USE OF FREE WATER KNOCKOUT IN PRODUCTION FACILITIES*

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ABSTRACT

The ever-increasing shortage and resulting higher prices of natural gas and oil make it important to conserve fuel whenever possible. One way is to remove all free water from the produced oil stream before treating the emulsion. This paper discusses the application, design, installation, operation, maintenance, trouble shooting, and corrosion protection of free-water knockouts used for this purpose.

USE OF FREE WATER KNOCKOUTS IN PRODUCTION FACILITIES

For years free water knockouts (FWKO's) were the most neglected and unused piece of equipment in the oilfield. With the coming of waterfloods, fuel shortages, and increased corrosion, they suddenly have become a vital part of many production facilities.

FWKOs are of simple construction and operation, yet many people have trouble with their application and operation, and thus they fail to get full benefit from their equipment dollar.

I. Purpose:

To remove all free (non-emulsified) water that will settle out in a predetermined amount of time. To remove all oil from free water before it is dumped to the water collection system.

It takes 350 BTUs to raise one barrel of water 1°F. It takes 150 BTUs to raise one barrel of oil 1°F (see Figure 1).

Heating unnecessary water is not only useless, but it takes more than twice as many BTUs as oil.

When calculating BTUs saved, you cannot figure on a straight line basis due to different heat transfer rates of different liquids, firetube efficiency, scale buildup, and other such factors, but you do know you save fuel and lots of it by not heating water.

Heated water deposits scale or requires expensive chemicals to prevent it. A one-sixteenth inch buildup on firetubes can cause as much as 11 to 13 percent fuel loss (see Figure 2). In severe cases of scale deposits you can pay out a FWKO on cleaning and maintenance costs alone.

II. Configuration:

A. Vertical: Easy to three phase

B. Horizontal
1. Large cross section at the interface
2. Less counter flow of liquids
3. Ease of installation and maintenance
4. Large gas area in some models
5. Wider selection of designs

III. Designs:

A. Fluid packed (see Figure 3)

Oil and gas go to treater together. Vessel is fluid packed except for gas area caused by down pipe on outlet connection. (see Figure 4) This design is best to use when possible, as it does not add back pressure on your flow line, has fewer valves to maintain, and has lower initial cost. It is recommended for flows containing low quantities of solution gas.

BTU'S OF HEAT REQ'D. TO RAISE 1 BBL. OF MIXTURE 1° F.

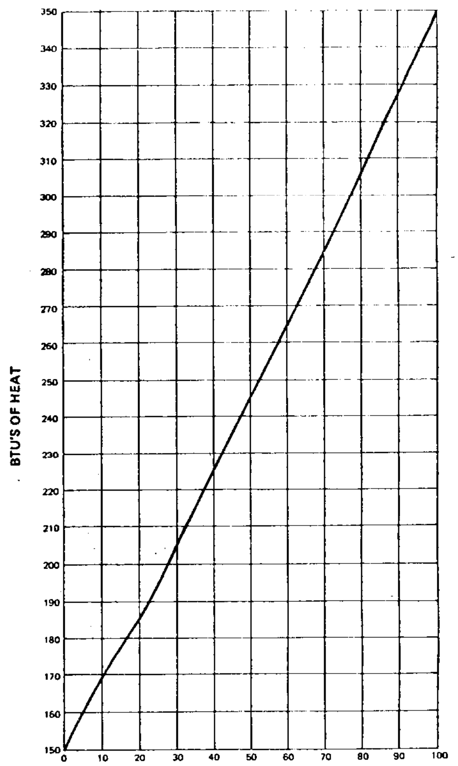


FIGURE 1

B.T.U. LOSS FROM SCALE
IS THE SAME AS FROM
INSULATION

LOSS FOR AVERAGE STATIONARY BOILER OPERATION

Scale Thickness	% Loss of B.T.U.'s
1/64".....................	1.5 - 4.0%
1/32".....................	6.0 - 8.5%
1/16"....................	11.0 -13.5%
1/8 "....................	16.0 -20.0%

The above figures can only be approximate due to the many factors and variables involved. These are presented, however, to provide an average and to compensate for the different types and thickness of scale and the locations in the boilers. The important point is that any scale location on any heating surface provides a direct drop in heat transfer resulting in loss of fuel and efficiency.

