INTRODUCTION

Imagine that today is August 27, 1859. You're in in Titusville, Pennsylvania. It is a warm sunny morning. All homes and factories worldwide are lit with oil lamps burning whale oil, or with candles. Today, whaling is the largest industry in the world because oil lamps burn whale oil … lots of it. But all of that is about to change. Today, August 27, 1859, oil was discovered in America!

Seventeen months earlier a group of wealthy men had an idea. If they could replace whale oil with something else, they could become even wealthier. Their idea was to try to find naturally occurring oil. Oil seeped from the banks of a dry creek nearby, so they chose this local site. They erected a drilling derrick and motor house near "oil creek" in Titusville, Pennsylvania, and then hired Edwin Drake to be the first man to ever drill for oil.

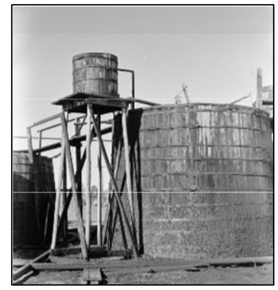
Drake hired a crew experienced in drilling for salt, and the adventure began. Several months of slow and difficult drilling ensued. The well caved in on itself repeatedly. As investor confidence and money ran low, Drake decided to take a gamble. He personally borrowed US$500 (US$18,500 in today's dollars), purchased fifty feet of cast iron pipe, and an 8" diameter 20' long billet of solid steel. He instructed the crew to drive the pipe down through the slushy sand clear to bedrock. The pipe successfully kept the hole from collapsing in on itself. Once they encountered bedrock, they could drive the pipe no deeper. So, they picked up Drakes's heavy iron solid steel ram, lowered it into the well, and used the rig to pound away at the bedrock.

No one had ever tried this before. But then, no one had ever drilled for oil either! It was slow going! They drilled and bailed about three' per day through the solid rock. But then, on the 27th of August, 1959, out of money, and thoroughly exhausted, they struck oil!

America's first well produced 12-20 barrels of oil each day for the next several years, and an industry was born. Within a decade the whaling industry was a thing of the past.

In these earliest days 42-gallon wine barrels were used to store and transport oil. A Canadian had just developed a method of producing kerosene from crude oil, so kerosene quickly displaced whale oil in oil lamps worldwide. The 42-gallon wine barrel became the "standard" for measuring crude oil volumes (1 barrel of oil = 42 gallons), and it remains the standard today.

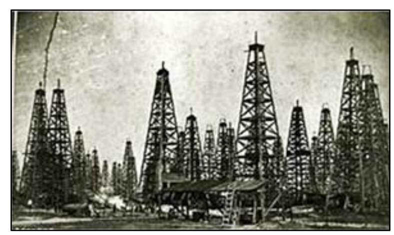
In these earlies days drilling rigs and pump houses were made from wood and were powered by steam engines. The world was still decades away from the invention of internal combustion engines! Steam was generated by burning fuel to heat water into steam. In the beginning, wood and coal were obvious fuels. But soon, crude oil replaced these forms of fuel on many oil rigs since it was readily available and cheaper.



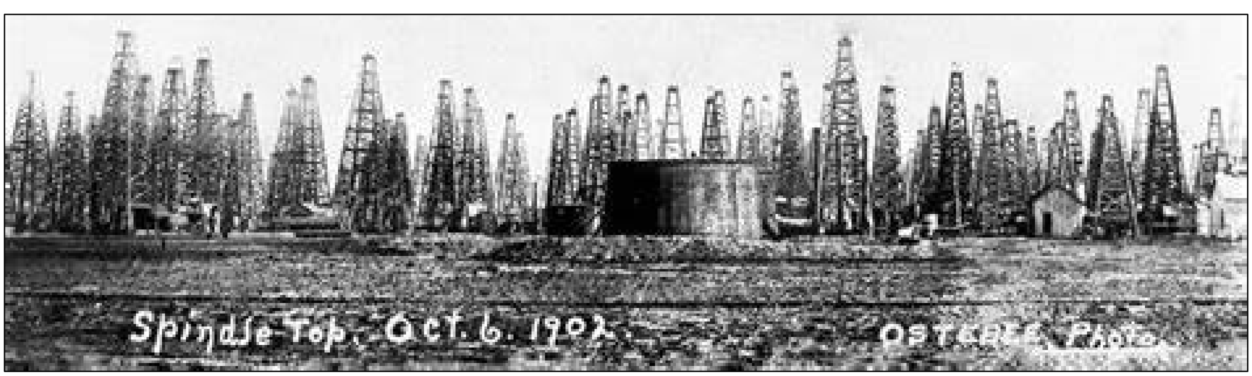
Wooden wine barrels were replicated into larger and larger forms, and soon wooden oil storage tanks became the standard of the industry. Steel tanks were still decades away as the world advanced toward the "industrial age."

