

TELEDYNE ANALYTICAL INSTRUMENTS (TAI)

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Comparison of Hydrocarbon Measurement Technologies

Total Hydrocarbon Analyzer in water (THC): Model 4080/4020

PPM Oil in Water UV Absorption Analyzer: 6600

PPM Oil in Water UV Fluorescence Analyzer: 6650

GENERAL DIFFERENCES

<u>ANALYSIS</u>	<u>MODEL 4080 THC</u>	<u>6600</u>	<u>6650</u>
OIL ANALYSIS	FID (FLAME IONIZATION DETECTION)	UV ABSORPTION	UV FLUORESCENCE
TECHNIQUE	LIQUID TO VAPOR STRIPPING ALL C ⁺ IONS MEASURED FROM C-H DESIGNED TO MEASURE DISSOLVED HC'S	DIRECT FLOW THRU SENSING AROMATIC FRACTIONS ABSORB DESIGNED TO MEASURE EMULSIFIED OILS	DIRECT FLOW THRU SENSING AROMATIC FRACTIONS FLUORESCENCE DESIGNED TO MEASURE EMULSIFIED OILS
SAMPLING	PRESSURE/FLOW CONTROL	EXTRACTIVE	EXTRACTIVE OR IN-SITU
RANGE(S)	5 PPM TO 1000 PPM	3 PPM TO 200 PPM	1 PPM TO 200 PPM
(WITH DILUTION)	300 PPM TO 1000 PPM	300 PPM TO 2000 PPM	300 PPM TO 2000 PPM
LIMITATIONS	TSS < 10PPM OR FILTER	TSS < 10% RANGE	TSS < 1000 PPM
OIL CONTENT	<10 PPM WITHOUT DILUTION	SEE RANGE	SEE RANGE
- MEASURE	VOLATILE C-H BONDED CPD'S	CPD'S THAT ABSORB UV IN WATER	CPD'S THAT UV FLUORESCENCE IN WATER
* TEMP/SAMPLE	NON-FREEZING TO ≤ 50 °C USUALLY COOLING PERFORMED	NON-FREEZING TO 120 °C -	NON-FREEZING TO 120 °C, BUT MORE TEMP SENSITIVE, REQUIRES POSSIBLE CONTROL
* SAMPLE	MUST BE SINGLE PHASE IF NOT EMULSIFIED AT HIGHER CONC'S	CONC'S > 20PPM RECOMMEND HOMOGENIZER	CONC'S > 20PPM RECOMMEND HOMOGENIZER
CALIBRATION	MAKEUP HC OF CHOICE IN WATER ALL HC'S READ AS EQUIVALENTS	SPECIFIC OIL OF INTEREST ALL OIL READ AS OIL OF INTEREST	SPECIFIC OIL OF INTEREST ALL OIL READ AS OIL OF INTEREST
PHYSICAL COND'S	PRESSURE ≥ 10 PSIG, OR PUMP	GRAVITY FLOW TO 10 PSIG OR PUMP IF NO HOMOGENIZER USED	GRAVITY FLOW TO 10 PSIG OR PUMP IF NO HOMOGENIZER USED
MAINTENANCE	FILTER CHANGE, SUPPORT GASES CALIBRATION, PREVENT HI TSS	SOURCE LIFE 1 YEAR + CLEANING SHS IF OIL SLUGS/RE-CALIBRATION	SOURCE LIFE 3 YR, CLEANING SHS CLEANING SHS IF OIL SLUGS/RE-CALIBRATION

TAI MODEL 4080 TOTAL HYDROCARBON ANALYSIS SYSTEM

More in depth information:

4080 FEATURES:

- Measures Carbon Hydrogen bonded hydrocarbons in water, 0-2 ppm THC and up to typically 0-1000ppm
- Microprocessor based electronics (4020 new)
- * High sensitivity FID detection technology

When N₂ is used to strip (remove) Hydrocarbons from water, the efficiency of doing this is related to the following:

1) The polarity of the HC's, is related to their solubility in water (a polar solvent). The more polar the HC's, the more soluble and therefore the more difficult they are to remove or strip out. Alternatively, the less polar the less soluble and the easier the HC's are to strip out of water.

Example: C₁ to C₂₀ straight chain HC's are quite non-polar and can be stripped out of water easily. The more branched the HC's are, the less soluble they are in water and so on. The more functional chemical groups there are in both the water as well as the HC's, the more difficult it is to remove them. These functional groups want to bond (cling to) the HC's, especially if the HC's have functional groups.

2) The chemistry of the water; meaning what else is in the water to grab hold of the HC's. The more polar things in the water (water is then more contaminated), the more they will want to keep polar HC's from leaving. The more purer the water is, the easier it is to remove HC's from it.

3 The chemistry of HC's are organic and contain many functional groups like: organic acids, esters, alcohols, amines, aliphatic (C₁-C₂₀) and aromatic (C₆ and higher like benzene, toluene, EB, Xylenes, Cumenes, naphthalenes, anthracenes and many more functional types. The degree of the type and no of groups and whether branched or straight determines how much can stay in water up to a saturated state. This may be at very low ppms and is temperature related also. Toluene solubility in water is about 490ppm, at 22 deg C. 700 ppm at 38 deg C, and 860 ppm soluble at 45 deg C. The solubility of water in toluene is 600ppm at 38 deg C, and 1400ppm at 57 deg C. The reasons for this is again bonding spacing to these functional groups vs the water bonds of Oxygen (with 2 unshared very negative attracting pair of electrons, and the OH- group also highly attractive. So water is a very polar molecule and therefore attracts polar molecules.. In chemistry, one usually identifies solubility with geometry, spacing, functional groups, and their polarity. Like dissolves like, meaning polar attracts polar molecules. nonpolar likes nonpolar. Therefore, a nonpolar molecule like C₅ to C₂₀'s come out of water easily than say polar molecules like acetone, alcohols, amines, organic acids, esters, etc.

4 Other parameters are also important in the stripping from water efficiency. Flow rate of the stripping gas versus sample water flow. Temperature is also important as explained above with toluene. Contact time and surface area are also important. One requires the design be a small volume but long enough contact time to strip HC's out. Glass beads are used to reduce the volume and allow the gas to contact the water much more efficiently using more surface area contact. Temperature of the water is also important in the ability to strip out HC's. A slightly higher water sample temperature will insure better stripping efficiency. This brings another important point. Vapor pressure of the HC's

The following important points must be considered for a full understanding of the correct operation: the partitioning coefficient of any compound is affected by the relative liquid and gas flow rates and temperature at the partitioning zone. These items are simply yet carefully controlled:

- Water flow (sample) by inlet pressure across a flowmeter or metering pump is used.
- Stripper gas flow by a regulator across a restrictor
- Temperature of the Teflon stripper column
- High surface bead contact using a sparger for the dissolved gas/liquid separation

As long as these conditions remain constant, the partitioning coefficient remains constant and the instrument repeatability is exceptionally good.