FIGURE 2

B. Fluid packed with back-pressure valve added to oil and gas outlet. This is used when it is necessary to pressure the water to some point of higher working pressure than that of treater receiving the oil and gas.

STYLE "A" FWKO

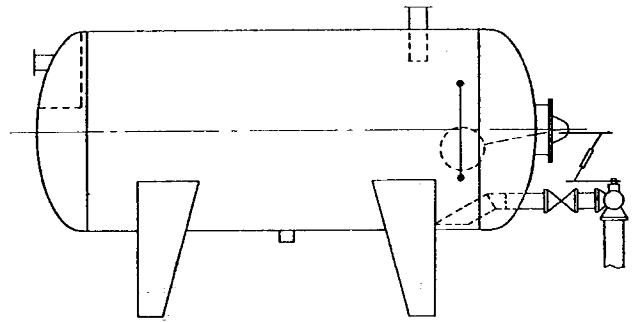


FIGURE 3

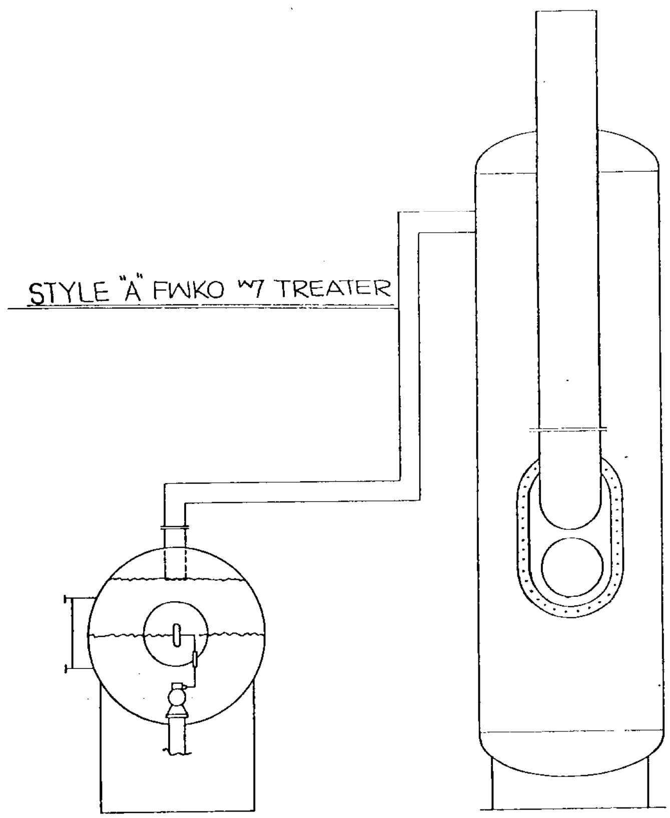


FIGURE 4

C. Three-phased with oil controlled by hydrostatic head valve such as C-E NATCO Diatroller or Kimray Type "W." Be sure to mount valve as low to ground as possible to use all hydrostatic head available. Use when wanting to remove gas, bypass treater direct to tank, etc. (see Figures 5 and 6).

