Oil Dehydration Design Error Found in Most Designs Worldwide!

This tip of the month (TOTM) discusses how to “Avoid a costly design error found in most oil dehydration systems worldwide”.

- Are you having reverse emulsion problems?
- Are you having problems meeting your discharge oil in water specifications?

An area to look for immediately, is the Process Flow Diagram (PFD). Normally systems work as they were designed. In cases where I have visited sites experiencing problems…the problem is the design.

Why does this occur? The world we deal with is more complex than process simulation models. They are simply thermodynamic models to predict the phase separation of multicomponent systems and perform heat and energy balances. They are useful and very well proven tools. Most designs however; do not consider the various chemicals, presented in in Table 1, that are added to a system on a routine basis.

Table 1. Example of various problems and their typical treatment

<table>
<thead>
<tr>
<th>Problem</th>
<th>Treatment Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrate Formation</td>
<td>Hydrate Inhibitor</td>
</tr>
<tr>
<td>Water Vapor</td>
<td>Dehydrator</td>
</tr>
<tr>
<td>Mineral Deposits</td>
<td>Scale Inhibitor</td>
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<tr>
<td>Chemical Corrosion</td>
<td>Corrosion Inhibitor</td>
</tr>
<tr>
<td>Bacterial Corrosion</td>
<td>Bactericide</td>
</tr>
<tr>
<td>Emulsions (Normal or Reverse)</td>
<td>Emulsion Breakers, Coagulants, Flocculants</td>
</tr>
<tr>
<td>Foaming</td>
<td>Defoamer</td>
</tr>
<tr>
<td>Paraffin</td>
<td>Paraffin Inhibitor, Solvent</td>
</tr>
</tbody>
</table>

Most of these chemicals are added to a system to improve a designs performance in oil water and water oil separation. Most of these chemicals are used in parts per million (ppm) fashion using proprietary formulations from Chemical Companies. Most assets will spend $5-$10 Million dollars per year on the use of these formulations. The ability to add the chemicals is included in most designs, but their effects are not normally included in the designs and it’s left to Field Operations and the Chemical Companies to come up with a solution.

So, What’s the design error? It’s mixing fluids that have come into contact with both oil treating and water treating chemicals and then recycling them back to the front of the process.
What are these streams?

- Oil skims from WEMCOs (induced gas floatation manufacture by Western Equipment Manufacturing Company) or Flotation Cells that are routinely re-routed back into the Oil Dehydration Train.
- Hydrocyclone Oil Skims
- Closed Drain Oil Skims

I would encourage you to check this out at your asset using the real fluids. I perform this demonstration during the Petroskills PF-3 Course. I take a 50% water cut sample of a 45 API Gulf of Mexico Crude Oil and produced water. I shake it up and the emulsion resolves in less than 30 seconds back into oil and water. I then add 5 -10 ml of Demulsifier and Water Clarifier being used on the Platform. Shake this up and voila… instant chocolate milk emulsion. This emulsion will not resolve in days. How is the emulsion resolved? We send it to a heater treater. In class I use a coffee cup of hot water. Let it heat soak for a couple of minutes and the sample resolves into three phases as shown in Figure 1: Oil / a scrambled eggs rag layer (complex emulsion- reverse and normal) / Water. The rag layer is normally about 25% of the total sample. This rag layer is very stable, and I have had samples stay stable for over one year.

Figure 1. Oil water complex emulsion

Never send these skims back into your main process. Consider sending them directly to the sales oil LACT. Most contracts allow you 3-5% BS&W. Use the contract to your advantage. You will not be able to break these emulsions with your existing process and they will continue to build. Some operators send them to the beach as hazardous waste for further processing. Other operators have a separate slop oil system for treating with higher temperatures, and then send streams to the sales LACT (Lease Automatic Custody Transfer), but never back into the process.
Every process needs a trash can for off spec product. Offshore it’s the closed drain tank / open drain tank. Never recycle this material back into the main oil dehydration system. Why? Let’s look at what fluids enter the closed and open drain tanks?

- Engine Lube Oils – these contain polymers that will generate emulsions
- Oxygenated water from rain. Oxygen will corrode your main production system.
- Oily Deck Drains from skid pans

**How to become an Expert?**

Use sources such as SPE’s One Petro. Chances are that sometime, somewhere, someone has faced the same issue you are trying to solve. In your company is it easy to publish a paper or are there controls and bureaucracy? In most instances, it’s not easy. What does it say to you about the person who has taken the time and written a paper. They want to communicate! What do you think their reaction will be if you contact them about their paper to get further information? They usually will be very happy to discuss the paper and give you even more insights / tips / advice / recommendations for your situation. It’s a way of leveraging your time, and getting to solutions quickly.

I once made a trip to an FPSO Offshore Brazil that was having water treating problems. They made the same design mistakes discussed in this TOTM. I searched One Petro and found another FPSO Offshore Brazil that faced similar issues and how they were solved [1]. The paper is listed in the references of this TOTM. Here is the recommendation from SPE 90409 paper:

**“Oil Reject Skid. To provide a positive path for removing oily solids and chemically stabilized emulsions from the process, an oil reject skid was installed on 135 D to receive hydrocyclone reject liquids and skimming from the surge drum, as well as skimming from the sparger IGF vessels. In the oil reject vessel (Fig. 9), larger solids are removed from the cone bottom, while oily solids and chemically stabilized emulsion separates into an oil-continuous phase that is pumped off the platform without recycling back into the process. The volume of this emulsion is low, a few barrels per day, so the impact on the BS&W of crude leaving the platform is low, increasing it by approximately 0.05 %. The clarified water is returned to one of the degasser vessels, from which it reenters the water treatment process. The oil reject skid installation has been one of the major contributors to the ability of 135 D to reliably reduce the TOG of the produced water to < 20 mg/L.”**

To learn more about similar cases and how to minimize operational problems, we suggest attending our **G4 (Gas Conditioning and Processing), G5 (Advanced Applications in Gas Processing), PF3 (Concept Selection and Specification of Production Facilities in Field Development Projects),** and **PF49 (Troubleshooting Oil & Gas Processing Facilities),** courses.

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Reference: