Instruction Manual
For
Model 2353-805
Equilibrium Flash Separator

P/N: 2353-1D01
Revision E – February 2016

S/N: _____

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General Information

Introduction

This instruction manual provides operation and maintenance instructions for a Model 2353 - 805 Equilibrium Flash Separator.

Purpose and Use

The Equilibrium Flash Separator can be used to measure gas-oil ratio, relative volume, residual oil gravity, and related information on bottom hole or recombination samples of petroleum reservoir fluids (oils and condensates). Optimum separator conditions are investigated by use of the flash liberation (separation) method. In operation, the instrument is used in conjunction with related equipment for the study of reservoir fluid samples.

Description

The instrument consists of a 1st-stage separator chamber, equipped with a micrometer needle valve inlet, and a drain valve leading to a 2nd-stage receiver tube. The 1st-stage chamber, with a volume of 30 ml, is connected through stainless steel tubing and fittings to a pressure gauge and a back-pressure regulator (which can be isolated with a cut-off valve or bypassed with another valve) to control the separator pressure. For controlled-temperature experiments, a polycarbonate jacket surrounds the 1st-stage separation chamber, with inlet and outlet hose connections for circulating heating or cooling fluids around the chamber from an external recirculating heating and/or cooling bath (not included).

Both the 1st-stage separator chamber and the 2nd-stage receiver tube are graduated, to allow manual measurements of the liquid volumes. An additional instrument, such as the Chandler Engineering Model 2331 Gasometer, is required to measure the liberated gas volumes, to enable measurement of GOR (Gas-Oil Ratio).

Features and Benefits

- 1-stage, 2-stage, and multiple-stage flash capability
- Working pressure of 500 psi
- Jacket for circulating heating or cooling fluids
- 1st-stage separator Chamber volume of 30 ml

Safety Requirements

READ BEFORE ATTEMPTING OPERATION OF INSTRUMENT!

This instrument is designed for operator safety. However, to ensure that safety:

- **Read** and **understand** instructions before attempting operation.
- Observe warning and caution notes throughout this manual.
- Observe and follow the **Warning Labels** on the instrument.
- **Never** exceed the instrument maximum temperature and pressure ratings.
- **Always** disconnect main power to the instrument before attempting any repair or when opening the instrument cabinet.
- Locate a suitably rated fire extinguisher within 50 feet of the instrument.
- Observe all H_2S safety guidelines when operating this instrument.
- Pipe all gas vents to a vented hood or other safe area outside the laboratory.

Note: All Chandler Engineering equipment is calibrated and tested prior to shipment.

H_2S Safety Notes

Hydrogen Sulfide is generally recognized by a characteristic foul odor. Prolonged exposure to low concentrations has a tendency to act upon the olfactory nerves, thereby dulling the sense of smell. This is important, especially to those who think they can detect dangerous concentrations by the sense of smell. It acts on the eyes and respiratory system, resulting in irritation. Irritation to the eyes often causes severe pain and may incapacitate the worker. When high concentrations are present, death by lung paralysis may occur before the odor is even detected. A laboratory monitoring unit is strongly recommended in laboratories where H_2S is handled.

Hydrogen Sulfide Properties

Property	**H_2S Characteristic**
Color	Colorless
Odor	Very offensive, commonly referred to as the odor of rotten eggs.
Vapor Density	1.5399 g/L. H_2S is heavier than air.
Boiling Point	-76^{o}F (-60^{o}C)
Explosive Limits	4.3 to 46% by volume in air
Ignition Temperature	500^{o}F (260^{o}C)
Water Solubility	4 volumes gas in 1 volume water at 32^{o}F
Flammability	Forms explosive mixtures with air or oxygen

Hydrogen Sulfide Toxicity Table

Note: ppm is equal to parts of H_2S per million parts of air, by volume.