STYLE "B" FWKO

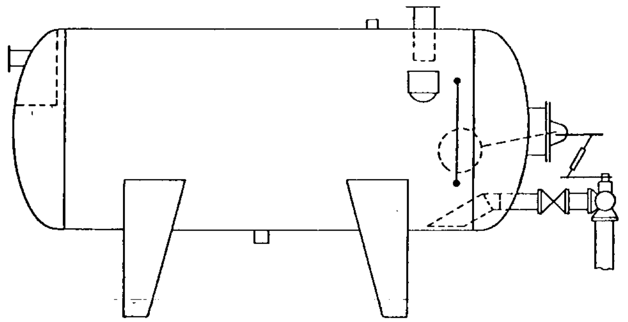


FIGURE 5

HOOK-UP STYLE "C" FWKO

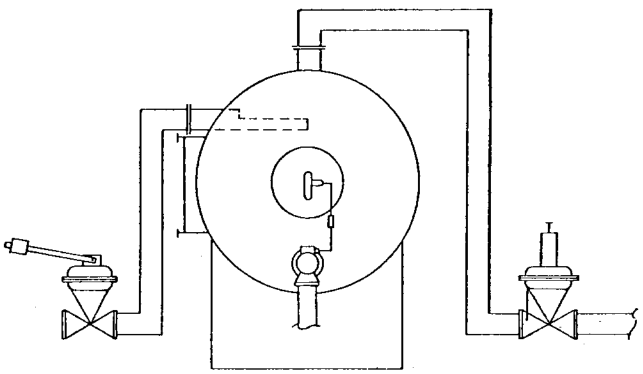


FIGURE 6

STYLE "D" FWKO

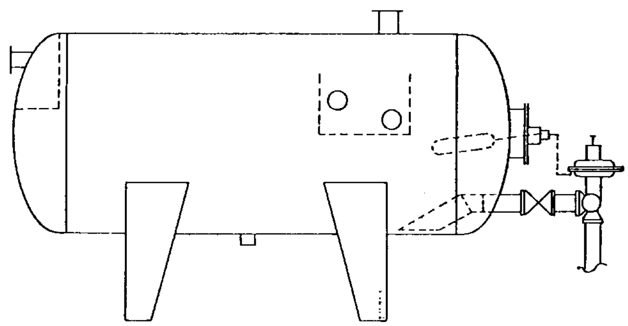


FIGURE 7

D. Three-phased with weir box. Oil is controlled by float operated level control with motor valve. Use as any three-phase FWKO (see Figures 7 and 8).