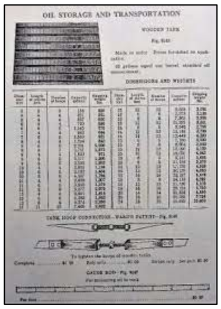
A few clever producers began to build wooden tanks that could separate natural gas from produced liquids. This photo is one of those, built so wells could pump oil and gas into the upper tank. The lighter gas would separate, and oil would gravity flow down into the lower, larger tank. Gas under a slight pressure was then piped from the upper tank to the engine house and used to fuel the steam boiler. Gas was a cleaner, generated less smoke and soot, and was generally preferred by these early oil men.

From 1859 to 1870 oil production grew from twenty barrels per day to over 40,000 barrels per day. Wherever oil was found, oilmen flocked to lease adjacent land. Wells were drilled next to one another until the derricks looked like a forest.

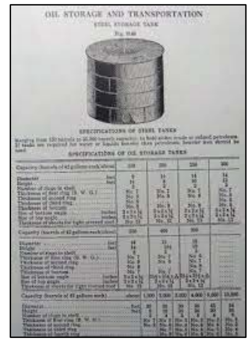


In 1870 John D. Rockefeller founded the Standard Oil Company and grew oil production to over 170,000 barrels of oil per day, becoming the richest man in the world. In 1892 Rockefeller told a group of reporters that there was no oil to be found west of the Mississippi River. But on January 10, 1901, a well in Spindletop Texas blew in at over 100,000 barrels of oil per day. The world would never be the same again!

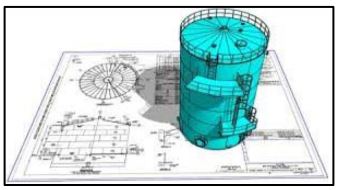




The Spindletop well prompted more and more oilfield supply companies to offer wooden oilfield tanks of various standard sizes. Exceptionally large tanks were needed, and companies were formed to provide them. But at the same time, the steel industry began to blossom. World War I kicked it into high gear as mass quantities of steel plates were produced for the building of war ships.

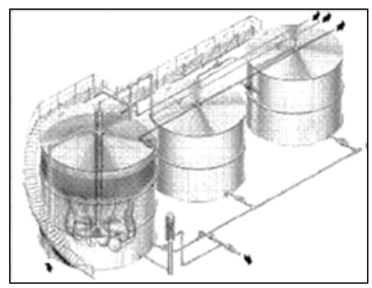


With steel plate then readily available, oilfield tanks began a transition away from wood and toward steel. The first of these were built using the overlapping rivetted plate method commonly used in steel bridge structures bridges and in tall buildings. In just a few years rivets gave way to bolts and nuts, and the industry entered the bolted tank era.



These bolted tank components could be fabricated in almost any size and shape. The component pieces could be easily transported and assembled quickly by unskilled workers. Overlapping sheets were gasketed and double bolted to prevent leakage.

From 1925 until just after World War II bolted tanks were the standard of the industry. They were inexpensive and easy to transport. If one stave failed or was bent, it was readily replaceable by a duplicate. These tanks could be designed for storage, separation, processing … whatever! And they were! They became the standard of the industry. Many new well sites were fitted with one 1,000-barrel process tank (Gunbarrel tank, aka wash tank), two 500-barrel oil storage tanks, and one water storage tank. One hundred years later, bolted tanks in all sizes and configurations are still available from local suppliers!



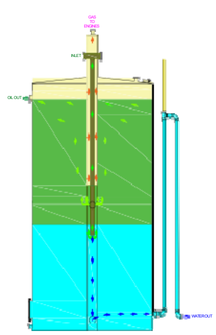
During the years following World War I welding technologies were developed and perfected. GE patented electric arc welding in 1920. In 1925 The National Tank Company of Tulsa, Oklahoma was the first firm to begin selling shop-welded oilfield storage tanks.

In 1927 A.O. Smith developed flux-coated welding rods, and in 1929 Lincoln Electric introduced the coated electric sub-arc welding rod which prevented welded metals from becoming brittle during the welding process. This became a standard welding process by the start of WWII and has been used in shipyards and oilfield tank shops alike ever since.