H_2S ppm	**Toxicity Effect**
1 ppm	Can smell
10 ppm	Allowable for 8 hour's exposure
100 ppm	Kills smell in 3 to 15 minutes. May burn eyes and throat.
200 ppm	Kills smell rapidly. Burns eyes and throat.
500 ppm	Lose sense of reasoning and balance. Respiratory disturbances in 2 to 15 minutes. Needs prompt artificial resuscitation.
700 ppm	Will become unconscious quickly. Breathing will stop and death will result if not rescued promptly. Immediate artificial resuscitation.
1000 ppm	Unconscious at once. Permanent brain damage may result unless rescued promptly.

Specifications

Maximum Pressure:

1st-stage Separator Chamber:	500 psig (3.45 MPa, 34.5 bar, 34.0 atm.) Relief valve set to approximately 660 psig
2nd-stage Receiver Tube:	25 psig (172 kPa, 1.72 bar, 1/7 atm. Gauge) Relief valve set to approximately 25 psig

Maximum Temperature:

Ambient Temperature:	140°F (60°C)
1st-stage Separator Chamber:	200°F (93°C)
2nd-Stage Separator Chamber:	200°F (93°C)

Volumes:

1st-Stage Separator Chamber:	Marked 0-30 ml, in 0.2-ml graduations
2nd-Stage Receiver Tube:	Marked 0-25 ml, in 0.2-ml graduations

Connections:

Inlet Connection:	HIP HF4 female port (same as Autoclave Engineers F250C, NBS 9/16-18, etc.) for 1/4”-OD, high-pressure, coned-and-threaded tubing. Swagelok adapter provided to connect to 1/4”-OD tubing.
1st-Stage Gas Outlet Connection:	1/8” NPT female (std. U.S. National pipe tapered thread), with Swagelok adapter provided to connect to 1/4"-OD tubing
2nd-Stage Gas Outlet Connection:	1/4” NPT female (std. U.S. National pipe tapered thread), with Swagelok adapter provided to connect to 1/4"-OD tubing
Relief Outlet Vent Connection:	1/8” NPT female (std. U.S. National pipe tapered thread), with Swagelok adapter provided to connect to 1/4"-OD tubing
Heating/Cooling Liquid Inlet/Outlet Connection:	Short stubs of 3/8"-OD brass tubing (can be removed to connect 3/8”-OD tubing to Swagelok connector)

Note: Qty. 1 Swagelok reducer (adapter) is included to adapt 1/4" Swagelok fitting to 1/8"-OD tubing.

Where to Find Help

On-site training classes are available. For more information, contact our sales department at Chandler Engineering. In the event of problems, your local sales representative will be able to help or you can contact the personnel at Chandler Engineering using the following:

Telephone: 01-918-250-7200
FAX: 01-918-459-0165
E-mail: chandler.sales@ametek.com
Website: www.chandlereng.com

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Section 1 – Installation

Unpacking the Instrument

After the instrument is removed from the shipping container, the operating equipment and spare parts on the packing list must be checked to affirm that all have been received and none are damaged.

Note: File an insurance claim with your freight carrier if damage has occurred during shipment. Verify all parts shown on the enclosed packing list have been received. If items are missing, please notify Chandler Engineering immediately.

Utilities Required

- No utilities required

Tools/Equipment Required

A standard maintenance or mechanics tool set is adequate for the installation, operation, and maintenance of this instrument. No special tools are required.

Setting up the Instrument

There is no set-up required for the Equilibrium Flash Separator.

Note: Verify that a receiver tube is installed under the drain valve as the 2nd-stage separator receptacle.

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Section 2 – Operating Instructions