HOOK-UP STYLE "D" FWKO

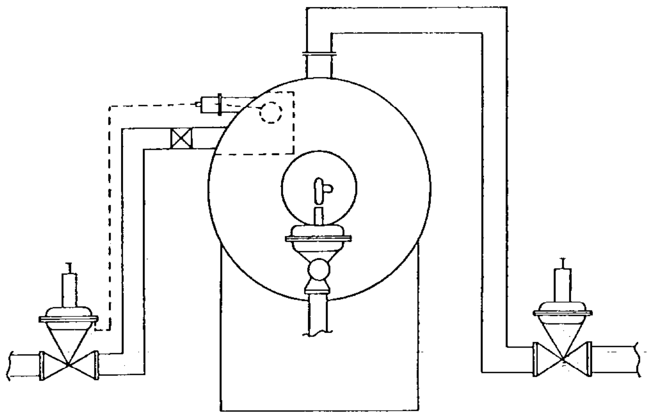


FIGURE 8

METERING STYLE "B" FWKO

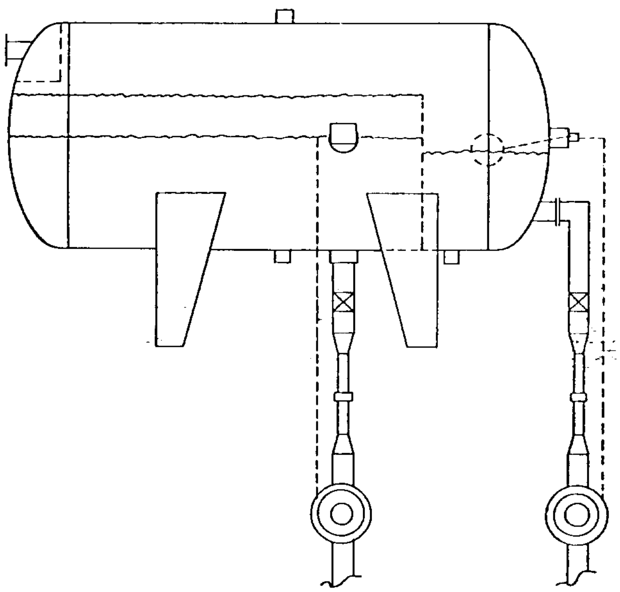


FIGURE 9

E. Three-phased with spillover weir and oil compartment. Oil is controlled by level control and motor valve. This makes an excellent vessel for metering water and oil (see Figure 9).

F. Same as three-phased with spillover weir and oil compartment except mist extractor has been added. Some people add a dome with mist extractor, but the internal type is able to handle larger volumes (see Figure 10).

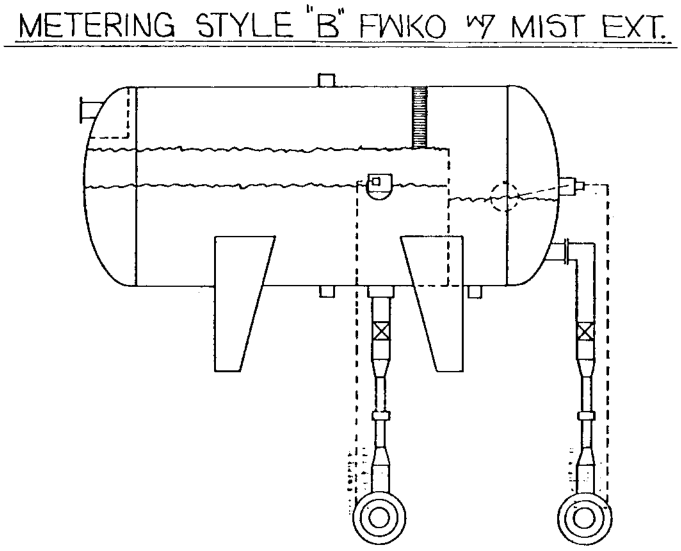


FIGURE 10

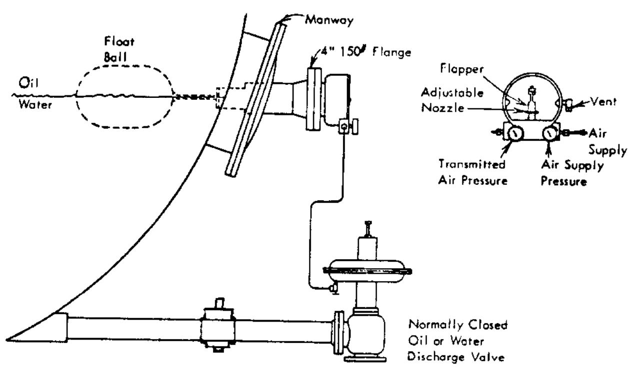
G. Water and interface controls
   A. Pneumatic
      1. Snap-acting, wire weighted (see Figure 11)
      2. Throttling, sand weight (see Figure 12)
      3. Electric, wire weighted (see Figure 13)

   B. Mechanical Linkage (see Figure 14)
      1. Simple and trouble free. Both systems use a weighted float ball that sinks in oil and floats in water. The larger the ball can be, the better control you have, as it is a matter of displacement as to how much force you have to operate the pilot in pneumatic systems and the valve in mechanical linkage.
      2. To weigh the float properly you add sand in a round ball to a point it almost sinks in fresh water. It will sink in oil and emulsions and float freely in salt water.
      3. If the float is horizontal, load it with wire or some substance that will not shift. If sand is used it can shift and change the buoyancy of the float. Wire that is cut the correct length is best.
      4. In setting the mechanical linkage you should space the water dump valve from the vessel so the turnbuckle is fastened to the float linkage no more than 4 inches from the float nose. To make it longer destroys the leverage and efficiency of the float ball and arm. The turnbuckle should hang as perpendicular as possible and the lower lever should be 8 to 10 inches from the valve lever collar. If a safety relief valve is needed, the standard 2 inch valve is for gas only. If you need to relieve fluid pressure, install a blow-down type or a regular spring loaded back pressure valve with cv large enough to relieve the necessary volume of fluid.