PARTITIONING COEFFICIENT TABLE FOR HYDROCARBONS FROM WATER

SET UP CONDITIONS:

0-10,100,1000ppm

ACETONE

Sample water liquid flow rate into stripper= **50 cc/minute; (range is 10-200 ccm)** **160 ccm**
N2 stripping purge flow rate into stripper **0.4 liter/minute; (range is .4 to 2 lpm)** **.8 LPM**
Dryer back purge N2 flow rate approx. 1 liters/minute 8-10 SCFH (4LPM)
Temperature of stripper zone 45.0 ±1 °C 45°C
Approximate response time to 90% FSD under 5 minutes (can be lowered with liquid and N2 or air flow rate changes)

<u>Hydrocarbon</u>	<u>Concentration in H₂O</u>	<u>402R calibrated on CH₄</u> <u>Methane equivalents</u>	<u>Partitioning</u> <u>coef's, 50 ccm</u>	<u>200 ccm</u> <u>Flow</u>
Hexane	2 ppm	20 ppm as Methane	10:1	40:1
Cyclohexane	2 ppm	93 ppm	46.5:1	186:1
Benzene	2 ppm	276 ppm	138:1	552:1 (.0018)
Toluene	2 ppm	190 ppm	95:1	380:1
Acetone	2 ppm	16 ppm	8:1	32:1
EDC	2 ppm	37.8 ppm	18.9:1	76:1
DMF	2 ppm	7.0 ppm	3.5:1	14:1
Methanol	2 ppm	3.75 ppm	1.87:1	7.5:1
Methylene dichloride	2 ppm	28.7 ppm	14.3:1	57:1
N,N DMAC	2 ppm	4.7 ppm	2.4:1	9.6:1
1- Hexene	2 ppm	37.9 ppm	19:1	76:1
THF	2 ppm	13.7 ppm	6.8:1	27:1
H ₂ O, Tap	0 ?	< 1ppm	-	-

5 The vapor pressure of the HC will determine or is greatly related to how much you can remove from the water. The HC (or classes of polar and nonpolar HC's) may be saturated in the water. Imagine the N2 at 1 Atm A (0 psig) coming out of the stripper is at some ambient temperature. If one raises the water temperature of the sample, one can strip out more but the HC's (depending upon the type, solubility and their vapor pressure) may condense out if the water is heated and HC's that come out are saturating the N2 stripper gas at a colder temperature. Don't forget, the water vapor with the HC vapors being stripped are at 45-50°C. A dryer removes all the water vapor specifically before cooling the sample to allow the dry enriched HC's to proceed to the FID detection analyzer. Meanwhile, the vapor pressure (vp) will determine how much the N2 can hold at ambient temperature and therefore by looking at their vapor pressures with respect to the ambient temp that they will contact the gas out of the stripper, which determines how high a concentration one can see. For example:

vp of c6 to c22 hc's

C6H12 = hexane = 121.26 [mmHg] at 20.0 [°C]= 16% v/v

C10H22 =decane 1 mm Hg or 1315ppm at 16.5 °C; 10mm Hg or 1.3% at 55.7 °C

C15H32 = pentadecane = 1 mm Hg or 1315ppm at 91.6 °C, 10mm =135.4°C, 40mm=167.7°C

C19H40 = nonadecane = 1mm Hg or 1315ppm at 133.2°C; 10mm Hg or 1.3% at 183.5°C; 40mm Hg or 5.26% at 220°C

C22H46= Docosane = 1 mm Hg or 1315ppm at 157.7°C; 10 mm or 1.3% at 10mm Hg or 1.3% at 213 °C or 40mm Hg at 254.5 °C

Ethylene Glycol = 0.04 mm= 52.6ppm at 20°C; 0.02mm = 26ppm = 10 °C

0.01mm Hg at 20 °C= 0.00131'%= 13.1 ppm for Soybean oil

So you cant measure any higher than 13 ppm of soybean oil nor any other oil that has a low vapor pressure at a low temperature.

6 The FID detector is also a factor in the sensitivity to detect HC's based upon their number of carbons. In general, a C1 or methane will be 6 times less sensitive than a C6 like Hexane, Cyclohexane and also Benzene. Besides the number of carbons, the ability or degree of ionization in the flame also determines how sensitive the measurement can be. An FID is not specific but very sensitive. Benzene can be seen down to low PPB's. Therefore, a C5 vs a C20 at the same low concentration of 1 ppm may respond 5-10 times more just because of the number of carbons.

7 Heavy oils (see soybean oil above) if they have sufficient vapor pressure and do not saturate the N2. (i.e., choose N2 to water flows properly to prevent this) and also when they are pumped into the FID detection system (usually 2-6 psig) can condense if not addressed as they have very, very low vapor pressures. It is best if the customer can provide to Teledyne the ratio profile of the C5 to C20 types (depending upon their concentrations in N2) to assure that they will not stick to nor condense to the tubing and pump before hitting the flame detection system. This will be based upon their vapor pressures at expected concentrations as they come out of the stripper and go into the pumping system at a slightly higher pressure. Also, the sample handling system (shs) is heated to 65 °C to assist in the vaporization before detection.

To summarize, the stripping efficiencies of most HC's particularly those as nonpolar in water are more than 99% removal provided they don't condense back because of their vapor pressure. If they are present in very low ppm's and can be stripped out at 45 deg C, without saturation into N2, then at satisfactory measurement is quite simple to do. The following information list the typical detectable concentrations one can measure at the same physical conditions of the N2 stripping flow and water sample flow rates.

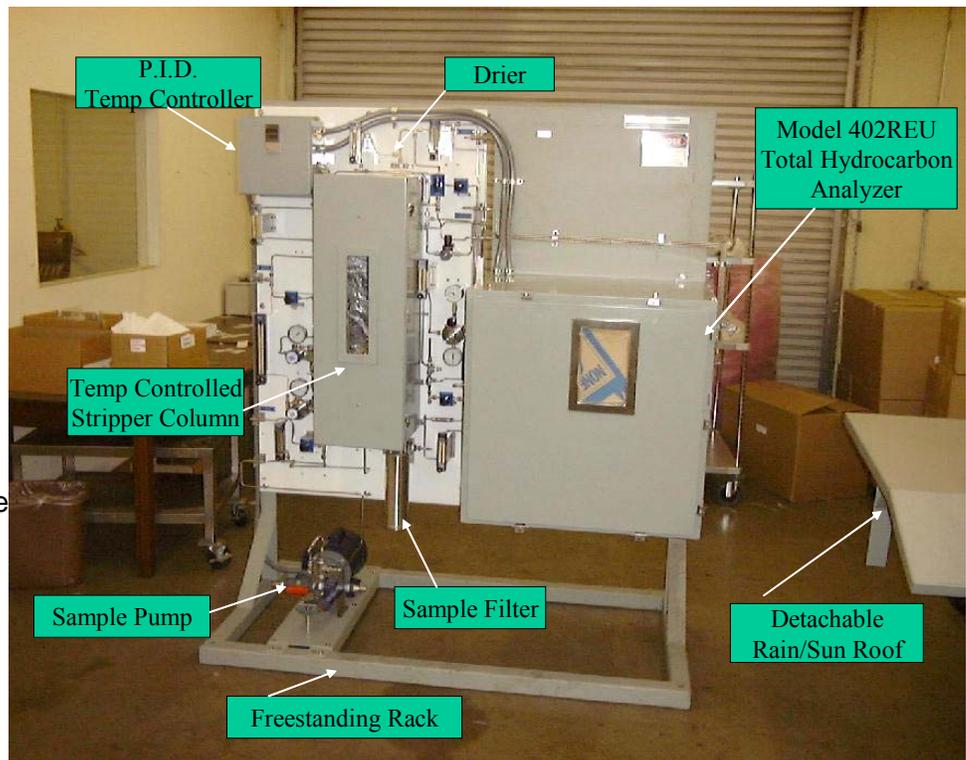
If one wishes to measure higher concentrations of heavier HC's, a dilution system is recommended.

A simple dilution system up front can reduce HC vapor pressures so that they don't condense based upon the info above. Thereafter, the temp in the stripper can be reduced hopefully near room temp or slightly above so that the oils don't drop out.

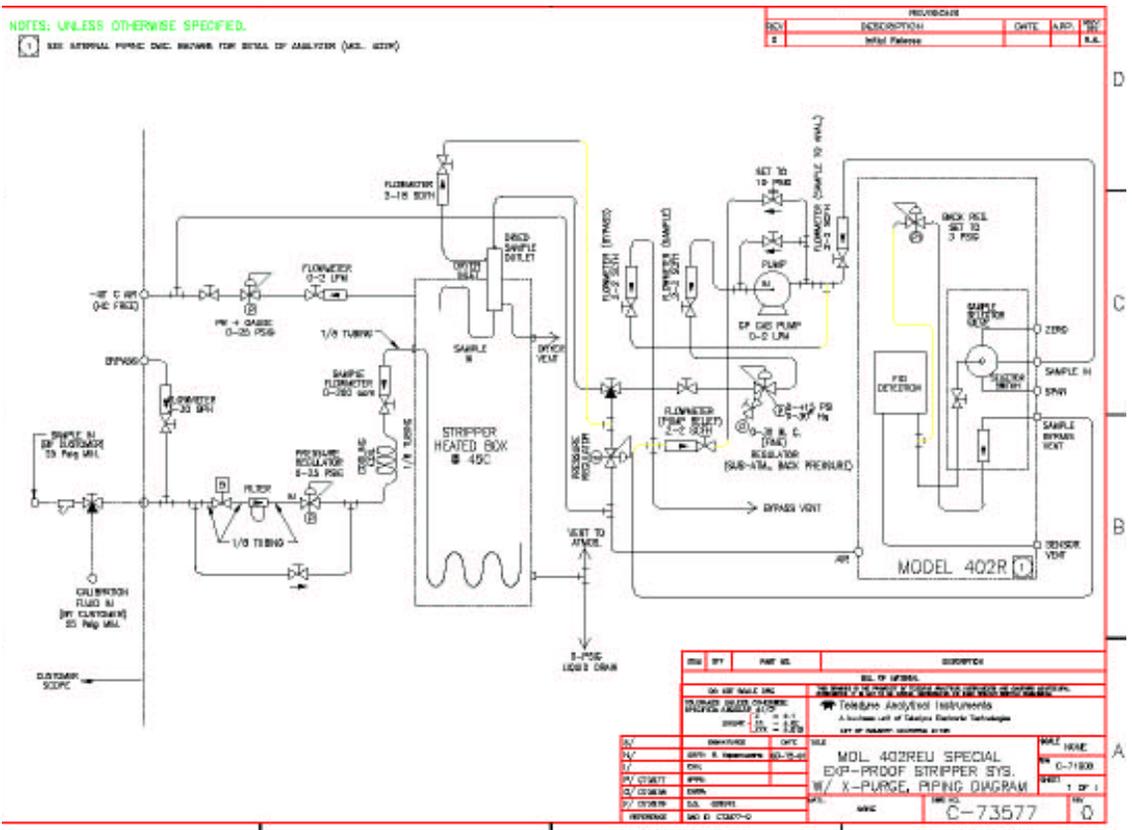
The TAI 4020 FID is very sensitive even with a dilution. The 4020 can normally see 0-1 ppm methane full scale, so many higher carbon homologs which are more sensitive are easily detectable below 1 ppm. All the HC's present are calibrated per the customers choice or whatever is the critical HC or class of HC's present in their water system that needs monitoring and control.



TAI Model 4080
X purged for Hazardous Area
Total Hydrocarbon ppm's in Water System



GP 4080 on Backplate



INTRODUCTION

Through this extensive application experience, TAI has been able to develop a revised system design that is well suited for intended applications. Teledyne's oil in water analyzers have been used extensively in many applications where the ranges may be 0-1 ppm up to 0-200ppm Oil in water. A 0-2000ppm oil range is also possible with sample handling system dilutions incorporated. These water(s) can be from the following sources:

- Pollution abatement programs involving effluents from refineries, chemical / petrochemical plants, oil fields, steel mills, automotive production, food processing, and other industries
- Offshore drilling platforms, produced water/separators, oil field water flooding, steam injection operations
- On-board shipping (fast analysis required <10 seconds) (Insitu or extractive possible)
- Onshore deballasting discharges and ballast treatment facilities
- Boiler return, feed water, steam condensate, cooling water, heat exchanger leak detection
- Monitoring of airport runoff, municipal water treatment plants
- Wastewater/sewage treatment plants

TAI MODEL 6600 OIL IN WATER ANALYSIS SYSTEM UV ABSORPTION TECHNOLOGY

More in depth information:

- 1 The 6600 is microprocessor based with the following standard features: (New) indicates improvements over the older 660 UV design.

The TAI Model 6600 UV absorption photometer (Summary)

-is generally the lower cost analyzer which can measure fossil fuel based oils as follows:

- 1 0-3 to 0-20 ppm oil (dissolved oil) in clean waters (steam/boiler condensates, feedwater, purity systems with extractive sample handling systems.
- 2 No homogenizer required (oils are dissolved in solution at the molecular level)
- 3 Auto zero and span on-line performed with oil free air or N2 and optical span flag. No samples needed.
- 4 0-10ppm to 0-20 ppm oil (dissolved oil) in contaminated waters, effluents, etc., but with added autozero filter assembly capability to allow for non-oil organic background corrections

TAI 6600 UV absorption photometer

Extractive sample handling systems with analyzers to measure:

- 1 0-25ppm oil to 0-200ppm oil in clean or contaminated waters
- 2 Ultrasonic powerful Homogenizer used to disperse the oil to the molecular size for continuous calibration and monitoring up to 200ppm levels.
- 3 Autozero filter assy used to compensate for non-oil organic background contamination.
- 4 0-500, 1000 to 2000ppm oil in intermediate input/output control separators, produced waters, effluents, etc., using built-in 5:1 to 10:1 ratio dilutions.