Figure 1: Equilibrium Flash Separator mounted on PVT Console

Figure 2: Equilibrium Flash Separator front panel

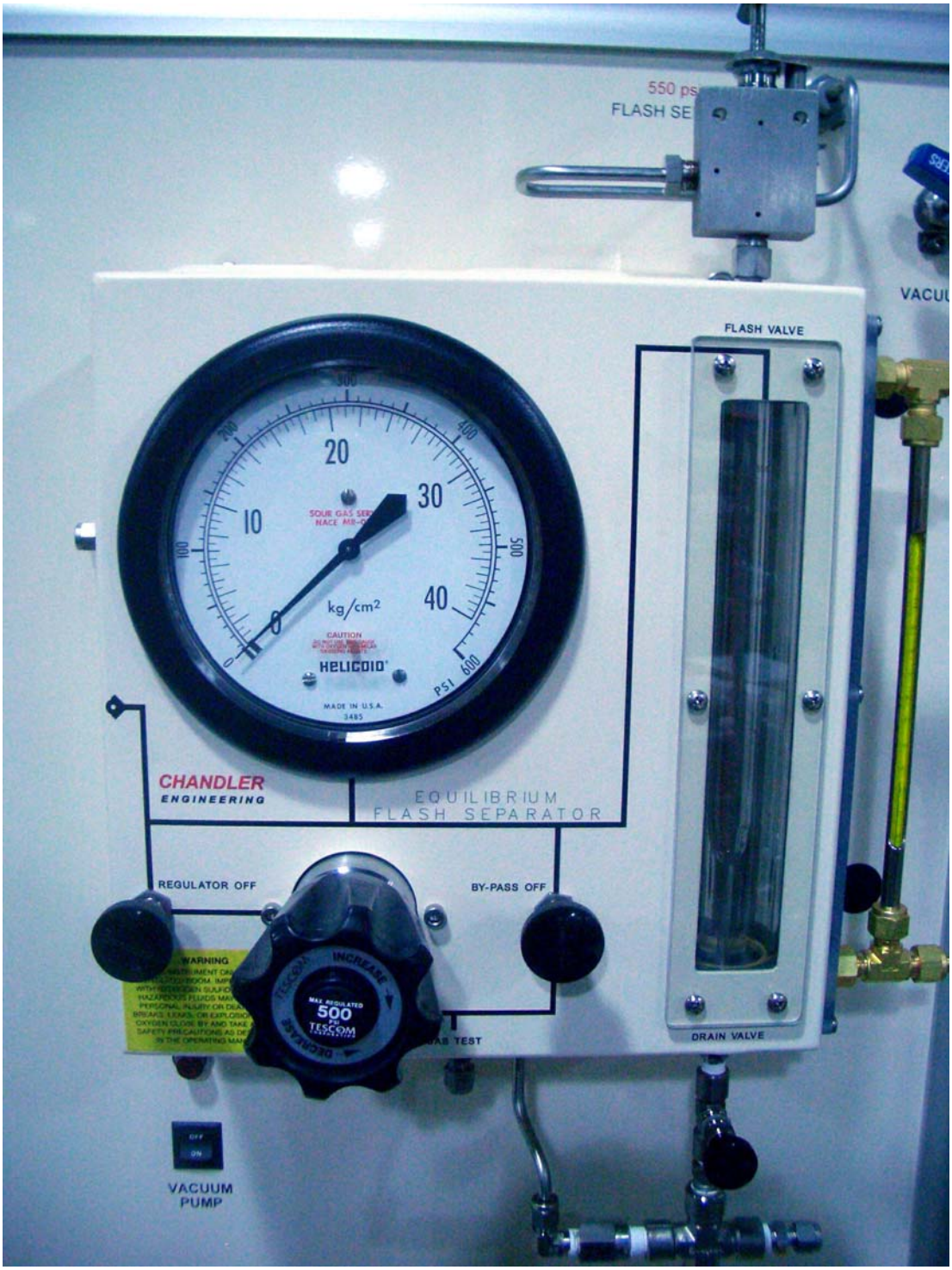

Figure 3: 1st-Stage Separator Chamber

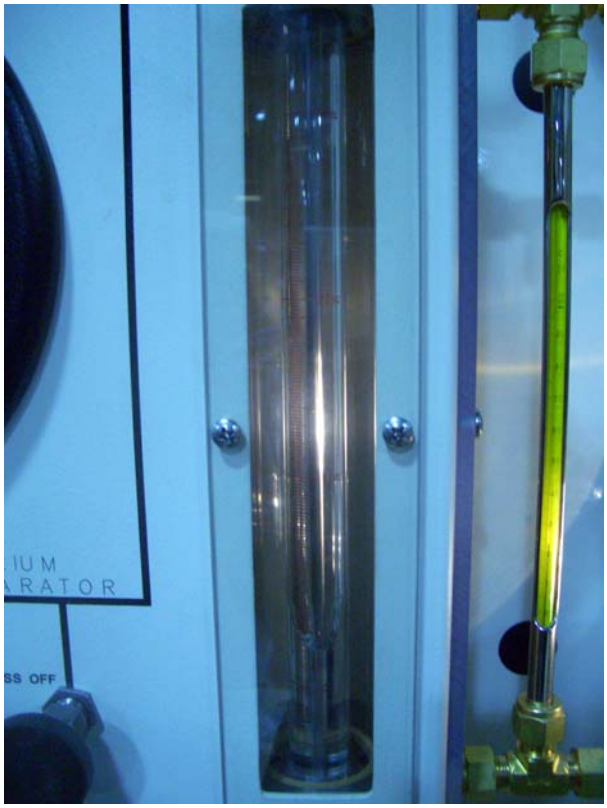

Figure 4: Bottom of 1st-Stage Separator Chamber, showing “0” reference mark

Figure 5: 2nd-Stage Receiver Tube

Operation of a Dynamic Flash

Standard 2-Stage Flash Separator Test

1. This test simulates flashing from Reservoir Pressure (or wellhead or gathering line) to Separator (1st-stage), and then to Stock tank (2nd-stage, atmospheric).
2. Close the inlet FLASH VALVE and DRAIN VALVE, open the REGULATOR OFF valve, and close the BYPASS OFF valve.
3. Connect a gasometer (gas meter) to the GAS TEST port, which is the outlet for the gas separated in the 1st stage (from the 1st-stage separator chamber).
4. Connect another gasometer (or the second cylinder of the same gasometer) to the 2nd-stage gas outlet connection (the right-side connector of the cross between the 1st-stage DRAIN VALVE and the 2nd-stage receiver tube). Place the gas weighing balloon in the line upstream of the gasometer (between the Flash Equilibrium Separator and Gasometer) so that gas gravity can be determined. If you wish to measure the gas gravity of both stages, connect a gas weighing balloon in both gas outlet tubing lines.
5. Connect a 2nd-stage receiver tube to the bottom of the instrument.

