a removable upper inside pipe water nipple, either several different length nipples should be cut and kept close by (on the walkway near the water leg, for instance), or the operator should order the external adjustment assembly and retrofit the water leg to make this adjustment fast and easy.

CENTER COLUMN DRAIN AND INTERFACE DRAW-OFFS

Most HWBS™s are fitted with two internal drains.

The first is the center column drain. The pipe in the center of the tank (aka the "center column") is divided into two vertical sections. The inlet section extends from the tank top to just above the lower baffle. At that point a blanking plate is installed to divide it so the inlet fluid cannot flow directly to the outlet below. Incoming fluid often contains some solids. These will accumulate preferentially above the blanking plate. A center column drain is provided so the operator can drain this area. It should be drained frequently until the water leaving the drain line runs clean.

The second is the interface drawoff. As oil accumulates it is common that some BS&W (basic sediment and water, aka "emulsion") will accumulate immediately below it at the oil-water interface. It since it is heavier than pure oil because of the water and solids in it, it will build downward from the normal interface level. About a foot below the normal oil-water interface level is a series of "interface drawoffs". These are 24" OD round horizontal baffles stacked 4" apart. A pipe is connected to the lower baffle and piped to a convenient elevation near the bottom. When the valve on that outlet is opened the BS&W layer flows horizontally between the plates and out through the piping. When either clean water or clean oil is observed in the sample of the outlet fluid the BS&W has been removed and the valve can be closed.

Some HWSB™'s also have sand removal systems. These should be drained daily until clean water is observed.

TROUBLESHOOTING AND PROBLEMS NEEDING SPECIAL ATTENTION

<u>Bad Effluent Quality</u>: Sometimes the oil or water leaving the HWSB™ may have excessive BS&W, solids, or other contaminants due to the chemistry of the water. Since physical separation systems can not compensate for this sort of issue, when this is observed it is time to call on the assistance of the local oilfield chemical company. These firms make their living evaluating and curing this sort of issue.

Cold Treating: Wintertime conditions can make separation difficult. Please read the technical papers on separation on HTC's website at www.hitec1.com or www.hightechconsultants.net to learn more about separation. Suffice it to say that cold temperatures may cause oil to congeal and get so thick that water can't separate from it. Applying heat will resolve this, but hot oiling fiberglass vessels (most HWSB™s are made from fiberglass) is discouraged unless the HWSB™ was ordered to made with high temperature resin. Otherwise, the maximum recommended temperature for FRP tanks is 120°F. The best remedy is to transfer the "bad" oil into a steel tank and hot oil that tank.

Freezing: Water, particularly fresh water, will freeze in many parts of the world. Immersion heaters installed in the tank near bottom will prevent this. And, recirculating water 24/7 will help prevent freezing, The greater the circulation rate the lower the freeze point will be.

Overflowing: Since HWSB™s are designed to prevent overflowing, should an overflow event occur it would be wise to look for a closed valve or a plugged line.

Improper Venting: All HWSB™s should have the gas phase piped to all other tanks being fed by the HWSB™. This includes the oil tanks. If all tanks are not equalized the gravity flow hydraulics will be disrupted and the HWSB™ could overflow. ALWAYS EQAULIZE ALL TANKS IN A TANK ABTTERY TO ASSURE PROPER FLOW!

Level Vessels: The HWSB™ is carefully designed to operate when it is set straight and on true level. When this is not the case the effluent qualities will suffer. Take care to set all tanks straight and level on a flat and level grade. Shoot in the tank grades with a transit before setting the tanks.

Set the Water Leg at the Same Elevation: The correct spillover level of the inside pipe in a HWSB™ water leg is calculated to within a fraction of an inch. If the water leg is set on a different elevation than the HWSB™ the levels will be incorrect, and performance efficiencies will suffer dramatically.

ABOUT THE AUTHOR AND HTC

Bill Ball is the founder and owner of HTC, Inc. He has a long history of oilfield separation system design experience, which when coupled with his hands-on oilfield experience and career portfolio, make him one of the industry's leading separation authorities today. After his university studies his career started in a 1,000,000 b/d waterflood operation where he was responsible to evaluate and improve the performance of all surface facilities. Through this hands-on effort, he learned the modifications that help improve process efficiency, and those that do not. In the 49 years since Bill has accumulated a lifetime of knowledge and experience in oilfield separation. He holds several patents in the field.

The culmination of this work is the HWSB™ Skim Tank, aka the "HWSB™ Gunbarrel". This unique design achieves the highest level of hydraulic efficiency known to exist in any design. The results are an unparalleled quality improvement in the effluent streams.

Today, HTC, Inc. is one of the industry's leading low-cost surface facilities design firms. Bill's team of seasoned veterans specialize in salt water disposal (aka SWD) plant, flowback water treatment plants, and crude oil processing and dehydration/desalting plant designs worldwide. HTC affiliates blanket every field of engineering discipline making HTC a full service firm capable of complete turnkey designs.