6600 FEATURES:

- Specific to oil (correlates to EPA Method 1664)
- Microprocessor based electronics (new)
- Auto calibration with oil free N2/Air and internal span flag (new)
- Remotely initiated cal / zero via customer supplied 24 VDC signal (new)
- Self-diagnostics with form C relay contacts (new)
- Total oil readout standard, undissolved oil readout possible (available with auto zero filtering option)
- Integral alarms
- Self-cleaning cell (new)
- Automatic turbidity compensation
- Full duplex RS-232 communication link (new)
- Process pressure up to 150 PSIG (higher pressure possible, application dependent) (new)
- Sample temperature to 120°C (higher temperatures possible, application dependent) (new)
- T90 Response time under 10 seconds possible (application dependent) (new)
- NEMA-4x (stainless steel standard) mounted control unit (new)
- Lower costing Z, X and ATEX purged designs to meet hazardous area classifications (new)
- * Faster response times with higher sampling flow rates possible (new)
- * Capable of lower cost Z, X and ATEX certification designs (new), (Fully Explosion Proof also available)

- 1 The 6600 is a totally closed analysis system capable of handling higher process line pressures and temperatures.
- 2 The 6600 has eliminated the need for all plastic components which previously limited the sample temperatures, corrosive nature and extremes for ambient location applicability.
- 3 Many components were eliminated or replaced with superior performance designed components such as:

Eliminated were:

De-aerator, homogenizer mixer and costly explosion proof motor, explosion proof sample integral peristaltic pump and all plastic tubing, sparger assembly and oil free air and oil filter requirements, plastic solenoid valves, sample header assembly, pump requirement for remotely installed field unit for the sparger and air regulator, and multiple needle valves. Also, no open drain is required as all samples should be returned to process unless performing an auto zero.

Other improvements :

- 1 New hi-powered ultrasonic homogenizer capable of dispersing/dissolving oil in the sample within 0.25 seconds time. (older homogenizer which had longer response time, required 3 minutes contact time to do the same sample prep.
- 2 Sample system contact/exposure materials are all 316ss standard. Cell contact materials are 316ss, kynar (like teflon but harder) or aluminum (application dependent)
- 3 Unit is first field calibrated on the specific oil of interest, thereafter, if can be calibration checked and verified by using only N2 and an internal span optical filter which simulates the specific oil. This can also be set up to automatically correct or update the instrument calibration if desired.
- 4 The life of the new Hg lamp is one year minimum.
- 5 A pump is not required in the system unless the differential system sample pressure is below 5 psid (0.35 Bar g, 0.35 Kg/cm² g).
- 6 Below 20 ppm oil the homogenizer is not required.
- 7 For clean streams such as steam condensates, boiler returns, and cooling waters, the filter system nor homogenizer is normally not required. A very simple sample system is all that is required while the instrument is autozero'd on Air or N2.

Calibration of the field systems for all TAI Oil in Water Analyzers with Systems.

TAI recommends the use of its Calibration kit (P/N A48715). This kit includes all the necessary tools needed to prepare a zero oil free process water sample for zeroing the analyzer as well as provide zero fluid for creating (make-up) a full range scale oil in water span calibration fluid. A half span make-up is also possible to check linearity.

A detailed *Calibration Procedure (QP 6000/6020)* is also provided in the manual and/or addendum associated with the particular TAI oil in water system chosen by the customer.

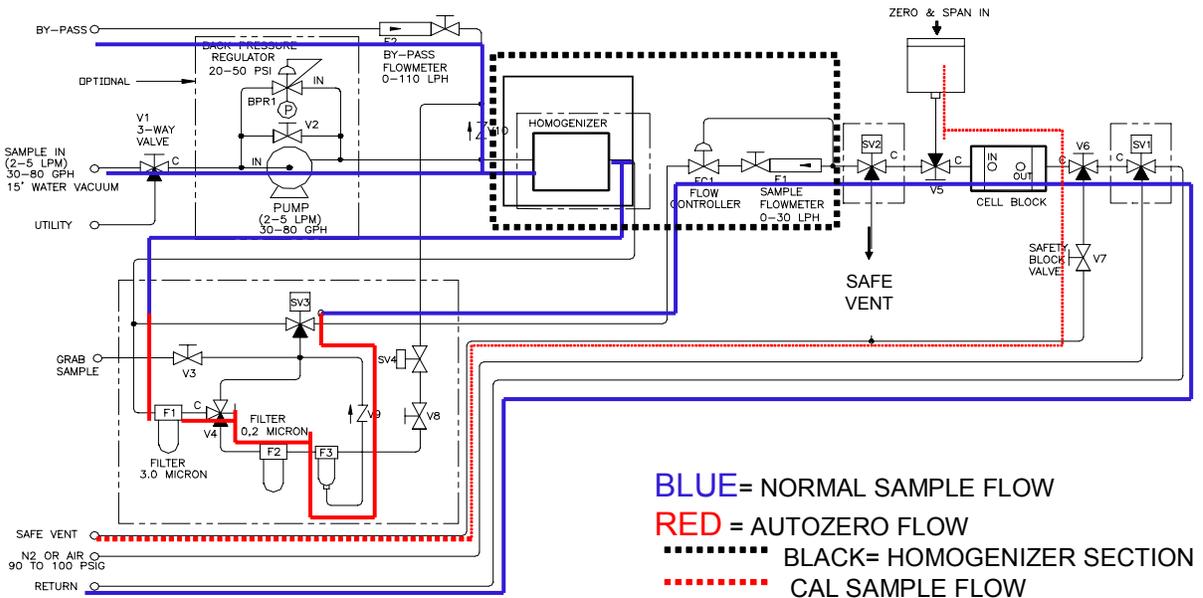
Other criteria:

- 1 Depending upon particle size distribution, in certain applications where slugs of sand could be present, a special homogenizing/sand removal system is incorporated where 0-50 ppm oil can still be measured.
- 2 Only one single analyzer enclosure is used with folded optics and with an external specially designed self-cleaning cell.
- 3 No moving parts in the total system unless a pump is required.

A Sample Handling System for Total Oil in different types of waters:

- **PIPING FOR TOTAL OIL APPLICATIONS**
- **SAMPLE FLOW IN BLUE SHOWN**

1. USE HOMOGENIZER AND FILTER ASSEMBLIES FOR HIGH RANGE, HIGH BACKGROUND
2. USE FILTER ASSEMBLY FOR LOW RANGE, HIGH BACKGROUND
3. USE BACKFLUSH SOLENOIDS FOR LOW RANGE, VERY LOW BACKGROUND
4. USE PUMP ASSEMBLY FOR LOW PRESSURE OR NO GRAVITY FEED



