TREATING WASTE WATER FROM GLYCOL RECOVERY SYSTEMS

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Wastewater treatment on a land location is not to difficult a task because most of the time the water is disposed of in a disposal well. However, for an offshore platform, you will most likely have to discharge the water overboard. To discharge overboard, you will naturally have to meet the discharge permit for produce water containing hydrocarbons according to the 29/42 rule, that is 29 mg/l monthly average and 42 mg/l daily maximum. This in itself would not present a real problem or dilemma except the components of the water does sometimes require a certain treatment criteria.

Brief History: The Shell Mensa WD143 produces approximately 200 mmscf, 300 BOPD with 300 BW/MEG/PD. MEG (Monoethylene glycol) is used as a hydrate control for the three subsea wells that tie back to the surface platform through a pipeline which is over sixty miles long. The process train for handling the returned fluid is the standard HP Inlet Separator, IP Separator and Retention Vessel. The retention vessel is the supply point for the first Glycol Recovery Unit on an offshore platform. Produced water that is removed from the processed MEG averages about 55 – 100 BWPD. For any other process, this would be an ideal water treating problem to design and maintain.

Based on our preliminary data, it was decided to use CETCO media filtration with granular activated carbon as the final polishing before discharging overboard. This combination was selected due to the low expected oil PPM and low water volume. The anticipated oil concentration entering into the media filters was anticipated to be 100 PPM with a 20 – 30 % of which would be soluble oil or other components that would be measured as oil & grease by the EPA 413.1 gravimetric method. Unfortunately, the actual inlet to the filtration system was 200 – 1000 PPM varying the concentration through out the day. This is not a major problem until you consider the cost to stay within the 29/42 mg/l discharge requirement, which was roughly $200,000 a year, in addition to a minimum of weekly change-out of media and carbon filters. An alternate approach was justified to either add additional equipment or use an alternate technology.

In order to determine what else could be used more effectively to remove the O&G content in the process to reduce the treating cost, was the following:.

- Equipment considered- a centrifuge, floatation vessel, hydrocyclone, and a coalescer.
- Lab data in the past reflected the components of the water which dictated the type of equipment best suited for the application.

The data below is an indication of the wastewater from the glycol recovery unit. This sample was taken from the process that was originally being processed on land. This process was being used during the period of time of shutting down the TEG offshore skid to the installation of the MEG Reclamation offshore.

<u>OIL & GREASE:</u>

Hexane Solvent	Gravimetric:	399 mg/l
Freon Solvent	Gravimetric:	440 mg/l
	IR:	581 mg/l

<u>CONTAMINANTS (in PPM):</u>

Phenols & substituted phenols	200	Acetic acid	40
1,2-ethandiol monoacetate	50	hydroxybensenesulfonic acid	50
1,4dioxane	15	Monoethanolamine	52
NH4	56	Na	1.0
Indane	1.5	Methyl ester butanoic acid	1.0
2,3,4,5-tetramethyl1,4-hexadiene	0.5	Octahydro4,7-methano-1H-indene	0.5
Xylenes	0.7		

Since phenols was the major concern, other samples were collected from the temporary reclamation unit onshore. Other lab data indicated the phenols level could be as high as 2000 PPM. Based on the knowledge and experience of the best available technology at the time, a choice was made to use the CETCO CrudeSorb media filter with GAC

Phase 1: Determine oil droplet size distribution to identify treating equipment.

Particle size analysis was performed by Tim Trappani with Western Enterprises.

Table 1:

Micron Size	2-5	5-10	10-15	15-20	20-30	30-50	50-100	100-200	Total Count
Run #1	170	668	1365	2965	4564	3183	553	0	13468
Run #2	203	800	1600	3478	4737	2419	339	0	13578
Average	186	734	1483	3222	4651	2801	446		13523
Size %	1%	5%	11%	24%	34%	21%	3%		

Based on this data, floatation cells and hydrocyclones were eliminated but a centrifuge was still applicable in accordance with droplet size.

Phase 2: Test centrifuge performance.

As shown in table 1, the centrifuge should be able to remove 94% of the oil with no problem. During the discussion prior to testing, that this may not be the solution because of the percentage of dissolved oil or other soluble components that show up as O&G using EPA 413.1 method.

Centrifuge Field Test Results.

Table 2.

Date	Time	Sample Pt	Grav	GravS	WSO
5/11/00	11:35	Centrifuge Inlet	742	521	221
5/11/00	11:35	Centrifuge Outlet	268	12	256
5/11/00	13:00	Centrifuge Outlet	208	5	203

From the above data one can conclude that the centrifuge performed as advertised to remove dispersed oil, however, the dissolved components remained pretty high.

Phase 3: Documented performance of the CETCO media filters were used to determine actual yearly cost projection through a performance test. With the assistance of CETCO, we converted some vessels to hold the filters since the media filters were not installed as per CETCO's design. This in itself created some inherent problems.

CETCO Media Test Data:

Table 3.