IV. Sizing (see Figure 15)

This is for normal Texas, New Mexico, and Oklahoma type crude, 21° to 46° gravity, normal salt water.

The range of 21° to 28° would be the lower range, 28° to 35° middle range and 35° to



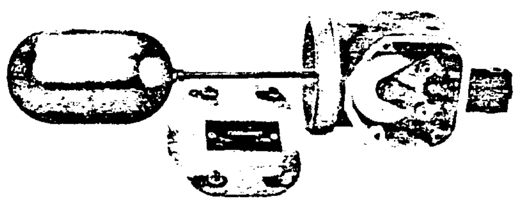
1. May be used for oil level controller with synthane disc type displacers.
2. May be used for oil/water interface controller with weighted float ball.

Adjustment of Controller

When fluid level reaches desired height turn adjustable nozzle counter-clockwise, moving nozzle closer to the flapper, until the output pressure on the left hand gauge is approximately 2-3 psi. From this point, as the level rises the movement in the flapper will increase the output signal to the control valve causing it to open. As the fluid level drops the cycle reverses and closes the valve.

FIGURE 12

MODEL CMAQ AND CMAF
FLOAT OPERATED LIQUID LEVEL CONTROL
SNAP ACTION – ADJUSTABLE



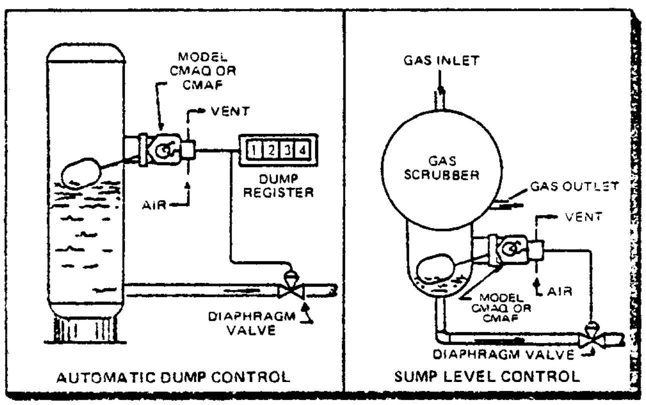
MODEL CMAQ

DESCRIPTION

The CMAQ and CMAF is a snap-action float operated level control, equipped with a patented 3-way Micro Valve, actuated by two adjustable yoke-type pusher arms. Adjustable pusher arms permit the control range to be adjusted easily and accurately to the range desired.

With the liquid level below the float the 3-way Micro Valve will be in the low level position, and will remain there until the float rises to the pre-set high level. The Micro Valve then will reverse positions until the float drops to the pre-set low level position.

This control has been thoroughly field proven by many installations throughout the country.



AUTOMATIC DUMP CONTROL   SUMP LEVEL CONTROL

MICRO VALVE SPECIFICATIONS

Model	316F1, 3 way
Ports	1/4" FPT
Body	Anodized Aluminum
Orifice	Standard 1/16" (100 PSI W.P.)
	Optional 1/32" (250 PSI W.P.)

LIST PRICES AND SPECIFICATIONS

Catalog Model Number	Nominal Connection Size, Type, Max. W.P. PSI	Materials		Stock Number	List Price
		Body	Float		
810-CMAQ-403	4" Grooved, 300	Ductile Iron	Monel	80002101††	$
810-CMAQ-601	6" Grooved, 125	Cast Iron	Monel	80002102††	
810-CMAF-401	4" 125 lb. Flange, 175	Cast Iron	Monel	80002001††	
810-CMAF-402-S	4" 150 lb. Flange, 275	Cast Steel	Monel	80002002††	

††Normally available from stock.