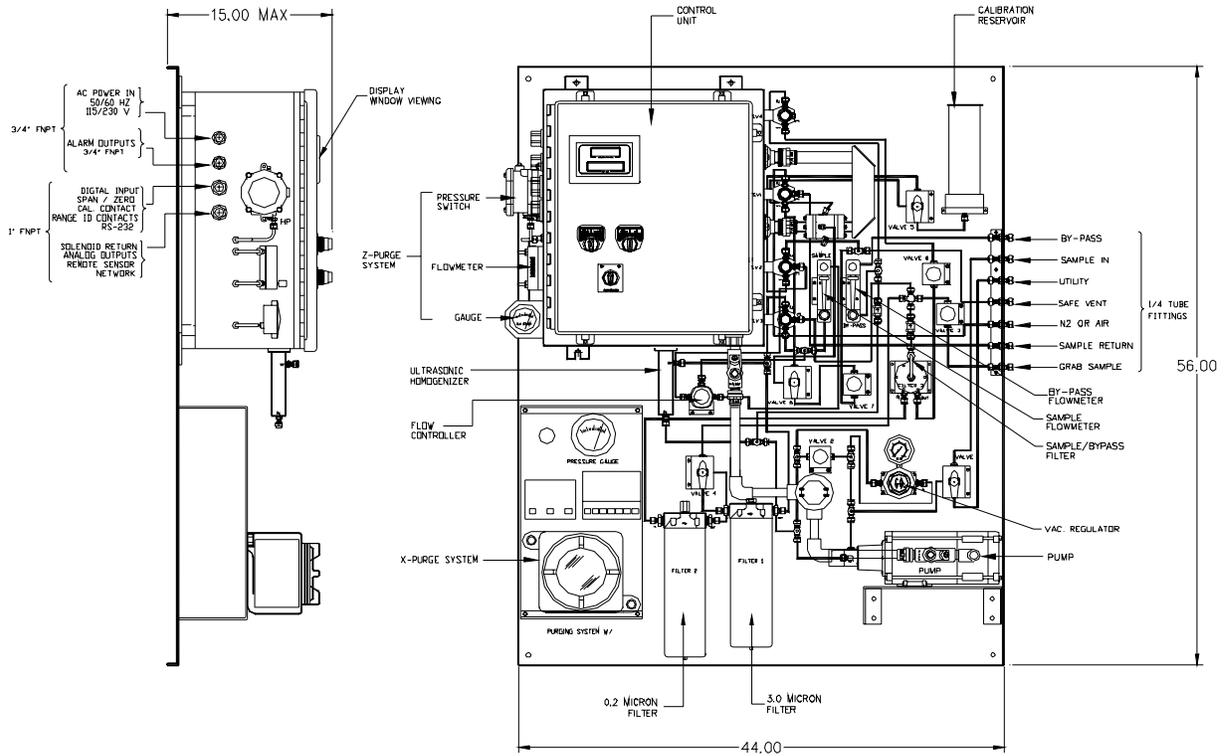
• HOMOGENIZER MODULE:

- A high frequency (20KHz) ultrasonic homogenizer is used to disperse the suspended oil droplets in the sample so they can be measured accurately (Typically, measuring processes above 20 PPM oil requires this Module).

- FOR MOST DIFFICULT APPLICATIONS

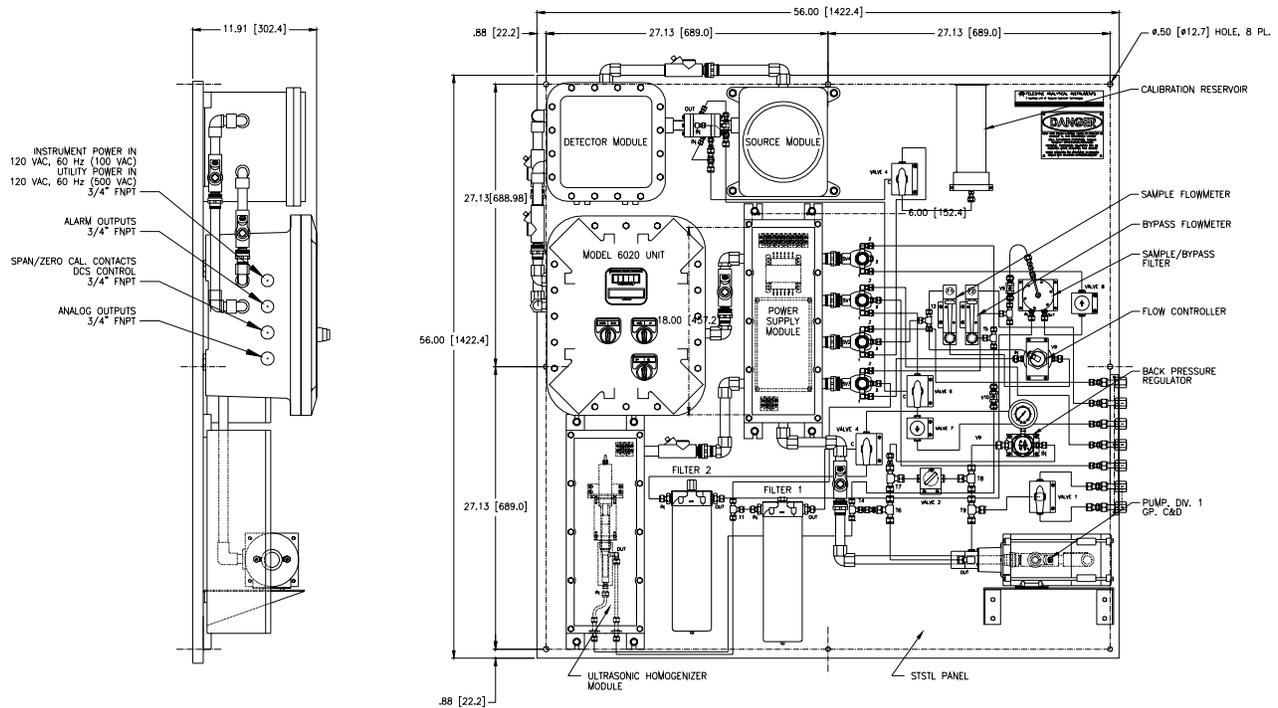
• SHOWS Z (Div II) or X (Div I) PURGING LAYOUT

• TOTAL OIL IN WATER, 0-10 to 0-200ppm



• FINAL ASSEMBLY
• SHOWS FULLY EXPLOSION PROOF SYSTEM
• TOTAL OIL IN WATER 0.10 to 0.200ppm

1. ALL DIMENSIONS ARE IN INCHES (±.06) AND MILLIMETERS (±1.0), INCHES[mm]



Important application information:

The ability to measure oils (which are fossil based) which are from crude oil source wells or as in “produced waters”, is determined by the proportional amounts of aromatic fractions within the oils. Both UV and UV-fluorescence techniques rely on this fact. Aromatics absorb in the UV at 254 nm and UV Fluorescence typically chosen between 280 to 500nm for excitation measurement. The UV fluorescent sources chosen are usually between 210nm to 350nm.

In general, other hydrocarbons like alkanes, alkenes which make up the bulk of oil do not absorb or fluoresce and therefore if aromatics are not present cannot be measured by these two analytical techniques.

OPTIONAL APPLICATIONS

- **When streams contain slugs of oil or heavy particulates/sand up to 3% weight levels.**

- **TAI solution:**

- Incorporate a self-cleaning continuous particulate filter which removes particles down to the 30 micron level.

- Streams are not cloudy in appearance after 30+ micron particles are removed. Customer to assure % particle size distribution below 30 microns is below 1% of total suspended solids.