BWPD	Date	V525 Grav	CS Out	CS Eff.	GAC Out	GAC Eff.	COMMENTS
79	6/16/00	281	74.8	73%			?6/14/00 New Filters
92	6/17/00	324	85.5	74%	8.7	90%	
	6/18/00	256	89.6	65%			
	6/19/00	322	192	40%			
	6/20/00	397	238	40%			
99	6/21/00	2830	279	90%			
67	6/22/00	536	320	40%			
14	6/23/00	223	224	0%	14.6	93%	Changed Carbon Filters Only
66	6/24/00	352	134	62%	4	97%	
113	6/25/00	535	217	59%	10.2	95%	
75	6/26/00	1030	349	66%	14.5	96%	
54	6/27/00	285	294	-3%	21.8	93%	
61	6/28/00	704	282	60%	44.8	84%	
91	6/29/00	467	313	33%	87.8	72%	
74	6/30/00	456	320	30%			
59	7/1/00	557	200	64%			
107	7/2/00	728	279	62%	107	62%	
66	7/3/00	266	4	98%			
104	7/4/00	1050	215	80%			Both Filters Changed
88	7/5/00	573	162	72%			
87	7/6/00						
74	7/7/00	155	82	48%	8	90%	
	7/8/00	392	52	87%	6	88%	
	7/9/00	141	39	72%	11	72%	
	7/10/00	234	72	69%	11	84%	
	7/11/00	114	3	97%	0	100%	Changed Carbon Filters
		CS Avg In:	528				
		GAC Avg In:	199				
		GAC Avg Out:	25				

Phase 4: Test Coalescer Skid:

A test with a coalescer skid had previously been done in conjunction with an acid flow back process. This test was part of a sponsored R&D project conducted by the Shell Chemical Team. The small water volume made this technology worth testing at this location. During acid flowback test, the major component that would limit its use with acid flow backs was the large amount of total suspended solids (TSS). The higher TSS dictated many pre-filter changes during the actual test due to the manufacture's recommendation of a 10 micron size filter. Their pre-filter sizing of 10 microns is to give the coalescer element a larger oil droplet size, thereby increasing the efficiency of the system. When a larger micron size pre-filter is used, the effectiveness decreases unless the flow rate is adjusted to increase the residence time across the filter.

Table 4.

Test Results from Coalescer Test Skid during an acid flow back.

Time	Location	Grav	Efficiency	Grav S	IR	IRS	GPM
0:01	Coalescer Inlet	288		161	415	402	
0:02	Coalescer Outlet	10	97%	3	20	16	3
9:05	Coalescer Inlet	3		2	8	7	
9:06	Coalescer Outlet	4	-33%	<1	8	6	4
9:58	Coalescer Inlet	424		203	660	574	
9:59	Coalescer Outlet	104	75%	44	183	174	6
10:58	Coalescer Inlet	517		316	542	497	
10:59	Coalescer Outlet	93	82%	53	127	118	8
11:59	Coalescer Inlet	270		114	428	402	
12:00	Coalescer Outlet	11	96%	3	16	15	2
14:30	Coalescer Inlet	411		184	642	497	
14:31	Coalescer Outlet	26	94%	13	29	28	1
15:30	Coalescer Inlet	411		184	642	497	
15:31	Coalescer Outlet	113	73%	55	274	262	10
	Designed Rate 3 - 5 Gal/Min						

*Inlet to coalescer was from bottom of the separation tank.

Judging by the above results, it was worth giving it a test run. This test skid had a design rate of 3-5 gpm, which is roughly 100 –170 BPD. We commissioned this test skid for an evaluation at our facility. The difference in coalescing properties of crude oil versus light condensate will not be discussed in this paper but will addressed in the future.

The test skid used was a PALL 6" liquid/liquid coalescer filter and with a 10 micron & 40 micron pre-filter.

Table 5.

Field Test of Coalescer Test Skid:

***10 micron pre-filter**

Date	Time	GPM	Pre-Filter O&G In	Pre-Filter O&G Out	PALL O&G Out	PALL O&G Eff(%)	Oil ml/hr
7/13/00	12:00	2	369	713	130	82	60
7/13/00	15:00	2	377	568	189	67	113
7/13/00	19:00	2.2	512		188	63	115
7/13/00	22:00	2.75	422		194	54	230
7/14/00	4:30	2.75		323	194	40	200

***40 micron pre-filter**

7/26/00	16:00	2.5	351	427	164	62
7/27/00	0:00	2.5	418	483	211	56
7/27/00	5:15		557		231	
7/27/00	19:17			288	175	39
7/27/00	21:00	1.75		398	169	58

After several discussions with the PALL's technical support staff concerning the results, several conclusions were drawn. First, the 10 micron pre-filter is highly recommended and 2 GPM is the maximum flow rate for this size skid in this particular service. In order to get within design specification of 3-5 GPM, a bigger filter would be required. The standard 20" filter versus the 6" filter should handle this condition with no problem. The only point of concern was the supply pressure into the coalescer system. Our normal supply pressure to the filtration system ranged between 10- 22 psi. As the differential increased across the pre-filter, the gpm decreased and this allowed the water level to increase in the V525 process vessel. Thus the need to try the larger micron pre-filter, since there were very little to no solids visible after changing pre-filters.

Table 6:

Full Scale Model Test Data.

Date	Time	GPM	V525	Pall Out	PALL Eff(%)	GAC
12/13/00	20:00	2	2639	278	89.5	196
1/10/01	13:00		594	279	53.0	188

Very limited data has been gathered due to lack of supplies during the sampling dates and lack of time to do an effective job before and after the holidays. At the printing date, we have not had enough time to review this data with PALL Corporation. Phase six of the project would be to install a progressive gravity pump because it is low shear and reposition the pre-filter closer to the coalescer unit. The pump is needed because the GRU water disposal pump design only considered the head pressure needed for recycle back to the front end of the glycol reclamation system. In addition to the pump, we will use test chemical addition to drive the WSO's into the oil phase.