NOTE: For Stainless Steel Gear and Guide Plug Assembly, ADD $51.00 List.

TO ORDER SPECIFY: Stock Number and Catalog Number. Float rod length if other than standard, see reverse side.

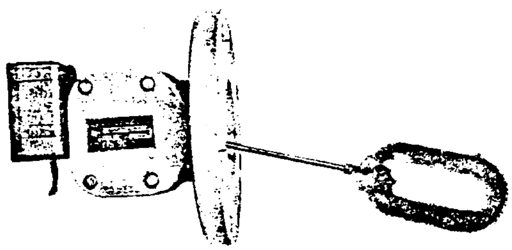
List Prices *DO NOT* include companion flanges or grooved couplings for vessel attachment.

Use M.F.'s on page IVC-800 to determine net prices.

LEVEL CONTROL SECTION
FLOAT TYPE
Issue 4; March 1, 1978

FIGURE 11

MODELS CMEAQX and CMEAFX
FLOAT OPERATED LIQUID LEVEL CONTROL



MODEL CMEAFX-401

DESCRIPTION

The CMEAQX and CMEAFX float controls provide electrical contact switch closure for alarm or control functions. An explosion-proof Micro Switch is actuated by two adjustable yoke type pusher arms permitting the control range to be easily and accurately adjusted.

With the liquid level below the float the Micro Switch will be in the low level position, and will remain there until the float rises to the pre-set high level. The Micro Switch then will reverse positions until the float drops to the pre-set low level position.

This control has been thoroughly field proven by many installations.

SWITCH SPECIFICATIONS

Contacts........Standard – SPDT, 15 amps @ 125, 250 or 480 V a-c
½ amp @ 125 V d-c
¼ amp @ 250 V d-c
Optional – DPDT, 10 amps @ 125 or 250 V a-c

(Note: DPDT switches will provide single point control only)

Switch Housing..................Explosion-proof

Approval.............. ....UL and CSA

LIST PRICES AND SPECIFICATIONS

Catalog Model Number	Nominal Connection Size, Type, Max. W.P. psi	MATERIAL Body	MATERIAL Float	*Stock Number	List Price
811-CMEAQX-401	4" Grooved, 125	D.I.	Monel	80002501††	S
811-CMEAQX-601	6" Grooved, 125	Cast Iron	Monel	80002504	
811-CMEAFX-401	4" 125 lb. Flange, 175	Cast Iron	Monel	80002302††	
811-CMEAFX-402-S	4" 150 lb. Flange, 275	Cast Steel	Monel	80002304††	

††Normally available from stock.

NOTE: For 316 S.S. Gear and Guide Plug Assembly Add $51.00 List.

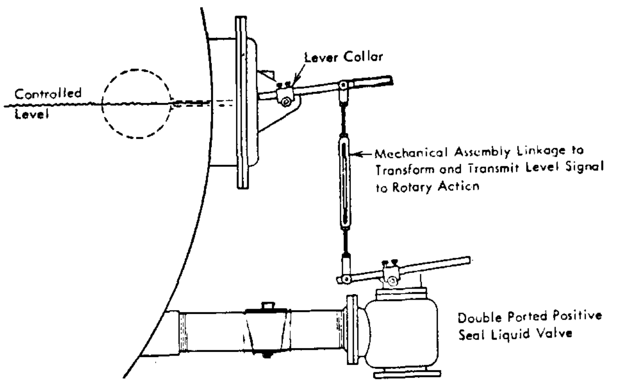
TO ORDER SPECIFY: Stock Number and Catalog Number. Float rod length if other than standard, see reverse side.

List Prices *DO NOT* include companion flanges or grooved couplings for vessel attachment.

*Stock numbers are for units with SPDT switches.