- **Filtration system**

- **Features: Capable of measuring 0-50 ppm oil at 30 microns.**
- **Lower ranges possible with smaller filter size micron retention.**
- **(Customer to specify)**

- **Removes particles larger than 30 micron**
- **Built in agitator creates turbulence to clean filter element**
- **Agitator and motor is magnetically coupled to prevent shaft leaks**
- **Small internal volume of the filter housing gives fast response to stream composition changes**
- **System uses an inexpensive disposable filter element**
- **Cleaning action of the filter element does not depend on bypass flow rate**



TAI MODEL 6650 OIL IN WATER ANALYSIS SYSTEM UV FLUORESCENCE TECHNOLOGY

More in depth information:

6650 FEATURES:

- **Direct Measurement (Insitu or Extractive)**
- **Resistance to High Turbidity (suspended solids)**
- **No Spare Parts required for 3 years**
- **Long life UV lamp**
- **Virtually NO Drift**
- **Intrinsically Safe FO probe**
- **High Sensitivity**

The generic Teledyne 6650 photometric fiber optic probe oil in water fluorescence analyzer is configured for excitation between 250 and 380 nm with a measured emission between 420 and 700 nm. Consequently, the background fluorescence from the produced water can be quite high if **chemical additives that fluorescence** are present or the makeup water has significant native background fluorescence. Furthermore, the fiber optic probe unit is calibrated based on a mid-range value that is the sum of the background fluorescence plus a known quantity of oil. Consequently, changes in the background fluorescence may significantly alter the calibration level. For example, if the produced water has a background of 400 counts and the calibrated level for 100 PPM of oil is 1000 counts, there are 600 counts that represent the oil concentration from 0-100 PPM. If chemical composition of the process water changes and the new background level is actually 300 counts, a fluorescence reading of 1000 counts now corresponds to an oil concentration of >100 PPM oil since the only way to increase the fluorescence counts to the calibration level is to increase the oil concentration. This could be the difference between environmental compliance and out of specification water that may have negative or positive alarm indications.

In order for Teledyne to offer a reliable oil in water measurement, it is required and recommended to do extensive testing and optimization of the fluorescence sensor for accurate monitoring of the oil content with minimal interference from chemical additives or changes in the process makeup water. The following points must be considered by the customer.

In our experience, produced water or complex waters of unknown origin may not be uniform from location to location. The makeup water composition may be variable and the chemical additives or background compositions may have variable concentration.

The presence of chemical additives or background variations raises questions about the following problems

Photon scavenging, if the chemical absorbs in the same region as the oil then fewer photons excite fluorescence and the overall signal level is reduced

In the broad band approach, do changes in the chemical levels result in significant (>40 counts) changes in the background level. Is there an excitation emission wavelength pair that is unique to the oil, while eliminating interferences from chemical additives or makeup water composition.

More often than not, Teledyne application engineers can optimize the customer's specific sensor to eliminate these variables down to an acceptable level provided sample testing can be done on representative samples of the produced water and on the specific oil of interest which requires monitoring.

It is strongly recommended that the customer send representative process water (1 liter of each sample from each sample tap point of interest) and the corresponding specific oil of interest (10cc each sample) from the same sample tap.

NOTE:

Is there native fluorescence from the chemical additives

Are there fluorescent tags on the chemical additives? Fluorescent tags are now more common since many chemical manufacturers monitor fluorescence as a way to determine actual chemical concentration.

How does temperature, pH and overall chemical composition affect the fluorescence signal. These potential factors are also investigated on the customer's submitted samples.

The issues are complicated by the fact that there is not a database of fluorescence for the oils of the world, the chemical additives used, or the temperature and pH correction factors. Consequently, these issues must be determined experimentally in order to provide a reliable quality oil in water monitoring system.

This work is always performed on a lab based fluorometer, not a photometric analyzer. The results from the fluorometer are used to configure the photometric analyzer hardware for optimum performance specific to the customer's application.

For quotation and delivery of the unit, practical caveats will also be submitted especially when the customer does not submit their water or oil samples for application feasibility.

To determine if fluorescence is a possible measurement option the sample evaluation should be strongly considered. The sample testing time typically takes only 2-4 hours wherein the results can hopefully eliminate field performance problems. This testing will determine the fluorescence characteristics of the produced water and then determine the produced water plus oil fluorescence. Comparison between these two scans will indicate if the generic broadband sensor setup approach is feasible or whether a specific excitation/emission pair configuration is required. Teledyne has sold both types of photometric analyzers for fluorescence. This screening process will provide a quick yes or no for the customer. The issue now is the types of caveats required in the quotation.

Important:

To assure acceptable performance of a Teledyne Analyzer Oil in Water(s) system, the customer must supply representative water samples as well as a sample of the specific oil type being monitored in the water. Any additives must also accompany the samples to ascertain any interferences. Only then, can Teledyne meet the intended compliance/performance of its Oil in water systems as well as provide proper start-up and field calibration. If these samples cannot be provided, the factory will calibrate your system with EPA#2 reference Oil in demineralized or tap potable water.

Prior to operation, you must calibrate this system with the required representative Oil and Water found in the sample fluid to be analyzed, Otherwise, sample related non-conformities may cause erroneous readings by which Teledyne cannot be held liable.

The sample background must be clear of strong interfering substances (such as additives that may be injected). The process fluid is also to have **no aromatic hydrocarbons** other

than those being measured as oil in the sample. The amount of suspended solids if above recommend quoted specifications will also exclude the performance requirements as outlined in the compliance data sheets supplied during the proposal stages. TAI cannot be held responsible for unsatisfactory performance of any of our oil in water systems due to nonconformities in the process sample.

If the customer knows that there is significant variability in the chemical constituents of the process water before the system is fully configured, a more rigorous application engineering sequence should be undertaken.

It should be noted that all these issues may be more or less relevant depending on the chemical additives used, and the chemical composition of the makeup water. We at Tele-dyne hope that this helps clarify the issues faced with utilizing fluorescence monitoring so that a quality performing system can be realized and obtained.

SPECIAL REMARKS & INSTRUCTIONS:

For proper evaluation of an application, TAI recommends that proper laboratory analysis of the oil and water samples be conducted. TAI offers these services free of charge. Please submit 30 cc of the representative oil and one liter each of the representative background water and process water if possible in suitable sealed glass containers. In the absence of the samples, TAI will conduct a factory calibration using EPA # 2 oil and tap water and we will not be held responsible for unsatisfactory performance of the TAI Oil in Water Analyzer due to any unexpected or improperly specified sample related nonconformities.

TAI recognizes that in the case of a new, noncommissioned plant, that oil and water samples may not be available for study. If the end-user is unable to provide samples, a spectral scan or a detailed description of the type(s) of oil present, the user is then responsible for properly calibrating the unit, at the time of commissioning, against the oil found in the sample fluid to be analyzed.

TAI MODEL 6650 UV FLUORESCENCE MONITORS. (SUMMARY)

-general extractive and on-line fiber optic insitu probe mounting configurations available.