After World War II the demand for steel declined, and the cost of steel declined with it. Some tank manufacturers hired welders trained in shipyards during the war years, and steel welded oilfield tanks were offered for sale. They were fabricated from steel twice as thick as bolted tanks. They could be shipped in one piece in most nominal oilfield sizes. They were ready for service when they arrived since there was nothing to assemble. And best of all, they cost less! This was a game changer for the oil industry.

Advancements in many oilfield operations after WWII came in rapid succession. Welded pressure vessels were designed and built for processing fluids under pressure: some for oil-gas separation, others for oil-water separation. Through this period the age-old Gunbarrel tank/wash tank made the transition from bolted to welded but continued otherwise unchanged to be the go-to tank for the low-pressure separation of oil, water, and remnant natural gas.

During the years from 1900 to 1955 "normal" oilfield operations and operating mindsets changed. Welded tanks were integrated with bolted tanks just as you see here at the right.

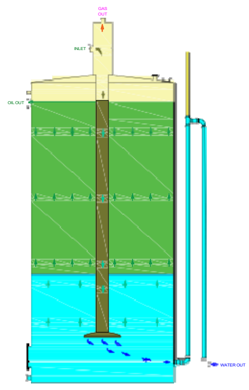


15'-6" X 30' GUNBARREL(WASH) TANK FLOW DIAGRAM FOR GAS AND WATER SEPARATION

In 1900 all drilling and pumping rigs were steam operated. Steam engines were fueled by wood or coal. But as many new oil wells also produced natural gas, tanks were constructed to separate the gas for use as fuel for the steam boilers. The drawing at the left is such a tank. This design became a standard by 1910, and remained so until the 1930s.

While produced natural gas became the friend of the oil producer, water was considered to be the enemy. As wells produced more and more water they were often abandoned because of an increase in produced water. Then, after World War II, petroleum geologists found that oil production in older fields could be vastly increased by pumping water into oil reservoirs in what became known as "water flooding." By 1955 wells producing copious quantities of produced water were common and were considered acceptable.

Additionally, as the industrial revolution got into full swing, natural gas was distributed to more and more urban and rural homes. Therefore, the more complex gas capturing Gunbarrel/wash tank internals of earlier designs like the one above became unnecessary and were deleted, simplifying those into predominately water-oil separation tanks.



15'-6" X 30' GUNBARREL (WASH) TANK
FLOW DIAGRAM FOR WATER SEPARATION

By the mid-1940s gun barrels/wash tanks no longer were designed to move gas to steam engines or nearby homes. The focus was strictly on separating produced water as we see here. Larger and larger water volumes became normal industrywide, spurred by waterflooding to increase oil production in older fields.

At about the same time the industry's engineers and R&D departments began studying the efficiency and design of its legacy equipment. One R&D finding was that the original wash tank/Gunbarrel tank, by then a "standard of the industry," was surprisingly flawed! It seems that under some conditions, when water flows approached oil flows, substantial amounts of oil exited with the water. Under other conditions oil was found to actually adsorb produced water creating severe emulsions.

As time went on oil carryover in water and water carryover in oil continued to plague operators industrywide.

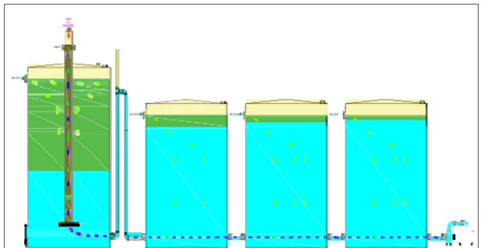
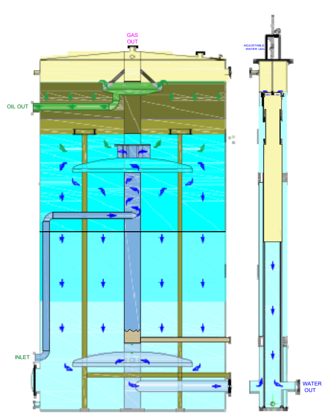


FIGURE 1
15'-6" X 30' GUNBARREL (WASH) TANK
FLOW DIAGRAM

FIGURE 2
15'-6" X 24' OIL CARRYOVER TANKS
FLOW DIAGRAM

To solve this problem operators added more tanks downstream of their Gunbarrel/wash tanks. It was feared that without these added tanks remnant oil plugged injection and disposal wells. Often two, and sometimes three more tanks were added. The results were dismal! It seems that the water flowing through these tanks flowed directly from the inlet to the outlet. Very little oil-water separation actually took place as the velocity of the flowing water was greater than the separation velocity of the oil. Therefore, the oily water sent to injection and disposal continued to plug them in truly short order.