6. Connect tubing from the RELIEF VALVE VENT port to a vented hood, or to some safe area outside the laboratory. Similarly, connect tubing from the outlets of the gasometer(s) to a safe area.
7. Adjust the back-pressure regulator knob to approximately the desired 1st-stage separator test pressure (or adjust it to near its maximum pressure {fully clockwise}, and later adjust pressure downward {counterclockwise} during sample charging/injection).
8. Connect the pressurized sample to the inlet FLASH VALVE of the separator, and use external pump (not included as part of Equilibrium Flash Separator) to pressurize the sample to the desired inlet pressure.
9. If the test is to be conducted at temperature other than room temperature (heated or cooled, that is), attach tubing to and from a recirculating heating and/or cooling bath to the heating/cooling liquid inlet/outlet connections on the side, and circulate the heated or cooled fluid around the chamber until equilibrium is reached at the desired separator test temperature. A thermometer is provided for monitoring the temperature.
10. Expand the fluid sample into the separator by maintaining constant sample inlet pressure with the external pump, and carefully opening the inlet FLASH VALVE to charge (inject) 10 to 20 cc to purge the system, while maintaining constant sample inlet pressure with the external pump.
11. Simultaneously, adjust the 1st-stage separation pressure by adjusting the knob on the back-pressure regulator, to a pressure just slightly above desired test pressure.
12. Close the inlet FLASH VALVE and slowly, carefully open the DRAIN VALVE to drain just enough liquid from the 1st-stage separator chamber to set the liquid level at the reference mark (0 cc) near the bottom of the chamber. The liquid drained into the 2nd-stage receiver tube becomes “stock tank oil” at atmospheric pressure and temperature.
13. Also, carefully adjust the back-pressure regulator knob to obtain the exact desired 1st-stage test pressure.
14. Record the initial external pump volume reading, and initial gasometer volume reading for the 1st-stage gas from the GAS TEST connection (gas separated during this 1st-stage separation from the sample in the 1st-stage separator chamber).
15. Disconnect the 2nd-stage receiver tube, discard the liquid (stock tank oil) from it, and clean it.
16. Weigh the 2nd-stage receiver tube and any small amount of stock-tank oil remaining in it.
17. Re-connect the 2nd-stage receiver tube to the separator.
18. Record or zero the initial gasometer volume reading for the 2nd-stage gas (gas separated during this 2nd-stage separation to atmospheric pressure, from the liquid in the 2nd-stage receiver tube). Also record the initial volume (if any) of liquid remaining in the 2nd-stage receiver tube.
19. Similar to Step 10 above, except with the DRAIN VALVE closed, charge (inject) more high-pressure liquid, expanding it into the 1st-stage separator chamber, while maintaining constant sample inlet pressure (with the external pump) and constant 1st-stage pressure (with the back-pressure regulator).
20. Continue charging into the separator until either the 1st-stage chamber or 2nd-stage receiver tube is nearly full (approx. 20 – 30 cc), and close the inlet FLASH VALVE.
21. Record the new (final) external pump volume reading, and final gasometer volume reading for the 1st-stage gas from the GAS TEST connection (gas separated during this 1st-stage separation from the sample in the 1st-stage separator chamber).
22. Record the volume of liquid in the 1st-stage separator chamber.
23. Calculate as follows:

a. Volume of reservoir fluid injected at high pressure = final pump reading – initial pump reading. Multiply by any Thermal Expansion (or Contraction) Factor, if necessary, if the pump and fluid sample are at different temperatures.
b. Volume of separated 1st-stage separator liquid = final separator volume reading – initial separator volume reading.
c. Volume of separated 1st-stage separator gas = final gasometer volume reading – initial separator volume reading – volume of separated 1st-stage separator liquid.

24. Carefully open the DRAIN VALVE to drain the 1st-stage separator liquid into the 2nd-stage receiver tube (where it becomes "stock tank oil" at atmospheric pressure), and close the DRAIN VALVE to set the liquid level at the reference mark at the bottom of the 1st-stage chamber.
25. Record the volume of liquid in the 2nd-stage receiver tube, and the new gasometer volume reading for the 2nd-stage gas (gas separated during this 2nd-stage separation to atmospheric pressure, from the liquid in the 2nd-stage receiver tube).
26. Disconnect the 2nd-stage receiver tube and again weigh it and the stock-tank oil it contains.
27. Calculate as follows:
    a. Volume of stock-tank oil = final receiver tube volume reading – initial receiver tube volume reading.
    b. Volume of separated 2nd-stage separator gas (also called "stock-tank vapors) = final gasometer volume reading – initial gasometer volume reading – volume of stock-tank oil.
    c. Density of stock-tank oil = (final weight of tube and oil – initial weight of tube and oil) / volume of stock-tank oil.
28. Correct the calculated liquid and gas volumes to the desired standard conditions, for reporting purposes.
29. Repeat the test at several different 1st-stage Separator pressures to find the optimum separator pressure, and make a table of the results for reporting purposes.