- 1 0-0.5 to 0-20 ppm dissolved oils in similar waters listed under 6600 uv.
- 2 No homogenizer required up to 20 ppm oil
- 3 No Auto zero, optical span flag check after field calibration. No samples required for checks
- 4 0-0.5 to 0-20ppm in contaminated water, effluents.
- 5 Turbidity, suspended solids up to 1000ppm can be handled with no interference. High ppm H₂S levels do not affect the fiber optic probe sensor.
- 6 Insitu or extractive sensor probe is intrinsically safe and probe with fiber cable can be mounted up to 3 meters from control unit (Z or X purged).
- 7 Insitu probe mount to process pipe/line can be configured with ultrasonic homogenizer to allow oil ranges from 0-300ppm oil. Homogenizer also keeps the probe distal sapphire window tip clean. On-line calibration and probe removal possible without affecting downtime of the process line or vessel
- 8 Extractive dilutions for up to 0-2000ppm oil are also available with the Fluorescence probe

SAMPLE HANDLING CONSIDERATIONS

Therefore, in order to monitor the truer concentrations for complex or contaminated process waters, one must be able to control or minimize any phase separation during the sampling and measuring stages. **The customer must be able to withdraw a fairly uniform and representative sample from a process line or vessel without allowing oil concentrations from immediately separating before it gets into an analyzer to measure the oil.**

To do this, the following recommendations should be adhered to:

- 1 Takeoff distances to the analyzer must be very short and use small volume sample line tubing/piping displacements if possible without plugging. Incorporate the probe where correction action is to be applied or as close as possible.
- 2 Incorporate the ability to obtain a correlating lab grab sample when possible keeping the sampling techniques in mind for as accurate oil in water representation to the off-line analytical method used.
- 3 Install probe in process line or vessel to avoid bottoms, stratification, separation, entrained air, sediments, level changes that render phase changes, pressure drops that cause flashing/boiling, phase changes from line diameter changes, etc. Sample probe should allow withdrawal of a uniform sample that is representative of the process variable with minimal chemical/physical sample changes such as phase separation occurring before reaching the analyzer.
- 4 Maintain uniformity and “representative ness” of the oil in water sample by incorporating static in-line mixing (perhaps several static mixers are needed) from takeoff to the inlet system and then to the homogenizer of the analyzer system.
- 5 Incorporate a very fast bypass loop up to the system and homogenizer of the analyzer system.
- 6 Avoid sampling from a stagnant line.
- 7 Flow rates should be as fast as possible
- 8 Avoid dead legs
- 9 Minimize adsorption on walls, lines. (Choose lines where oil does not stick; as with polished surfaces or Teflon surfaces (that also meet pressure restraints).
- 10 Avoid sampling where excessive particulates are present, as these cannot be removed by filtration. (Note: This also removes oil). (Refer to TAI model Specs)
- 11 Use a suitable accurate continuous monitoring system to render the oil in water sample in the range of interest to give proper homogenization before analysis.
- 12 Use a suitable homogenizer that disperses (emulsifies) the prepared oil process sample immediately and properly while sustaining the dispersion long enough to measure without separation before analysis.
- 13 Measure the sample accurately within a closed analytical oil in water measuring system, quickly and efficiently without loss of volatiles from the sample. This also applies to any lab grab sample.
- 14 Return the sample and bypass fluids safely to a proper drain, vent or sample return where the intake will not cross-contaminate.

Other Notes:

To reiterate, the sample to our system must be a completely dispersed or mixed homogeneous representative process sample delivered to the TAI Model 6600 as fast as possible (short distance preferred) without mud or other high suspended solids present.

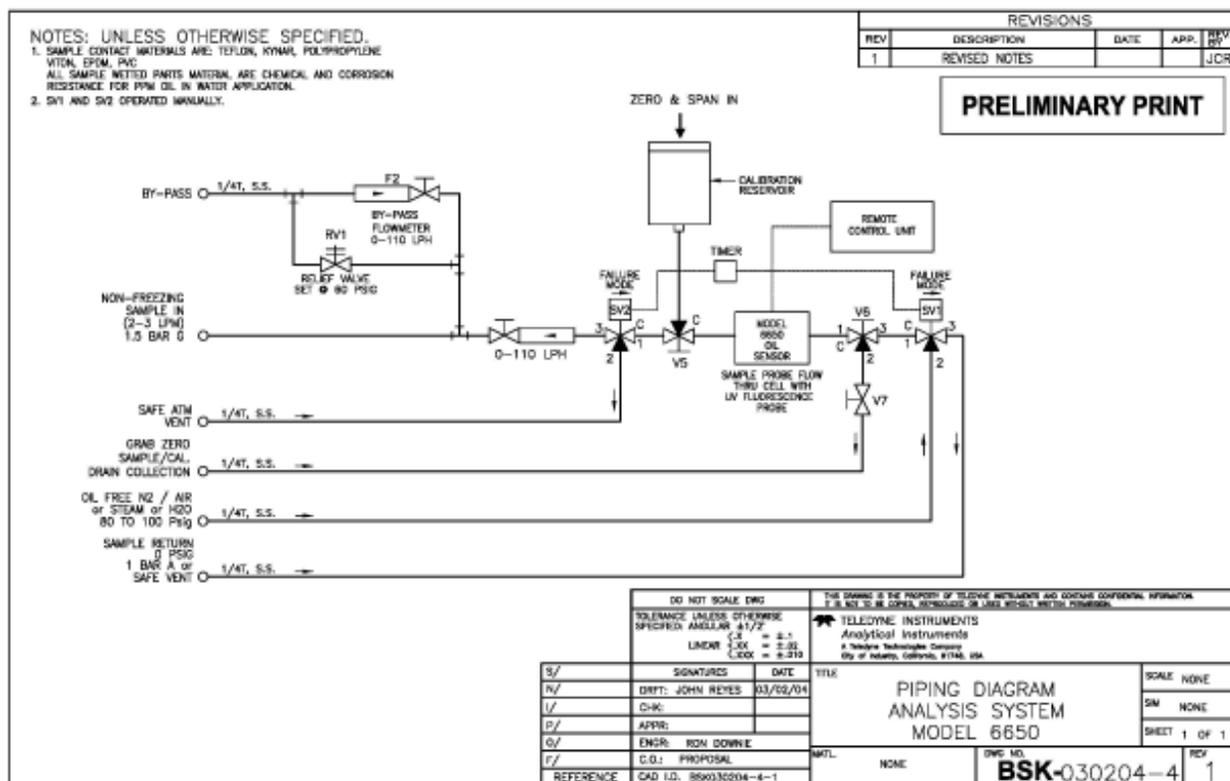
If mud or solids are possible, the customer should provide some detection system of this phenomenon and divert the process from reaching the oil in water system, otherwise, extensive cleaning/flushing may be required to return the system to normal operation.

Also note, should the oil concentrations exceed 200ppm without a dilution system and/or static mixers designed in, contamination of the system characterized by the oil sticking to component contacted surfaces is highly likely and again extensive cleaning/flushing will be required. This coating phenomena is subject to the customers knowledge of their particular process (to maintain an emulsion) and to whether there is any oil buildup tendency possible. This information should also be specified in the application information submitted to TAI during the proposal stage.

In addition, whatever sample probe is used, it should not be a filtering type as this will serve to trap/filter out oil from the sample causing lower readings to be realized. The probe should be a straight run pipe with no filtration device present.