Use M.F.'s on page IVC-800 to determine net prices.

FIGURE 13



1. May be used for oil level controller.
2. May be used for oil/water interface controller with weighted float ball.

Proper Hook-Up of Level Controller Linkage Assembly

Proper installation of lever collars; install collar on level controller with the flat side of the shaft hole sloping down toward the treater, or to the left.

Adjustment

When fluid level reaches the desired height, close liquid valve by pulling down on lever end farthest away from treater. With liquid valve held closed adjust turnbuckle so that lower end is roughly 1" above the end of the liquid valve lever. (See detail) Tighten locknuts on turnbuckle and connect lower end of turnbuckle to lower end of valve lever. Controller is ready to operate automatically.

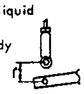


FIGURE 14

46° upper range. This sizing is based on 75 barrels per day water per square foot of cross-sectional area at the interface.

Water capacity of a horizontal FWKO is mainly a function of disengagement area or cross-sectional area of the oil-water interface. Residence time has an effect on the sizing. This is because the main body of the fluids is traveling in a horizontal direction and the particles of water or oil to be separated travel along and across rather than counter-current to the main bodies of fluid.

FREEWATER KNOCKOUTS APPROXIMATE CAPACITIES

Size O.D. x Length	Working Pressure psi. ASME Code	Water, Bbl/Day Low Rate	Water, Bbl/Day High Rate	Residence Time (Minutes) Low Rate	Residence Time (Minutes) High Rate
24"x7'-6"	50	750	1,500	4	2
30"x7'-6"	50	940	1,880	5	2½
36"x7'-6"	50	1,125	2,250	6	3
36"x10'	50	1,500	3,000	6	3
4' x10'	50	2,000	4,000	8	4
4' x15'	50	3,000	6,000	8	4
6' x15'	50	4,500	9,000	12	6
8' x20'	40	8,000	16,000	18	9
10'x15'	40	7,500	15,000	20	10
10'x30'	40	15,000	30,000	20	10
10'x40'	40	20,000	40,000	20	10
12'x40'	40	24,000	48,000	24	12

FIGURE 15

Things to consider in sizing FWKOs:

A. Densities of the two fluids. The closer they are to each other, the larger the size needed. (Watch out for fresh water)
B. Large instantaneous flow rates due to pumps, long flow lines unloading, wells heading, etc.
C. Reverse emulsion. This may take a special application.
D. High gas-oil ratio.
E. Working pressure above 40 to 50 pounds.
F. Space for installation.
G. Transportation and installation.
H. Ambient temperatures.

V. If the FWKO causes trobule, you should check the following:

A. Realize it removes only *free* water.
B. Be sure float is weighted correctly.
C. Capacity is large enough.
D. Headings or pump surges.
E. Proper linkage adjustment.
F. Proper valve sizes.
G. Most effective interface control for conditions.
H. Check chemical.
   1. If the trouble is a high emulsion cut, adding your emulsion breaker at the wellhead will give the chemical time to mix and work before reaching the FWKO, thus releasing more free water. Sometimes a faster acting chemical will help.
   2. Iron sulfide buildup on interface. This can be eliminated by adding a wetting agent.

I. Introduction of fresh water to the system.

VI. Coating:
Basically an empty vessel, the FWKO is easy to protect from corrosion by coating with your preferred internal coating. Remember the coating is only as good as the application (see inspection instructions below).

Installing one or more anodes in the water section will protect for holidays in the coating. Galvalum type anodes last longer than magnesium and are not as expensive to install or maintain as graphite type with induced current.

You can expect almost one year of protection from galvalum and you should clean and inspect your vessel once each year regardless. This makes it easy to replace the anodes at the same time.

VII. Flo-Splitter - FWKO (see Figure 16 and 17)
The Flo-Splitter performs the functions of a standard three-phased FWKO. In addition, you can split the oil and emulsions to as many different treaters as needed. The flow can be of different volumes to different treaters.