1-Stage Flash Separator Test

1. This is a simplified test which simulates flashing directly from Reservoir Pressure (or wellhead or gathering line) to Stock tank (1st-stage in this case, in the "2nd-stage receiver tube", at or near atmospheric), without any Separator in-between. The "1st-stage separator chamber" is used as the collection and liquid measurement chamber, with the gas separated and measured from it at atmospheric pressure.
2. Close the inlet FLASH VALVE and DRAIN VALVE, open the BYPASS OFF valve, and close the REGULATOR OFF valve (to bypass the regulator and direct the gas separated in the 1st-stage separator chamber (at atmospheric pressure) out through the GAS TEST port.
3. Connect a gasometer (gas meter) to the GAS TEST port, which is the outlet for the gas separated in the 1st stage (from the 1st-stage separator chamber). Place the gas weighing balloon in the line upstream of the gasometer (between the GAS TEST port and the Gasometer) so that gas gravity can be determined.
4. Connect a vent tube to the 2nd-stage gas outlet connection (the right-side connector of the cross between the 1st-stage DRAIN VALVE and the 2nd-stage receiver tube) to a vented hood, or to some safe area outside the laboratory.
5. Connect a 2nd-stage receiver tube to the bottom of the instrument.

6. Connect tubing from the RELIEF VALVE VENT port to a vented hood, or to some safe area outside the laboratory. Similarly, connect tubing from the outlet of the gasometer to a safe area.
7. Connect the pressurized sample to the inlet FLASH VALVE of the separator, and use external pump (not included as part of Equilibrium Flash Separator) to pressurize the sample to the desired inlet pressure.
8. If the test is to be conducted at temperature other than room temperature (heated or cooled, that is), attach tubing to and from a recirculating heating and/or cooling bath to the heating/cooling liquid inlet/outlet connections on the side, and circulate the heated or cooled fluid around the chamber until equilibrium is reached at the desired separator test temperature. A thermometer is provided for monitoring the temperature.
9. Expand the fluid sample into the separator by maintaining constant sample inlet pressure with the external pump, and carefully opening the inlet FLASH VALVE to charge (inject) 10 to 20 cc to purge the system, while maintaining constant sample inlet pressure with the external pump.
10. Simultaneously, open the DRAIN VALVE and adjust it to drain liquid from the 1st-stage chamber into the 2nd-stage receiver tube, while maintaining the liquid level in the 1st-stage separator chamber slightly above the bottom of the chamber.
11. Close the inlet FLASH VALVE and slowly, carefully open the DRAIN VALVE to drain just enough liquid from the 1st-stage separator chamber to set the liquid level at the reference mark (0 cc) near the bottom of the chamber.
12. Record the initial external pump volume reading, and initial gasometer volume reading (gas separated during this 1-stage separation from the sample in the 1st-stage separator chamber).
13. Disconnect the 2nd-stage receiver tube, discard the liquid (stock tank oil) from it, and clean it.
14. Weigh the 2nd-stage receiver tube and any small amount of stock-tank oil remaining in it.
15. Re-connect the 2nd-stage receiver tube to the separator.
16. Similar to Step 9 above, except with the DRAIN VALVE closed, charge (inject) more high-pressure liquid, expanding it into the 1st-stage separator chamber (which is at atmospheric pressure), while maintaining constant sample inlet pressure (with the external pump).
17. Continue charging into the separator until either the 1st-stage chamber is nearly full (approx. 20 – 30 cc), and close the inlet FLASH VALVE.
18. Record the new (final) external pump volume reading, and final gasometer volume reading for the 1st-stage gas from the GAS TEST connection (gas separated during this 1-stage separation from the sample in the 1st-stage separator chamber).
19. Record the volume of liquid in the 1st-stage separator chamber, at atmospheric pressure.
30. Calculate as follows:
    a. Volume of reservoir fluid injected at high pressure = final pump reading – initial pump reading. Multiply by any Thermal Expansion (or Contraction) Factor, if necessary, if the pump and fluid sample are at different temperatures.
    b. Volume of stock-tank oil = final separator volume reading – initial separator volume reading.
    c. Volume of separated 1-stage gas (also called “stock-tank” vapors)= final gasometer volume reading – initial separator volume reading – volume of stock-tank oil.
20. Carefully open the DRAIN VALVE to drain the atmospheric stock-tank oil from the 1st-stage separator chamber into the 2nd-stage receiver tube, and close the DRAIN VALVE to set the liquid level at the reference mark (0 cc) at the bottom of the 1st-stage chamber

21. Calculate as follows:
    a. Volume of stock-tank oil = final receiver tube volume reading – initial receiver tube volume reading.
    b. Volume of separated gas (also called “stock-tank” vapors) = final gasometer volume reading – initial gasometer volume reading – volume of stock-tank oil
22. Disconnect the 2nd-stage receiver tube and again weigh it and the stock-tank oil it contains.
23. Density of stock-tank oil = (final weight of tube and oil – initial weight of tube and oil) / volume of stock-tank oil.
24. Correct the calculated liquid and gas volumes to the desired standard conditions for reporting.