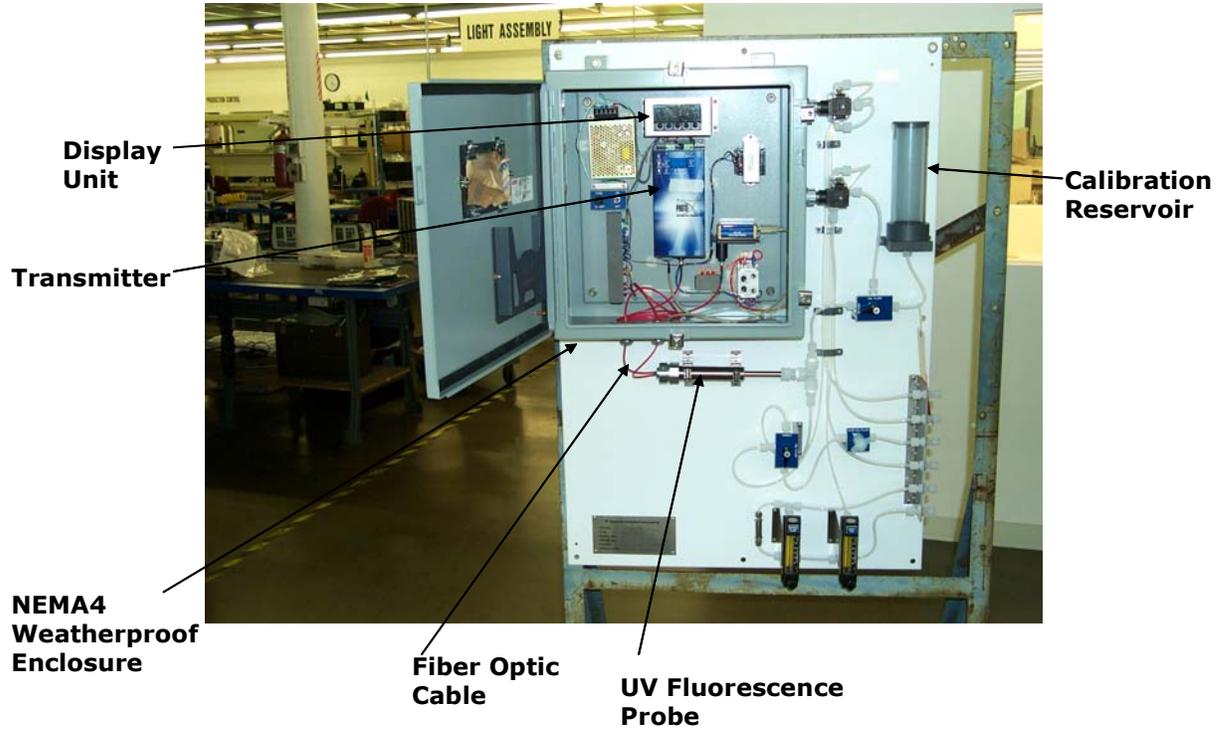
Typical installations:

**Extractive:
Piping**

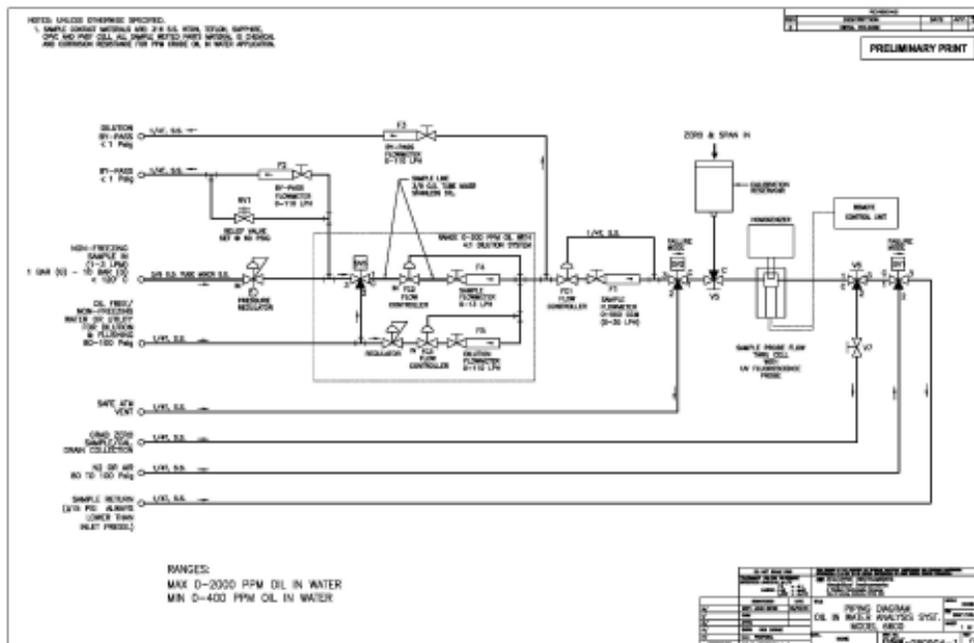


Outline:

Teledyne 6650 Oil in Water System for Sysco, Singapore Range : 0-3 ppm Oil in Sea Water



Piping dilution:



Piping on-line insitu 8" pipe section

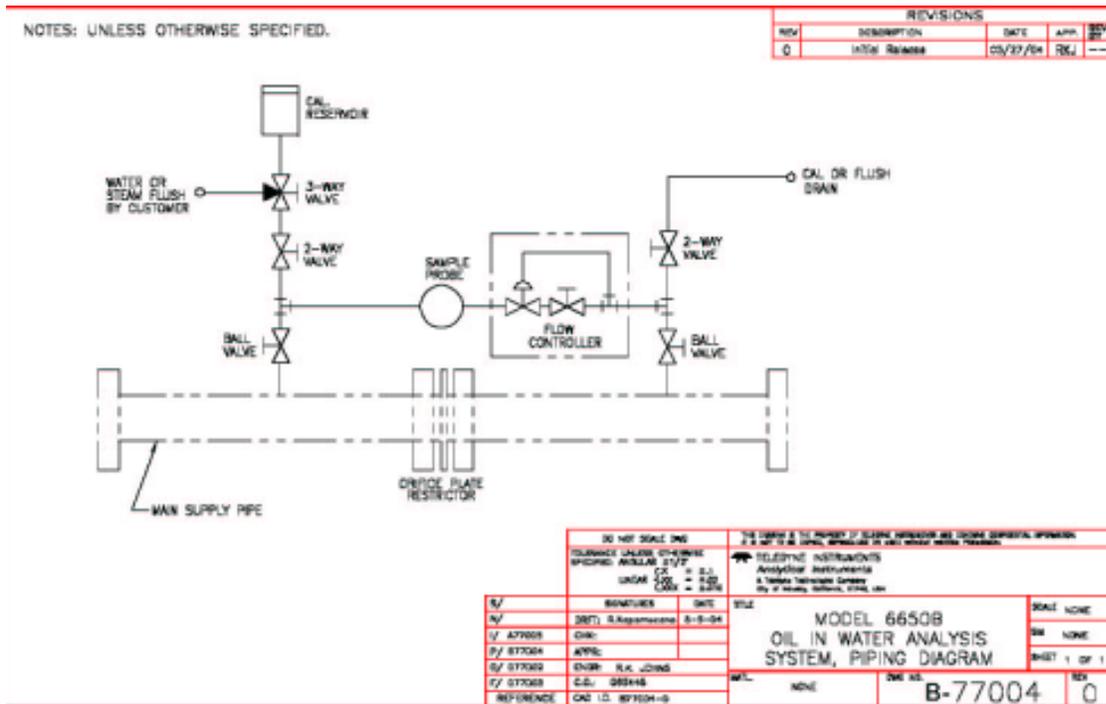


Photo of 6650 Insitu System (Produced Water)

