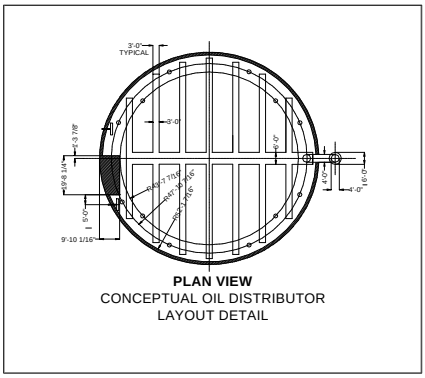
Crude Oil Dehydration
in Atmospheric Tanks

"Gunbarrels Then and Now"

A Technical Paper

Prepared for

All Interested Oilfield Personnel



PLAN VIEW
CONCEPTUAL OIL DISTRIBUTOR
LAYOUT DETAIL

HTC's
HWGB™ DISTRIBUTION
SYSTEM
Patent Pending

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PREFACE

Too little effort is given to the selection of process equipment today! The results can cost any operator millions of dollars.

The most common mistake made by many oil operators is to pick up the phone and order a separator, a gunbarrel or heater treater, a couple of oil tanks, and a water tank. The seller often does the sizing, if any sizing is done at all.

Why does it happen this way? Because we've always done it this way. This statement, factual as it is, is the bane of the oil industry!

It's time to catch up with today's conditions, and match the equipment we buy with those conditions. In fact, it's past time! All of the "normal" conditions are now completely different than they were when you could get away with a casual approach to selecting process systems.

The "normal" condition when most oilfield equipment was developed was a predominance of oil, produced with little or no water. Today, most operating conditions are just the opposite!!

So, it should be surprising that yesterday's low water cut process equipment designs don't fit well in today's high water cut operations. The poor fit can cost us hundreds of thousands of dollars annually!

Let's see why … and what we can do about it.

IN THE BEGINNING

Oil-water separation became a necessity in Drake's fist well in Titusville. As this well began to water out a system to separate the water needed to be developed.

That effort took a couple of generations to mature. But when it did, it became a standard of the industry that has survived all the time since. It was, and is today, called a "Gunbarrel or Wash Tank". The design focused small amounts of water from large amounts of oil. In the earliest days, most wells produced sizeable quantities of natural gas. Since the gas tended to mix the water and oil, it needed to be removed. So, a gas separator was added. It was, and still is, called the "Degassing Boot", or just "Gas Boot".

The Wash Tank/Gunbarrel evolved as a very design. A pipe was inserted through the roof of a standard tank, extended a few feet above the roof, and down to a foot from the tank bottom. A horizontal plate was installed on the

bottom of the pipe near the tank bottom to distribute the inlet liquids. Oil rose through the water where the water was thought to "wash" the oil, removing any water in it. The oil rose in the tank accumulating a layer equivalent to about 8-24 hours of the oil production.

The stored oil volume was dependent on the oil gravity. It was found that lighter oil could be dehydrated in about 8 hours, while heavier oil might require 24 hours, sometimes longer.

Some designs placed the gas boot and downcomer outside the tank to minimize the corrosive effects of salt water. Others placed the gas boot on top of the tank (see Figure 1 on Page 3).

For better or worse, this simple design remained unchallenged for over 100 years! It was the standard of the industry until the 1930s when heater treaters were developed to take advantage of the otherwise often wasted natural gas.

But in fields where gas production was depleted or non-existent, it is was, and still is, the system of choice.

Finally, in the 1970s, when the price of crude oil soared to $45/barrel field from $3.50/barrel, this oilfield "standard" was challenged by some of the industry's R&D labs. The results were startling, and very disappointing!

Retention time studies a showed that the hydraulic efficiency of Wash Tank/gunbarrel designs were extremely low, most ranging from 1% to 3%. Bigger had been thought to be better, but in most cases, bigger was proven to be worse!
After all, oil industry separation designs had always been assumed to work efficiently!

It had always been presumed that fluids naturally distributed uniformly and flowed through the entire tank. These studies also proved that all fluids predictably take the path of least resistance. They move through the tank in the shortest, narrowest flow path between the inlet and outlets.