The flow is controlled by weirs and is dumped by standard float valve and linkage as in a standard separator.

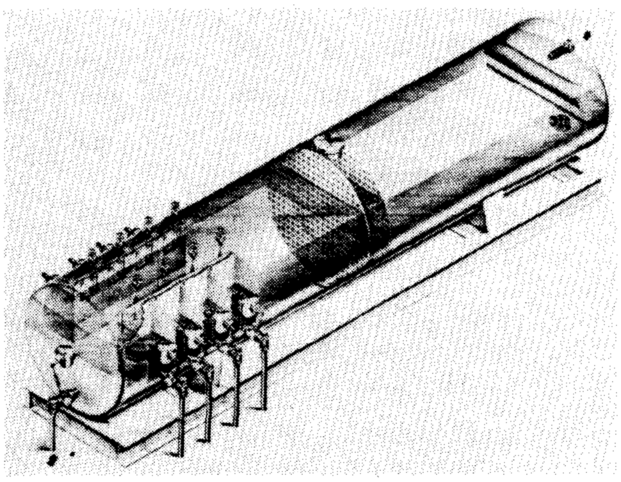


FIGURE 16

APPROXIMATE FLO-SPLITTER SEPARATOR CAPACITIES

Model Number	Free Water (Bbl/Day)	Oil(Bbl/Day) F.S. & FWKO	Oil(Bbl/Day) F.S. Only	Gas MMSCFD	Max. No. Splits
FS-420-50	1,600	13,500	19,000	1.0	12
FS-615-50	3,000	20,000	27,000	1.5	8
FS-625-50	4,700	25,000	39,000	1.9	16
FS-820-40	7,000	37,000	61,000	3.5	12
FS-835-40	12,000	54,000	71,000	5.0	24
FS-1020-40	11,000	63,000	90,000	6.7	12
FS-1040-40	21,000	90,000	135,000	9.0	28

Above is flow splitter capacities only. If based on Free Water Knockout capacities, use Figure XV.

FIGURE 17

A SUGGESTED METHOD OF INSPECTING MOST INTERNAL COATINGS

1. *Look for obvious mistakes.*
   - A. Bare Metal
   - B. Sand under coating
   - C. Nozzles not coated
   - D. Attached piping not coated
2. Proper trim out on nozzles
   - A. Grooved nozzles should be coated on outside back past the groove.
   - B. Raised face flanges should be coated only to the point of seal on the edge of the flange. The coating should form a seal under the edge of the gasket, but if the entire face is covered, the gasket may blow out under high pressure.
   - C. *Flat-faced flanges should have the entire* face coated, as they are only used in low pressure service.
   - D. Threaded couplings are almost impossible to coat satisfactorily. The best method is to sandblast, tape during coating, and then coat after the pipe fitting has been installed. Another way would be to install *a pipe fitting before blasting, then coat in* place. Another would be to blast and coat, then install pipe fitting while coating is still wet.
3. Check mil-thickness
   - A. Use a mil-thickness gauge. We prefer a micro tester.
   - B. *Use manufacturer's recommended* thickness.
   - C. It is better to be on the thin side as long as metal is covered, rather than the thick side, to avoid cracking.
4. Jeep test if required
   - A. A jeep tester is a battery operated device that sends a signal when you have a completed circuit. One wire is attached to ground. One wire is attached to a sponge holder. A wet sponge is attached and used to contact the coating surface. When a holiday (bare metel) is touched the circuit is completed back to ground and a signal is received.
   - B. Check closely around corners, sharp edges, under baffles, etc., as these are likely places for holidays.
   - C. Check tester to ground often to be sure it is working.
5. Anode protection
   - A. Install anodes to protect any present or future coating failures.
   - B. They should be placed in each section of vessel that contains water. Anodes will not work in oil.
   - C. They may be operated at a low current, as all you are protecting are the holidays.
   - D. For type and installation contact an expert on anodes.