HWSB® 15'-6" X 30' SKIM TANK
FLOW DIAGRAM

Due in most part to the boom-and-bust culture of the oil industry, more specifically the exodus of industry-wide knowledge after each boom, this problem persisted until the 1990s when the first true oil-water separating skim tank design was introduced. This skim tank was a design departure from the wash tank/Gunbarrel. Unlike the wash tank/Gunbarrel, this design maximized retention time and therefore separation. Where the Gunbarrel/wash tanks carried over 1-3% oil or more, the HWSB® separated all oil down to below 50 parts per million.

The inventor named it the HWSB® after a conversation addressing how hard working a vessel it was. While the HWSB® proved to be a marvelous oil-water separator, reducing effluent oil-in-water concentrations to below 50 parts per million and most often even lower, it was slow to catch on.

Reality was that by the 1990s the industry had used Gunbarrel (wash) tanks for over a hundred years. It had become an "industry standard" even though increased water throughput had hampered its effectiveness. But since the entire industry had used it for so many decades, and had no real alternatives, it was hard for even consider looking for a substitute. Then, when the HWSB® was introduced, most end users were afraid to move away for their old standby.

Nevertheless, by the time the shale oil/long lateral/massive frac boom got underway in the early 2000s, the industry finally began to accept and use the HWSB®. Today there are more than 4,000 HWSB®s in service worldwide. To see how it works, just go to YouTube and type in http://www.youtube.com/watch?v=jOv-eT7iQNM in the search bar.

To say that oilfield tanks have come a long way from the leaky, banded together, handmade wooden tanks of the yesteryear to the CNC automatically welded leak-free steel tanks of today would be a vast understatement.

We have learned a lot in the last 165 years. Looking back at the early oil facilities of the 1800s, it is clear that the industry has changed a lot too, and mostly for the better!

Compare the oilfield in the picture above taken in the 1800s with the one at the left, taken in 2024. There are roughly the same number of oil wells in each picture. But instead of drilling wells as close together as possible, we now understand the value of proper well spacing.

Instead of having oil storage for every well, today's central tank battery clusters process separation and storage tanks for optimum operation and efficiency. And instead of storing oil in oversized and leaky wooden wine barrels, todays tanks are mass produced from welded steel and each designed specifically for its individual application.

ABOUT THE AUTHOR

Bill Ball is the founder and owner of Breakthrough Engenuity LLC. He has a long history of oilfield separation system design experience, which when coupled with his firsthand oilfield experience and career portfolio make him one of the oil and gas industry's leading separation authorities today.

Bill worked summers in the oil field to help pay for college. After his university studies he started his career in the mechanical engineering department in the Wilmington oilfield. This was a 1,000,000 b/d oilfield waterflood operation producing 150,000 BOPD where Bill was responsible for the construction and performance of all surface facilities.

Challenged by the industry's general lack of knowledge about how its process equipment worked, and how the role of oilfield treating chemicals influenced process successes or failures, Bill changed career paths, joining and oilfield chemicals firm: Diversified Chemicals Corp., aka Di-Chem. The lessons learned there would serve him well throughout the rest of his career. Bill then joined CE Natco where he first helped R&D engineers install the internals in CE Natco's first offshore electrostatic crude oil dehydrator. He subsequently served as Branch Manager in west Texas, and then as R&D/Engineering liaison where his efforts resulted in the development of Natco's "Dual-Flow" filtration system. While at Natco, Bill served as director of branch operations, manager of safety and training, liaison to R&D, and executive advisor to Natco's design engineering group.

Bill started his own consulting engineering company in 1992, High Tech Consulting Inc., to promote the HWSB® technology. It was a good move. This unique technology became one of Bill's best contributions to the industry. It was needed and eventually recognized as the best oil-from-water separation system known to exist. He sold the HWSB® patent and others to KBK Industries as an exit strategy, to ensure that his technologies would live on long after he is gone. In 2015 Bill converted High-Tech Consultants into Breakthrough Engenuity LLC to broaden his consulting exposure and retains a solid relationship with KBK. Today the HWSB® technology is exclusively available through KBK Industries.

In 2024, Breakthrough Engenuity LLC is a leading separation and surface facility design firm, specializing in unique designs for old and new oilfield facilities alike, often using one of Bill's twenty-two US patents. Bill's influence, and his designs, can be found in every sector of the oil and gas industry today … and each is guaranteed to outperform the expectations of its owner!

If you have an interest in 21st century separation technology please feel free to contact Bill Ball at 918-231-9698. If you would like to purchase a new HWSB®, please contact KBK's CEO Steven White at 832-404-3742.