Section 3 – Maintenance

Be sure to thoroughly clean the Equilibrium Flash Separator after each test to avoid contamination.

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Section 4 – Replacement Parts

PART NUMBER	DESCRIPTION
2350-807	Angle Valve
2353-2-6	Jacket
2353-805-001	Assembly, Drain Valve Extension
54-700-118	O-ring, Buna
66-680	Regulator, 0-500 psi
83-131	Thermometer
P-0301	Valve, SST,Needle,1/8 FPT

To ensure correct part replacement, always specify model and serial number of instrument when ordering or corresponding.

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Section 5 – Drawings and Schematics

DRAWING NUMBER	DESCRIPTION
2350-807	Angle Valve – Flash Separator
2353-12	Chamber Assy - Flash Separator

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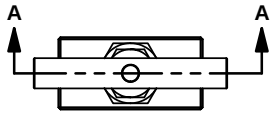
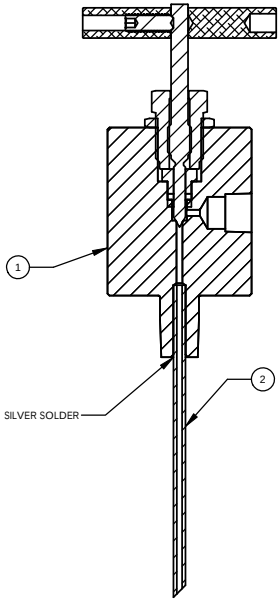
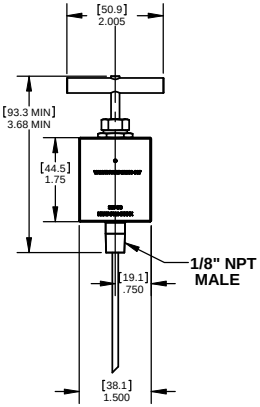
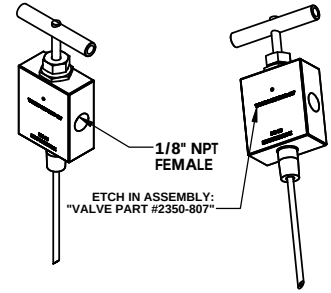
REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	A	ISSUED	8/16/11	TC





SECTION A-A





Maximum Allowable Working Pressure
= 103.4 MPa (15,000 psi, 1034 bar, 1021 atm.)

NOTE: DIMENSIONS SHOWN IN inches AND [mm].

2350-807				
ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	Default/ QTY.
1	2350-807-101	VALVE,ANGLE,FLASH SEP	316 SS	1
2	2154-5-1	TUBE -FLASH VALVE ASSY .12OD	SS,TB,0.125X0.035W ,316SS,ANNEALED	1