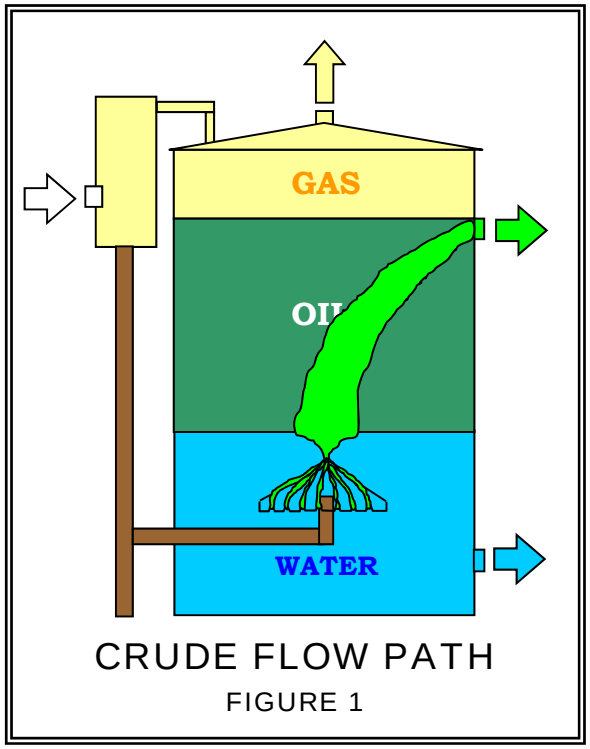
It was found that only a very small portion of the storage volume actually came in contact with the crude. In many cases the inlet crude was found to actually reside in the oil phase for just a few minutes, and the water for even less time, sometimes just a few seconds!

At this point, design emphasis began to shift away from the assumed oil retention time of the past. Designers began to look for new ways to increase separation using better fluid distribution and collection systems to optimize the use of the entire vessel.

It became clear that as fluid flows and distribution were more uniform the results dramatic. As these studies progressed it was eventually discovered that truly uniform distribution of incoming crude and emulsion through the entire cross section of the oil layer

increased retention times enormously, often up to a factor of 35!

A look at the flow paths through the original Gunbarrel/Wash Tank reveals all of this.



CRUDE FLOW PATH
FIGURE 1

It was also found that process capacity and separation efficiency increased even more when the inlet crude and emulsion is NOT washed through the water phase, but is introduced into the emulsion rich layer just above the water phase instead.

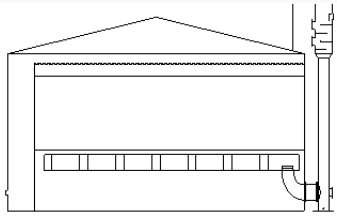
The conclusions of these studies proved that new wash tanks/gunbarrels can be sized much smaller, reducing the capital investment, and that new designs could produce better results regardless of summer-winter swings in temperature.

A BETTER DESIGN

Efficient and effective physical separation is a function of efficient fluid distribution, efficient fluid collection, and the resulting retention time. The required separation time can be calculated using Stokes Law (see HTC paper titled "Separation in Oilfield Operations - Myths vs. Reality"). However, as a reminder, the key to oil-water separation in facility design is a focus on distribution and collection, which result in real retention time.

HTC's approach does just that. The "HWGB™ design uses dual phase hydraulics to achieve uniform distribution and collection of the crude oil. Let's see how it works.

As in all Gunbarrels/Wash Tanks, the inlet fluid is first degassed. The gas free liquid phase flows into a very large hydraulic distributor. This distributor is a series of horizontal inverted troughs, designed to slow the inlet fluid velocity



HTC's HWGB™ Oil Dehydrator
FIGURE 2

in an oversized main distributor so uniform distribution into lateral distributor troughs can be achieved.

The design balances flow, internal distribution, and trough interface depression to achieve a uniform pressure drop across the hundreds of oil an emulsion distribution holes in the troughs.

The holes are strategically located in the lower area of the tanks BS&W layer where all emulsion breaking chemicals tend to concentrate.

The internal trough interface depression creates a uniform pressure drop across every distribution hole, thus assuring uniform flow through each and every hole.

With uniform distribution accomplished, oil rises vertically and uniformly through the oil layer at the minimum velocity, maximizing retention time. The heavier water droplets now counter-flow downward and into the water layer below.

As the oil nears the top of the oil layer, it is collected uniformly throughout the entire circumference of the tank, thus maximizing the utilization of the tank.

ABOUT THE AUTHOR

Bill Ball has focused on oilfield facilities design throughout his fifty year oilfield career, which began after his university studies in 1963. In the years since Bill has accumulated a unique exposure to and knowledge of oilfield operations worldwide. His comprehension of separation facilities, hydraulics, and oilfield chemicals are all enhanced by hands-on experience.

Bill currently holds six patents and is founder and president of High-Tech Consultants, Inc. (aka HTC, Inc.)

ABOUT HTC

HTC was incorporated in 1993 in Tulsa, OK to provide proprietary and patented design technologies to the oil and gas industry. These include the patented warm and cold weather HWSB™ Skim Tank (Gunbarrel), the HWGB™ Crude Oil Dehydrator, Flow Splitters, Sand Tanks, Heater Treaters, Separators, Dissolved Gas Flotation Cells, and many others. HTC is a leading design firm for 21st century salt water disposal (SWD) plants.

HTC is proud to be able to share this paper with those interested in improving their oilfield water-oil-gas separation operations.

HTC's attention to detail assures each and every owner of an HTC HWGB™, or any of its other designs/technologies, of the unprecedented success in each and every application.

Feel free to contact HTC and Bill by calling 918-298-6841 or by emailing Bill at billball@hightechconsultants.net .