.	.
NEXT ASSY	USED ON
APPLICATION	
BREAK SHARP EDGES, DEBURR	

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES

TOLERANCES:
1 PLACE ±0.030
2 PLACE ±0.010
3 PLACE ±0.005
ANGLES ±1/2°
SURF. FINISH 63

APPROVALS		DATE
DRAWN:	TC	8/16/11
CHECKED:	TC	8/16/11
ENGR.:	DWC	8/16/11

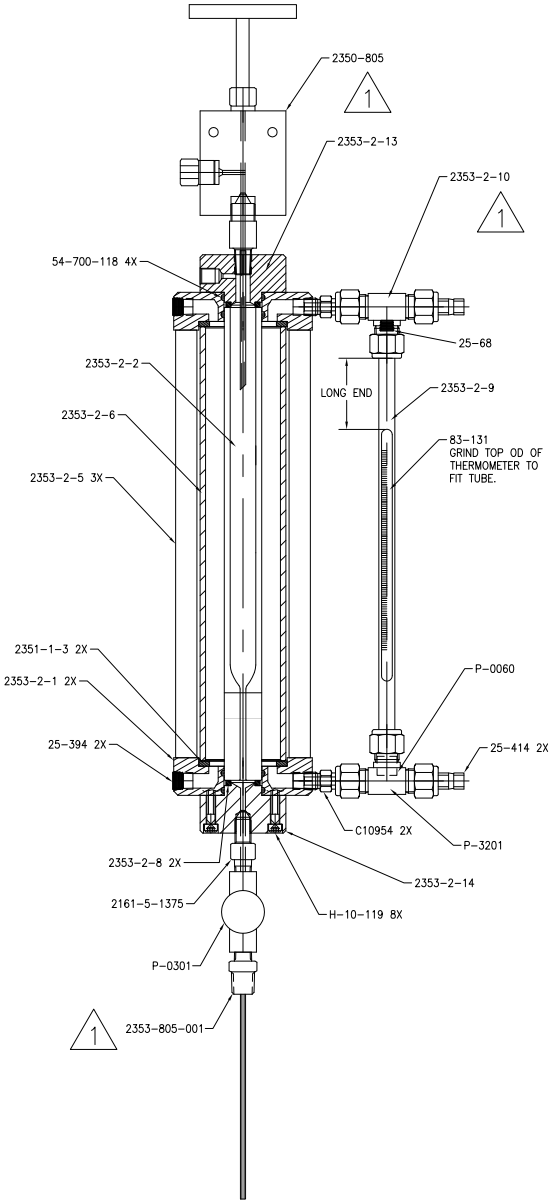
CHANDLER ENGINEERING

TITLE: VALVE,ANGLE,FLASH SEP

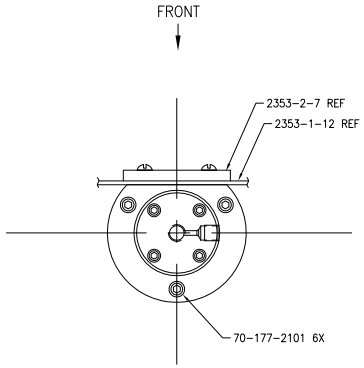
SIZE	DWG NO.	REV.
B	2350-807	A

SCALE: 1:1 | TITLE BLOCK REV: 2.0 | SHEET: 1 of 1

REVISIONS					
ZONE	REV	DESCRIPTION OF REVISION	DATE	APPROVALS	
	E	ECN 8056; UPDATED PART NUMBERS	1/6/04	TC	RW
	F	ECN 748, UPDATED BOM P-0060 WAS 99289-3	3/29/07	JB	TC
	G	ECN T1494; DEL 88-1027, ADD P-0301	2/26/08	TC	DAH



FRONT VIEW



VIEW A-A
ROTATED 180°

NOTES:

1. ASSEMBLE UPPER, LOWER, AND SIDE ITEMS AFTER MOUNTING INTO CHASSIS (2353-1-12).

		UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES [mm]		CHANDLER ENGINEERING			
		TOLERANCES: 1 PLACE ±0.030 [.76], 2 PLACE ±0.010 [.25], 3 PLACE ±0.005 [.127], ANGLES ±1/2°, SURF. FINISH 63		TITLE: CHAMBER ASSY FLASH SEPERATOR			
NEXT ASSY	USED ON						
APPLICATION							
BREAK SHARP EDGES, DEBURR		APPROVALS	DATE	SIZE: C	S.O. NO.	DWG NO. 2353-12	REV. G
		DRAWN: JC	1/6/04				
		CHECKED: JC	3/30/07				
		ENGR.: RD	1/6/04	SCALE: 1 = 1	TITLE BLOCK REV: 1.0	SHEET: 1 of 1	